TROPICAL LEPIDOPTERA, 5(1): 43-53

# IMMATURE STAGES OF *EXELASTIS* PLUME MOTHS IN FLORIDA (LEPIDOPTERA: PTEROPHORIDAE: PLATYPTILIINAE)

**DEBORAH L. MATTHEWS[1], DALE H. HABECK[1], AND BERNARD LANDRY[2]**

[1]Department of Entomology and Nematology, IFAS, University of Florida, Gainesville FL 32611, USA; and
[2]Biological Research Division, CLBRR, Neatby Bldg., CEF,
Agriculture Canada, Ottawa, Ontario K1A OC6, Canada

**ABSTRACT**.– Last instar larvae and pupae are described for three plume moths, *Exelastis cervinicolor, E. rhynchosiae*, and *E. pumilio*. A key to the known larvae of this legume-feeding genus is given for Florida. The new combination *Exelastis rhynchosiae*, formerly *Stenoptilia*, is presented. Comparisons of the immature and adult characters of the three species are discussed to support the new combination.

**KEY WORDS**: *Adaina*, Africa, Arkansas, Asteraceae, Austral Is., behavior, biology, Borneo, Cayman Is., chaetotaxy, China, Compositae, Cuba, distribution, Ecuador, Fabaceae, *Fuscoptilia*, Galapagos Is., Gentianaceae, Haiti, hostplants, immature stages, India, Jamaica, larva, Leguminosae, Marantaceae, *Marasmarcha*, Marquesas, Maryland, morphology, Nearctic, New Caledonia, New Guinea, New Jersey, Oxalidaceae, plume moth, Pterophorinae, Puerto Rico, pupa, Ryukyu Is., Samoa, Society Is., Solomon Is., *Sphenarches*, *Stenoptilia*, Taiwan, Texas, *Tomotilus*, USA.

Plume moth larvae feed on a variety of plant families, but most use species of Asteraceae. Known larvae of a small group of species belonging to the genera *Exelastis* Meyrick (1907) and *Marasmarcha* Meyrick (1886) feed on species of Fabaceae (Meyrick, 1910). The systematics of these two genera is not well defined, and for several species, both generic names are found in synonymies. From the literature, there are apparently 16 known species of *Marasmarcha*, and 8 species of *Exelastis*. Of the 16 *Marasmarcha* species, 3 are known to feed on species of *Ononis* (Fabaceae) (Buszko, 1979; Bigot and Picard, 1983), including the type species *Marasmarcha phaeodactyla* (Hübner) [a junior synonym of *M. lunaedactyla* (Haworth)] (Gielis, 1988; Razowski, 1988). Larval hosts and immature stages are known for 4 species of *Exelastis*. The type species, *Exelastis atomosa* (Walsingham), is a well known tropical pest of the following leguminous crops: pigeon pea (*Cajanus cajan* (L.) E. Huth); red gram, arhar, or tur (*Cajanus indicus* Spreng.); and kulthi, lablab, or hyacinth bean (*Lablab purpureus* (L.) Sweet (= *Dolichos lablab* L.) (Fletcher, 1914, 1920, 1931).

In this paper we describe the immature stages and report larval hosts for 3 species that are native, but not restricted to Florida: *Exelastis cervinicolor* Barnes & McDunnough, *Exelastis rhynchosiae* (Dyar) **n. comb.**, and *Exelastis pumilio* (Zeller). Larvae of these species, like many pterophorids, have numerous setae on elevated protuberances or verrucae, as well as scattered short setae not on protuberances. As in most plume moth larvae, some or all of the setae have modified tips. *Exelastis* larvae can be recognized best by their host plants since these species, along with *Sphenarches anisodactylus* (Walker), are the only known legume feeders of the family in Florida. The polyphagous species, *S. anisodactylus*, is a pantropical pest of *Cajanus cajan* and *Lablab purpureus*, where these plants are major crops. In Florida the primary host of *S. anisodactylus* is the aquatic monocot *Thalia geniculata* L. (Marantaceae); the larva has not been found on any Fabaceae (Cassani *et al.*, 1990).

Larvae, but not pupae, of *Exelastis rhynchosiae* were briefly described by Dyar (1898). The larva and pupa are described in detail in this paper. *Exelastis rhynchosiae* has previously been included in the genus *Stenoptilia* and is here transferred to *Exelastis*. A discussion of characters supporting this change is given below. Florida larval hosts for *E. rhynchosiae* and *E. pumilio* were reported by Matthews *et al.* (1990). Fletcher (1921) reported *E. pumilio* larvae feeding on *Alysicarpus vaginalis* (L.) DC. (Fabaceae) and illustrated the adult, larva, pupa, and host, but did not actually describe the immature stages. Descriptions of larvae and pupae of *E. pumilio* and *E. cervinicolor*, and host records for *E. cervinicolor* are presented here for the first time. A key to known last instar *Exelastis* larvae in Florida is provided and comparisons of larval and pupal morphology are made between the three species.

## METHODS

Larval and pupal descriptions are based on live observations and examination of preserved material with a dissecting microscope. In addition, details of setal morphology and head chaetotaxy were studied using scanning electron microscopy (SEM). Material used for scanning electron microscopy was killed in boiling water and preserved in 70% isopropyl alcohol. All SEM material was dehydrated in an ethanol series of 70%, 80%, 90%, and 100% for 10-20 minutes each. Head capsules and mandibles were air dried. Whole larvae were transferred to 1:1 ethanol:


Fig. 1-8. 1. *Exelastis pumilio* larva on *Desmodium incanum* shoot; 2. *E. pumilio* pupa, dorsal view; 3. *E. pumilio* pupa, lateral view; 4. *E. cervinicolor* larva, dors
view; 5. *E. rhynchosiae* larva, lateral view; 6. *E. cervinicolor* pupa, dorsal view; 7. *E. rhynchosiae* larva, dorsal view, with feeding damage on *Rhynchosia cinerea* le
8. *E. rhynchosiae* pupa, dorsal view.

amyl acetate for 5-20 minutes and then 100% amyl acetate for at least 24 hours. Specimens were then critical point dried using a Denton DCP-1 critical point dryer. All samples were mounted on aluminum stubs using mounting tape or wet silver paint and coated with a gold-palladium alloy using a Denton Vacuum Desk II cold sputter/etch unit. Specimens were examined and Polaroid photomicrographs taken with a Hitachi 570 SEM at 10-15 kV and 30-32mm working distance.

Setal nomenclature and abbreviations for segments follow Stehr (1987) and Heinrich (1916). The terms short, medium, and long are often used in setal descriptions; these terms are relative to the species being described. Generally, primary setae are long and secondary setae are shorter. When primary setae are referred to as being medium or short, they are being compared to the longest setae elsewhere on the larva. Setae referred to as normal are smooth and have a pointed tip or apex. Several types of modified setae are illustrated. The terms spatulate, bifurcate, and tined refer to the modified tip or apex only (Figs. 9, 20, 22, 24).

**Exelastis cervinicolor** (Barnes & McDunnough)

## IMMATURE STAGES

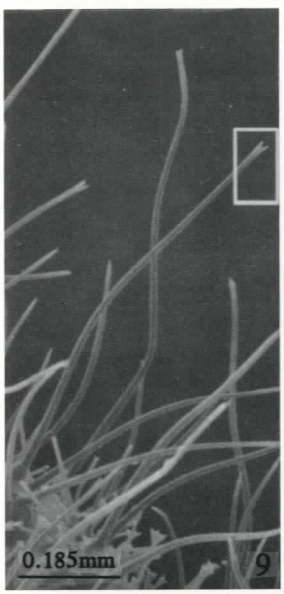
FINAL INSTAR LARVA (Figs. 4, 10, 13, 16, 19-20, 25).– Head translucent greyish yellow. Body light green with dark green mid-dorsal line. Mid-dorsum bordered by raised ivory longitudinal ridge bearing dorsal setae. Body covered with conspicuous bifurcate primary and secondary setae (ventral and head setae normal). Primary setae mostly light brown; secondary setae usually translucent. Setae arranged on verrucae but scattered bifurcate secondary setae also present. Maximum body length 9mm.

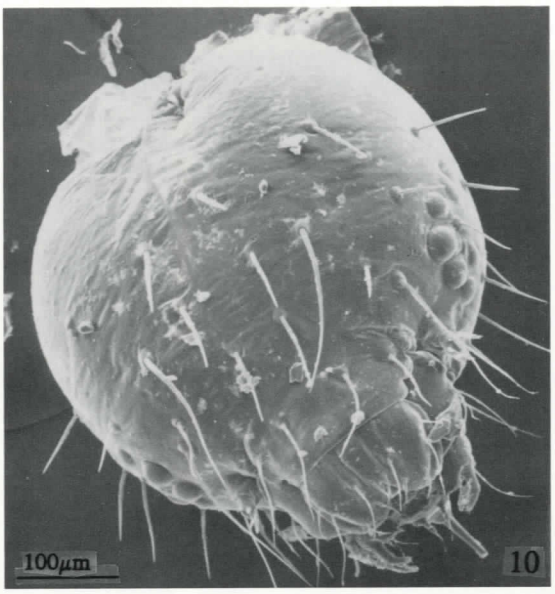
*Head*: Fig. 10. Mean width 0.49 ± 0.04mm (n = 41). Hypognathous. Adfrontals extend to epicranial notch. Frontoclypeus extends 0.80 to epicranial notch. Mandibles 5-toothed, first tooth subtended by ridge (Fig. 16). Labral notch acutely V-shaped. Six labral setae present. Labrum with furrow extending from base to seta M1, between M1 and M2 (Fig. 13). Seta M2 longer than M1. M2 dorsad of M1 and M3. M3 ventrad of M1 and in line with M2 (not posteriad as in E. pumilio). Head setae on slightly elevated pinacula. Setae AF2, AF1, F1, C1 about equal in length and nearly forming straight line but with AF1 and C1 slightly posteriad of AF2 and F1. P1 directly posteriad of AF1. P2 midway between AF2 and AF1. Length of A1 > A2 > A3. Frontal pores inconspicuous. Six stemmata present arranged in tight semicircle; 3-5 particularly close together. Stemmata 3 and 1 largest in diameter. Stemma 1 flattened and inconspicuous. Base of seta S1 posterior and ventral to stemma 2. S2 posteriad of stemma 1. Seta S3 equidistant from stemmata 5 and 6.

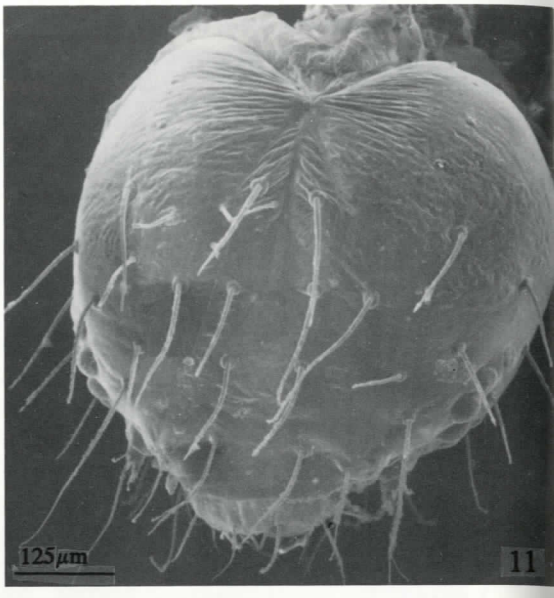
*Thorax*: Prothorax lacking conspicuous shield. Setae XD1, XD2, and SD1 normal (apex not tined or bifurcate) and forming nearly straight line. T1 dorso-anterior margin also with fringe of normal secondary setae just anteriad of XD1, XD2, and SD1; these secondary setae variable in length but not exceeding 0.75 length of XD setae. Seta D1 tined or bifurcate, about 0.75 length of D2. Seta D2 normal. Seta SD2 bifurcate, posteriad of SD1 and ventrad and slightly anteriad of D1 and D2. Area between XD and D setae, and area posteriad of D setae with numerous bifurcate secondary setae, these setae variable in length but distinctly shorter than primary setae (Fig. 19). Prothorax with 3 distinct primary L setae on verruca with normal and bifurcate secondary setae. Anterior 2 L setae and secondary setae on anterior margin normal. Posterior L seta 0.67 length of other 2 L setae and bifurcate as are secondary setae on posterior margin. Prothoracic spiracle round, distinctly elevated, and with lightly sclerotized peritreme. SV-verruca with about 10 setae; 2 central setae with elevated bases and distinctly longer than others, apparently primary. Most setae normal except for one or more bifurcate and/or spatulate setae on posterior side of verruca. Scattered bifurcate secondary setae (Fig. 20) numerous posteriad of SV-verruca. Seta V1 and secondary setae on leg short and normal. Segment T2 with D1 and D2 on common verruca with shorter secondary setae. All setae on D-verruca bifurcate. A smaller, often inconspicuous verruca with several bifurcate secondary setae present posteriad of D-verruca. Scattered short, bifurcate secondary setae present, most are translucent but those along dorsal midline as dark as primary setae. Setae SD1 and SD2 on common verruca with many secondary setae; all setae on SD-verruca bifurcate to minutely tined. L-verruca on T2 similar to one on T1 but with primary setae more widely spaced and with more secondary setae; nearly all setae bifurcate. SV-verruca on T2 with more setae than that on T1. Segment T3 similar to T2 but lacking small verruca posteriad of D-verruca.

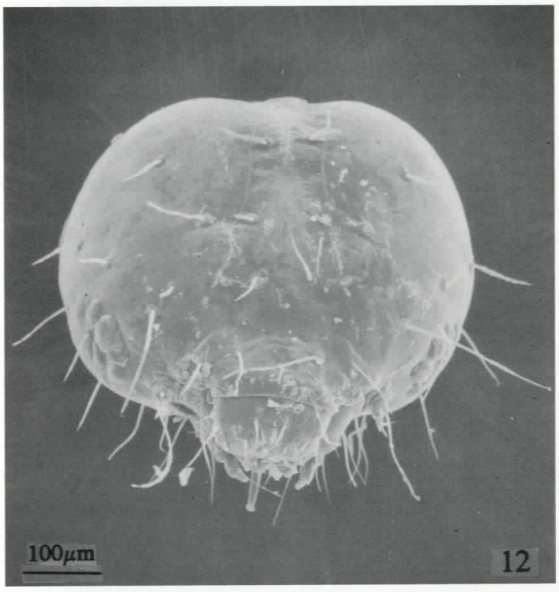
*Abdomen*: Segments A1-A7 each with 8 verrucae. Setae D1 and D2 on separate verrucae with secondary setae; primary and secondary setae bifurcate. D2-verruca posteriad of D1-verruca. SD-verruca with about 9-12 bifurcate setae, at least one primary seta distinguishable (Fig. 25). Primary and secondary setae difficult to distinguish on remaining verrucae. Scattered bifurcate secondary setae also present, those near dorsal midline dark. Spiracles round, with lightly sclerotized peritremes, not elevated as on T1. One large L-verruca with 2 primary setae and about 10-15 bifurcate secondary setae ventrad of spiracle. A smaller verruca, with about 10 bifurcate setae posteriad of each spiracle. Another small verruca with about 7 bifurcate to minutely tined setae posteriad and slightly ventrad of larger L-verruca. Two verrucae present in subventral area, the most dorsal of the 2 bearing seta L3 and about 10 secondary setae; setae on verruca mostly normal, a few minutely tined or bifurcate. The most ventral verruca (just above proleg on A3-A6) with about 6 normal setae. Seta V1 normal. Planta of prolegs on A3-A6 long and cylindrical, 4 (occasionally 5) crochets arranged in a mesopenellipse. Segment A8 similar to A7 but verrucae with fewer setae; D1-and D2-verrucae distinguishable but joined, and 2 small verrucae posteriad of spiracle and posteriad of larger L-verruca absent. Spiracle on A8 slightly elevated with wide peritreme. Segment A9 with D1 and D2 on common verruca, D1 bifurcate, D2 normal and longer than D1. One SD-verruca with about 9 setae (including normal, minutely tined, and bifurcate), 1 normal SV seta, and V1 normal on A9. Segment A10 lacking distinct verrucae, anal plate with 4 primary setae and numerous bifurcate secondary setae. Of the primary setae, D1 is bifurcate, D2 much longer than D1 and normal or minutely tined, SD seta bifurcate, and SD2 normal. Anal proleg with many normal setae and 4 crochets.

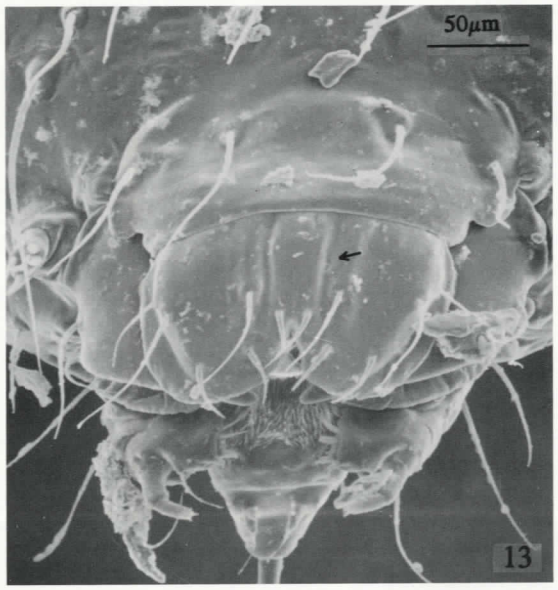
PUPA (Fig. 6).– Maximum length 8.5mm. Light green with long white primary setae (seta length over 0.50 body width). Entire body densely covered with short spinule-like setae arising from transverse striations. Dorsum of metathorax and abdominal segments with white elevated ridge formed by elongate verruca-like protrusions bearing primary and secondary setae. Dark green mid-dorsal stripe forming broken band along abdomen. Head with several short setae. Frontal area with 4 or more setae and 2 median setae. Clypeus with 3-5 setae. Labrum with 1 seta. Glazed eye piece with 8 or more setae. Sculptured eye piece lacking setae. Labial palpus and maxilla lacking setae. Antenna with several short setae at base and a single row of short setae along entire length. Forewing with similar rows of setae marking margins and veins. Exposed part of hindwing with one row of short setae. Prothorax with 3 medium length setae. Mesothorax with 4 long setae. Dorsum of metathorax with 3 long setae. Spiracles on A2-A7 ovate with sclerotized peritremes. A8 spiracle apparently lacking. Abdomen with a long seta directed posteriorly on dorsal ridge of each segment. Several additional setae on dorsal ridge, variable in length. Two medium to

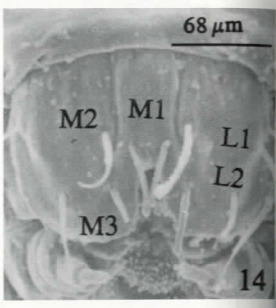


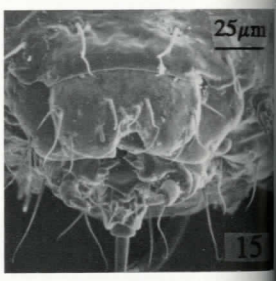



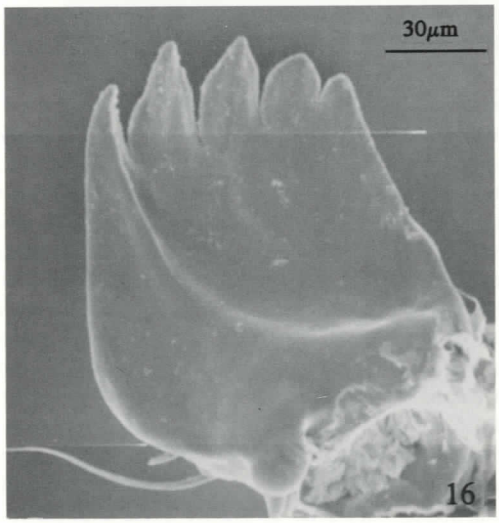



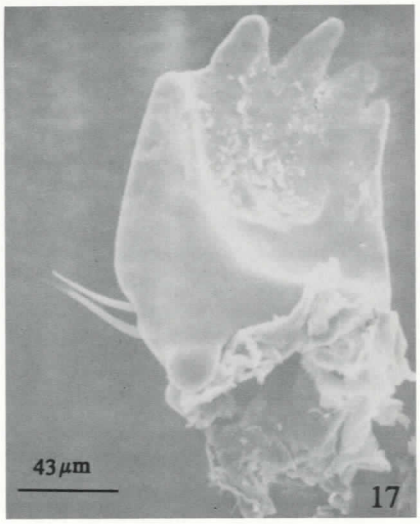



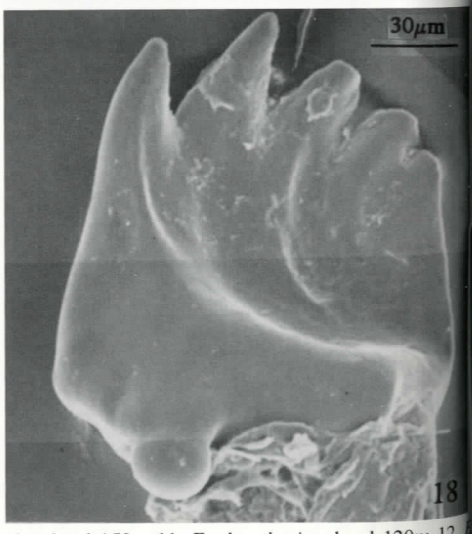




Fig. 9-18. 9. *Exelastis rhynchosiae*, long primary setae, 81x, box shows minutely tined tip; 10. *E. cervinicolor*, head 150x; 11. *E. rhynchosiae*, head 120x; 12. *E. pumilio*, head 110x; 13. *E. cervinicolor*, labrum 300x, arrow shows labral furrow; 14. *E. rhynchosiae*, labrum 220x; 15. *E. pumilio*, labrum 150x; 16. *E. cervinicolor*, left mandible, mesal view 500x; 17. *E. rhynchosiae*, left mandible, mesal view 350x; 18. *E. pumilio*, left mandible, mesal view, 400x.

short subdorsal setae dorso-posteriad of spiracle. Two lateral setae ventro-posteriad of spiracle. An additional seta ventrad of 2 lateral setae on A4-A6. Posterior margin of segments with ring of medium to short setae, these setae longer than spinule-like setae that cover cuticle. Cremaster and ventral juncture of A7, A8, and A9 with patch of hook-tipped setae.

**Material Examined**.– FLORIDA.– *Hernando Co.*: Withlacoochee St. For., Croom Wildlife Management Area 13-14 Jul 1991 (36 larvae, 4 pupae), 25 Aug 1991 (30 larvae, 2 pupae), D. Matthews & T. A. Lott, on leaves of *Rhynchosia minima*. *Dade Co.*: Homestead, 23 Jan 1992 (1 larva), D. Matthews & J. Gillmore, on leaves of *Rhynchosia minima*; Florida Turnpike, between mile marker 27 & 26, 11 Dec 1991 (1 larva), D. Matthews & J. Gillmore, on leaves of *Rhynchosia minima*.

ECUADOR.– *Galapagos Is.*: Pinta 13-14 Mar 1992, B. Landry, on *Rhynchosia minima* (3 larvae, 1 pupa).

**Distribution**.– Florida: Citrus, Collier, Dade, Flagler, Hernando, Manatee, and Monroe Counties. Outside Florida: Cayman Brac and Haiti. Landry and Gielis (1992) reported this species from the Galapagos Islands.

**Hosts and Biology**.– Larvae feed on leaves and shoots of *Rhynchosia minima* (L.) DC. More larvae were found on small seedling plants than on older vines. In South Florida the host may be found throughout the year and one larva was found in Dade Co. in January. In northern and central Florida, the host dies back in the winter. Larvae may be found throughout the summer but the overwintering stage is unknown. There are 4 larval instars. Pupation occurs on the leaves.

**Exelastis rhynchosiae** (Dyar), **n. comb.**

## IMMATURE STAGES

FINAL INSTAR LARVA (Figs. 5, 7, 9, 11, 14, 17, 26).– Larvae were first described by Dyar (1898) but are redescribed here and compared with the larvae of *E. cervinicolor*. Head light yellow. Body light green with primary and secondary setae arranged on lighter colored verrucae. Also numerous secondary setae not on verrucae. Most primary setae with minutely tined tips (Fig. 9). Smaller secondary setae spatulate (Fig. 22) or cone-tipped (Fig. 21). Maximum length 9mm.

*Head*: Figure 11. Mean width 0.59 ± 0.02mm (n = 10). Hypognathous. Adfrontals extending to epicranial notch. Frontoclypeus extends 0.75 to epicranial notch. Mandibles 5-toothed; first tooth subtended by ridge but rounded and smaller than other teeth (Fig. 17). Labrum as in *E. cervinicolor* including furrow between seta M1 and M2 but with setae M1 and M2 similar in length (Fig. 14). Setal arrangement of head nearly identical to *E. cervinicolor* but setae proportionally longer in *E. rhynchosiae*. Stemmata as in *E. cervinicolor*.

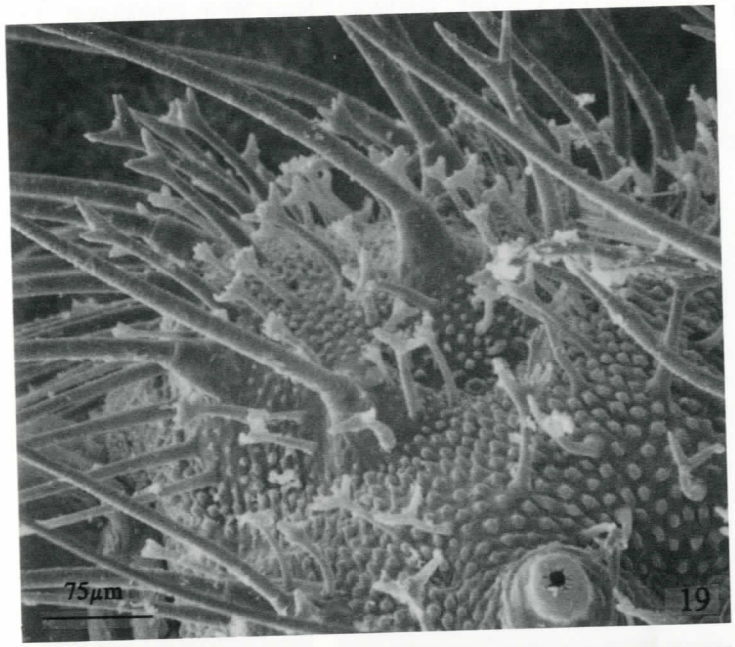
*Thorax*: Prothorax without shield. Dorsal and lateral cuticle surface covered with short cone-tipped and spatulate setae (Fig. 21). Scattered medium length, normal secondary setae also present. Primary setae difficult to distinguish from normal secondary setae. Primary setae usually with slightly elevated bases and about 0.25 longer than longest secondary setae. Dorso-anterior margin of T1 with dense fringe of normal secondary setae. Setae XD1, XD2, and SD1 in line within fringe setae. Seta D1 posteriad of XD1, about 0.67 from T1 anterior margin, slightly shorter than D2. Seta D2 ventrad and slightly anteriad of D1. Seta SD2 posteriad and ventrad of SD1. L-verruca with 3 primary and about 7 secondary setae, all normal. SV-verruca with about 11-15 normal setae. Three short setae at coxa base near meson. Segment T2 with D1 and D2 on same verruca with 10 or more secondary setae. Secondary setae tips minutely tined; tined or spatulate tips more evident on shorter setae. Primary setae on T2, T3 and abdominal segments inconspicuously tined unless specified. Six or fewer setae arising from a slightly elevated verruca-like ridge posteriad of D-verruca on T2. D- and SD-verrucae appressed or nearly joined at base. Distance between SD-verruca and L-verruca much less than between L-verruca and SV-verruca. SD-, L-, and SV-verrucae with many setae. Segment T3 similar to T2 but lacking verruca-like ridge posteriad of D-verruca.

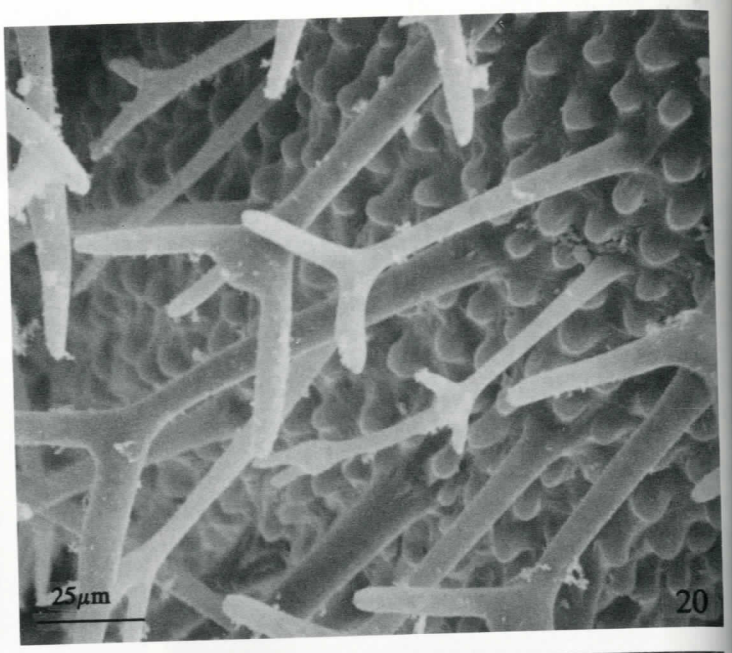
*Abdomen*: Segments A1-A7 each with 7 verrucae, arrangement of these similar to *E. cervinicolor* larva. Setae D1 and D2 on separate verrucae. D1-verruca with 10 or more setae, D2-verruca with 8 or more setae. D2-verruca posteriad and slightly ventrad of D1-verruca. SD-verruca dorsad of spiracle with at least 12 setae. Spiracle round with lightly sclerotized peritreme. At least 6 setae present on small verruca posteriad of each spiracle and small verruca posteriad of L-verruca. L-verruca ventrad of spiracle with about 15 setae (Fig. 26). Most dorsal of 2 verrucae in SV area with about 10 setae; most ventral verruca with about 6 setae. Prolegs as in *E. cervinicolor* but with 5-8 crochets. Seta V1 normal. Segment A8 similar to A7 except D1- and D2-verrucae joined at base, spiracle peritreme wider, and small verrucae posteriad of spiracle and posteriad of L-verruca absent. Two most ventral verrucae in SV area replaced by 1 normal seta. Segment A9 with 1 D, 1 SD, and 1 L verruca. One normal seta in SV position. Segment A10 with 5 long setae and many setae of variable length. Proleg with many short normal setae, crochets as on A3-A6.

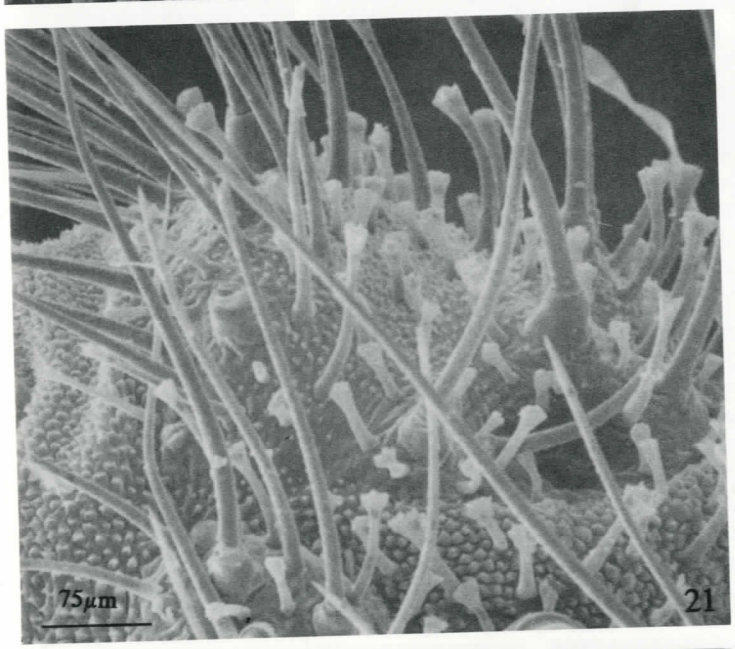
PUPA (Fig. 8).– Maximum length 8mm. Light greenish yellow, covered with cream colored variable length spinule-like setae as in *E. cervinicolor*. Primary setae length shorter than in *E. cervinicolor*, not exceeding 0.50 body width and difficult to distinguish from longest spinule-like setae. Head with front and clypeus covered with short spinule-like setae, primary setae indistinguishable. Labrum with 2 setae. Glazed eye piece also covered with numerous spinule-like setae; sculptured eye piece naked. Maxilla with a few minute setae near base. Labial palpus with longitudinal row of minute setae. Antenna and wings with longitudinal rows of setae as in *E. cervinicolor*. Dorsum of thorax with primary setae arranged as in *E. cervinicolor* but barely distinguishable from longer spinule-like setae. Dorsum of abdomen with longitudinal ridge formed by elongate verruca-like protrusions as in *E. cervinicolor*, but ridge less conspicuous than in *E. cervinicolor*, and concolorous with body. Many spinule-like setae of abdomen arising from transverse striations; spinule-like setae longest on posterior margins of each segment. Spinule-like setae on mid-dorsal line forming distinct single row (A3-A9); posterior seta of row on A3-A8 distinctly longer than other setae of mid-dorsal row. Spiracle on A2-A7 lacking sclerotized peritreme. A8 spiracle apparently lacking as in *E. cervinicolor*. At least 1 SD and 2 L setae present on abdomen but not distinctly longer than spinule-like setae. Cremaster and ventral junction of A7, A8, and A9 with hook-tipped setae as in *E. cervinicolor*.

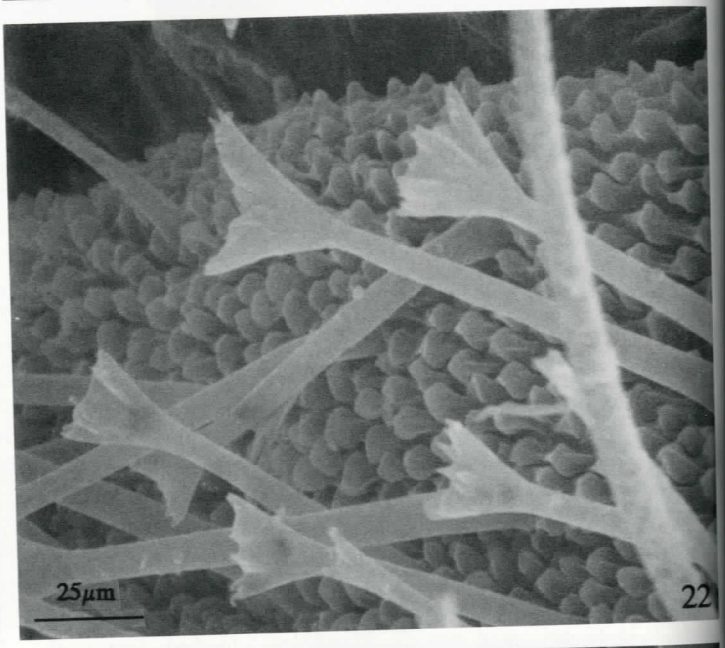
**Material Examined**.– FLORIDA.– *Clay Co.*: W. side of SR 21 near Deer Spring Rd. 13 Sep 1990 (1 larva, 1 pupal case), D. Matthews & J. Gillmore; 10 Nov 1990 (1 larva) pres. 17 Nov 1990, D. Matthews & T. A. Lott; 21 Jul 1991 (1 larva) pres. 30 Jul 1991, D. Matthews & T. A. Lott. *Marion Co.*: East Silver Springs Shores, 10 Aug 1991 (3 larvae, 1 pupa), D. Matthews & T. A. Lott; 3 Oct 1991 (1 larva), D. Matthews & J. Gillmore; 24 Jun 1992 (3 larvae), D. Matthews & J. Gillmore; 1 Jul 1992 (2 larvae), D. Matthews, T. A. Lott, D. W. Hall, J. Gillmore, & R. L. Goodson; 18 Sep 1992 (2 larvae), R. L. Goodson & J. Gillmore; Ocala Natl. For. 5.7mi. N. of Hwy 314a on 314 11 May 1991 (3 larvae, 1 pupal case), D. Matthews & T. A. Lott; 28 Sep 1991 (1 larva), D. Matthews & T. A. Lott. All material examined was collected on leaves of *Rhynchosia cinerea*.

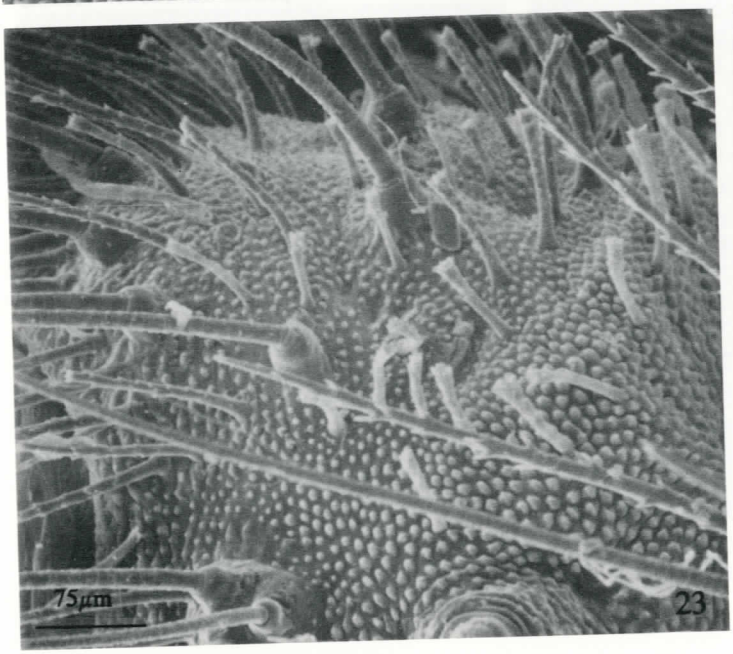
**Distribution**.– FLORIDA: Clay, Dade, Hillsborough [Kimball (1965) record], Marion, and Putnam Counties. ARKANSAS: Washington Co. (record from USNM adult specimens).

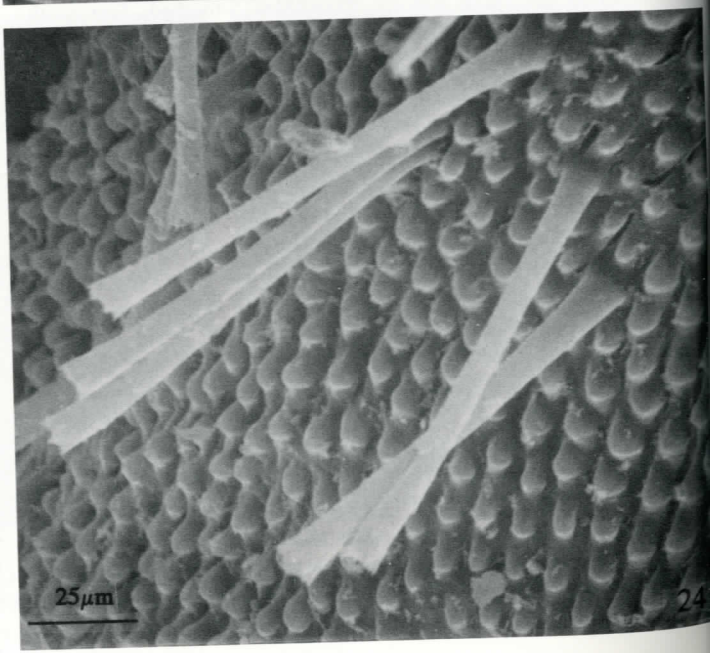

75μm
19


25μm
20


75μm
21


25μm
22


75μm
23


25μm
24

**Hosts and Biology**.– Dyar's holotype (1898) was reared from a larva feeding on the young leaves of *Rhynchosia*, but the host species was not determined. Recent specimens have been collected as larvae and pupae on ashy rhynchosia, *Rhynchosia cinerea* Nash. Most have been collected in turkey oak sandhill habitats. This species probably overwinters as larvae in the northern parts of its range; larvae have been found as late as 17 November. Dyar's specimens from Miami were collected in December as larvae but emergence dates were not reported.

### **Exelastis pumilio** (Zeller)

## IMMATURE STAGES

FINAL INSTAR LARVA (Fig. 1, 12, 15, 18, 23-24, 27-28).– Head yellowish. Body usually green with diffuse white longitudinal stripes or entirely reddish purple if feeding on flowers. Body covered with long translucent setae on verrucae. Primary setae normal but the secondary setae on verrucae are barbed (Fig. 28). Short secondary setae on verrucae or scattered on cuticle with slightly expanded instead of pointed tips. Secondary setae less numerous than on *E. cervinicolor* or *E. rhynchosiae*. Maximum body length 8mm.

*Head*: Fig, 12. Mean width 0.55 ± 0.04mm (n = 27). Hypognathous. Adfrontals extending to epicranial notch. Frontoclypeus extends 0.83 to epicranial notch. Mandibles with 5 teeth, first and third subtended by a ridge (Fig. 18). Labral notch V-shaped, extending over one-third length of labrum. Six labral setae present. M2 dorsad of M1 and M3. M3 ventrad of M1 and posteriad of M2 (Fig. 15). Setae on raised pinacula and positioned as in *E. cervinicolor*. AF2, AF1, F1, and C1 about equal in length. P1 longer than P2. A2 about one-fourth length of A1 and anteriad of A1. A3 about one-half A1 length, anteriad and dorsad of stemma 2. Stemmata and stemmatal setae as in *E. cervinicolor* but stemma 2-5 closest together.

*Thorax*: Prothoracic shield inconspicuous. Setae XD1, XD2, SD1 forming straight line, elevated, sclerotized bases distinct from secondary setae. Several secondary setae present, lengths variable. Shorter secondary setae with slightly expanded tips (Fig. 24). Seta D2 ventrad but not posteriad of D1. Seta SD2 posteriad and slightly ventrad of SD1. Prothoracic spiracle round with peritreme lightly sclerotized. L-verruca on T1 with about 8 setae; L1, L2, and L3 distinct as longer, unbarbed setae with sclerotized bases. SV-verruca on T1 with about 9 setae, 2 with sclerotized bases. Segments T2 and T3 with one D-verruca with 8 setae. Segment T3 with 2 secondary setae posteriad of D-verruca. A few short scattered secondary setae with slightly expanded tips also present. SD-verrucae with 9 setae (2 long and not barbed). L-verruca similar to and ventrad of SD-verruca. SV-verrucae on T2 and T3 with 9-10 setae, including 2 primary. V1 on T1-T3 indistinct from secondary setae on legs.

*Abdomen*: Segments A1-A8 with D1- and D2-verrucae separate, D2-verruca posterior and ventrad of D1-verruca. Both verrucae with 6-9 setae. Segment A9 with one D-verruca. SD-verruca on A1-A9 with 6-12 setae. A small inconspicuous verruca with 5-6 setae present posteriad of main SD-verruca on A1-A7. Scattered short secondary setae with slightly expanded tips present (Fig. 24, 27). Spiracles on A1-A9 round with lightly sclerotized peritremes, those of A9 twice diameter of others. L-verrucae on A1-A9 with 8-9 setae. An additional small verruca with about 5 setae posteriad of L-verruca on A1-A8. A third verruca in lateral area on A1-A8 ventral and posterior to main L verruca, and with 6-8 setae. SV-verruca on A1-A7 with 6-7 setae. A single SV seta present on A8. SV-verruca on A3-A6 anterior to proleg. Prolegs on A3-A6 peglike but shorter than in *E. cervinicolor* and *E. rhynchosiae*, with 8-9 crochets arranged in a mesopenellipse. Anal prolegs with 11 crochets arranged in a mesopenellipse. All prolegs with an inconspicuous sclerotized dot in center of crochet ellipse. Seta V1 present on A1-A9. Anal plate with about 12 pairs of setae.

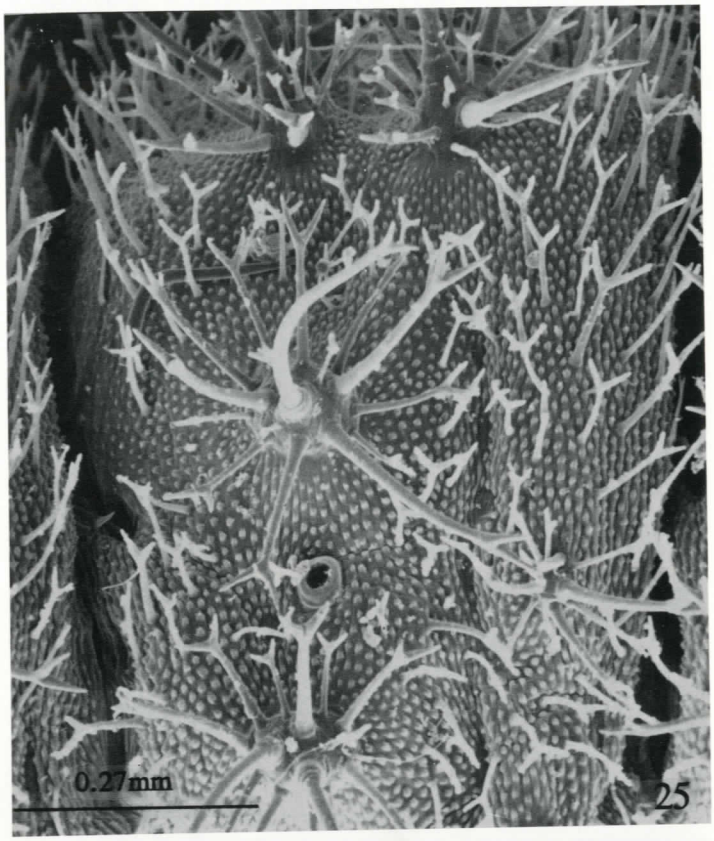
PUPA (Fig. 2-3).– Maximum length 8mm. Light green with long white setae. A conspicuous purple mid-dorsal longitudinal stripe present on A1-A9. Cuticle lacking spinule-like setae, but transverse striations present. Front of head with 1 seta. Clypeus and labrum naked. Glazed eye piece with 1 seta near maxilla base; sculptured eye piece lacking setae. Maxilla and labial palpus also without setae. Antenna with 8-9 setae in longitudinal row at base; distal portion naked. Forewing with longitudinal row of setae on anal margin, setae extend to posterior margin of A1. Hindwing naked. Dorsum of T1 with 3 long setae (over 0.50 body width); T2 with 4 long setae and several shorter setae; T3 with 3 long setae. Dorsal ridge extending from T2 to A10, broken on A4-A7 where D-verruca is more round than elongate. Abdominal segments with 4-6 setae on D-verruca ridge; 1 apparently primary D seta over 2 times length of other setae on ridge/verruca. One long SD seta on A1-A8 on slightly elevated ridge. Spiracle on A2-A7 with lightly sclerotized peritreme. Spiracle on A8 inconspicuous, more posterior and slightly dorsal than on A7. Segments A2-A3 with 2L setae; A4-A8 with 3 L setae. Venter of A4-A7 with 3-4 setae. Hook-tipped setae as in *E. cervinicolor* and *E. rhynchosiae*.

**Material Examined**.– FLORIDA.– *Alachua Co.*: Gainesville UF campus near Bivens Arm 25 May 1989 (2 larvae, 1 pupa), T. A. Lott. on leaves of *Desmodium incanum*; Gainesville-UF Agronomy Farm 1 Sep 1981 (1 larva), C. Wiboon, leaves of *Desmodium tortuosum*; near Hawthorne 14 Sep 1988 (2 larvae), D. Matthews & J. Gillmore, on leaves of *Desmodium incanum*; NE of Gainesville Airport 13 Sep 1988 (4 larvae), D. Matthews, on leaves of *Desmodium incanum*; near Santa Fe River Boatramp off Hwy 441 10 Sep 1989 (18 larvae), D. Matthews & T. A. Lott, on leaves of *Desmodium incanum*. *Columbia Co.*: 1 Oct 1975 (1 larva), J. R. Mangold. *Hendry Co.*: Felda, Church Rd. & SR 82 16 Oct 1988 (1 larva), T. A. Lott, on leaves of *Desmodium incanum*. *Hernando Co.*: Withlacoochee St. For., Croom Wildlife Management Area 13-14 Jul 1991 (3 larvae), D. Matthews & T. A. Lott, on leaves of *Desmodium incanum*. *Leon Co.*: Tall Timbers Res. Sta., SR 12 near Lk. Iamonia 30 Sep 1989 (16 larvae), D. Matthews & T. A. Lott, on flowers of *Desmodium tortuosum*. *Madison Co.*: Madison 6 Oct 1980 (2 larvae), A. Yao. *Marion Co.*: Ocala Natl. For., Juniper Springs 4 Jun 1988 (15 larvae, 1 pupa), D. Matthews & T. A. Lott on new leaves of *Desmodium incanum*. *Putnam Co.*: Interlachen 14 Sep 1988 (11 larvae), D. Matthews & J. Gillmore, on leaves of *Desmodium incanum*, 25 Aug 1988 (2 larvae), D. Matthews, T. A. Lott, & J. Gillmore, on leaves of *Desmodium incanum*; near Interlachen 20 Aug 1988 (5 larvae), D. Matthews & T. A. Lott, on leaves of *Desmodium incanum*

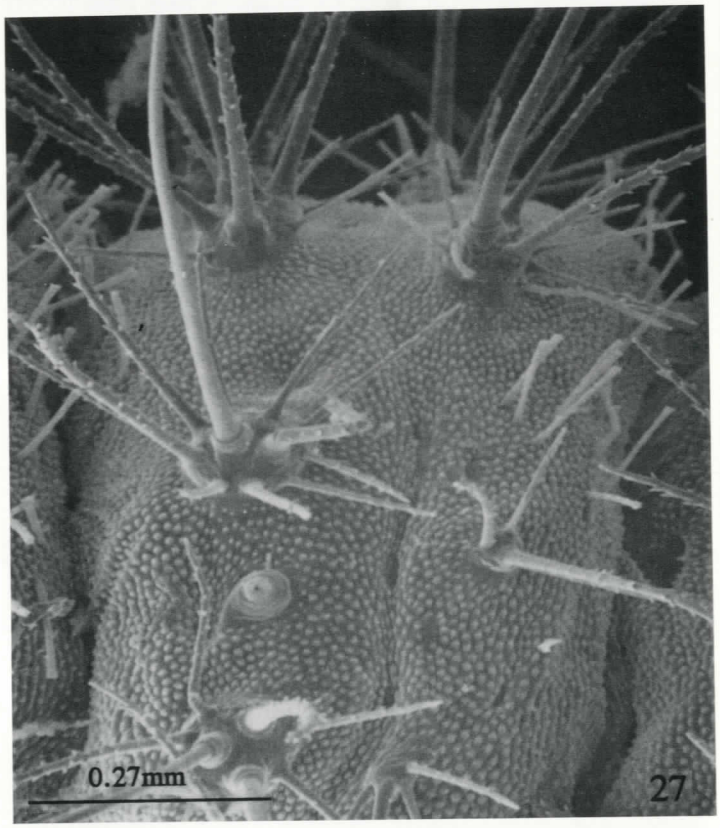
ECUADOR.– *Galapagos Is.*: Isabela, Volcan Darwin, 300m 15 May 1992 (8 larvae, 3 pupae), B. Landry on *Desmodium glabrum* Mill. DC.

**Distribution**.– This species is very common and occurs throughout Florida. USNM adult specimens examined were from Arkansas, New Jersey, Maryland, Texas, New Caledonia, Jamaica, and India. Wolcott (1936) reported this species from Puerto Rico and Kimball (1965) indicated its presence in Cuba. Barnes and Lindsey (1921) included China and Africa, and Yano (1963) reported Ryukyu Is., Taiwan, Borneo, Bismarck Arch., Solomon Is., Society Is., Austral Is., Samoa, Marquesas Is., and New Guinea in the distribution of *E. pumilio*. Landry collected this species from the Galapagos Islands.

Fig. 19-24. 19. *Exelastis cervinicolor*, prothorax dorsum, lateral view 200x; 20. *E. cervinicolor*, scattered secondary setae 600x; 21. *E. rhynchosiae*, prothorax dorsum, lateral view 200x; 22. *E. rhynchosiae*, scattered secondary setae 600x; 23. *E. pumilio*, prothorax dorsum, lateral view 200x; 24. *E. pumilio*, scattered secondary setae 600x.







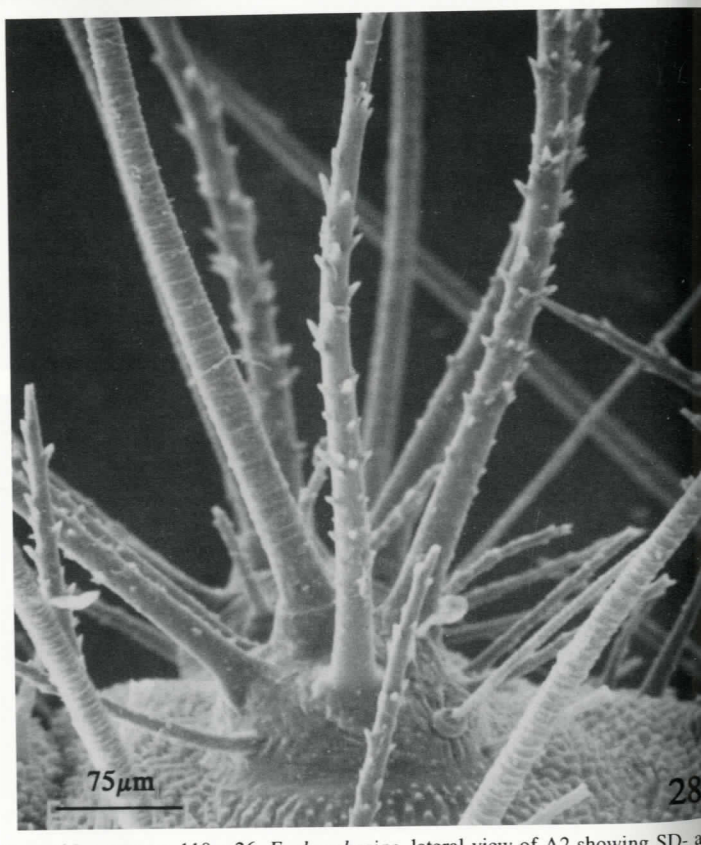




Fig. 25-28. 25. *Exelastis cervinicolor*, lateral view of A2 showing spiracle, D-, SD-, and L-verrucae, 110x; 26. *E. rhynchosiae*, lateral view of A2 showing SD- a L-verrucae, 110x; 27. *E. pumilio*, lateral view of A1 showing spiracle, D-, SD-, and L-verrucae, 110x; 28. *E. pumilio*, D1 verruca of T3 showing central primary s with transverse striations surrounded by barbed secondary seta, 200x.

**Hosts and Biology**.– Many specimens were collected as eggs and larvae and reared on *Desmodium incanum* (Fabaceae), a plant very common in disturbed areas. Adults were observed flying in copula in late afternoon and evening around the host plant. Females oviposit primarily in the evening hours on the young shoots of the host or on the undersurface of young leaves. Larvae feed on the shoots, skeletonize young leaves, or feed exclusively on the flowers. Larvae which have fed on flowers are often bright reddish purple while those feeding on leaves are light green. In Florida, *E. pumilio* larvae have also been found on *Desmodium tortuosum* (Sw.) DC., primarily on the flowers. In India, *E. pumilio* has been reared on *Alysicarpus vaginalis* (L.) DC. Fletcher (1921, 1931) and *Desmodium* sp. Fletcher (1931). Fletcher (1920) also reported *Oxalis* (Oxalidaceae) as a host, but in this case, pupae were found attached to upper surface of leaflets and no larvae were found feeding on the plant. Although Fletcher predicted the larvae feed on flowers of *Oxalis*, this is very unlikely since this plant is unrelated to the Fabaceae. Another unlikely record is *Ambrosia*. Barnes and Lindsey (1921) found one specimen of *E. pumilio* mixed with Murtfeldt's (1880) type series of *Adaina ambrosiae* (Murtfeldt). The type series label, identical to those on *A. ambrosiae* indicated the specimen was reared from *Ambrosia artemisiifolia* L. (common ragweed) (Asteraceae). There is little doubt that this was an error in labelling. Kimball (1965) perpetuated the record, and indicated *Ambrosia* as the host in Florida, with *Desmodium* the host in Cuba. As a result of this record, larvae of *Adaina ambrosiae* have been previously misidentified as *E. pumilio* in museum collections.

### Key to last instars of known *Exelastis* larvae of Florida

1. – Most primary setae (usually long central seta on verruca) conspicuously bifurcate; secondary setae also distinctly bifurcate . . . . . *Exelastis cervinicolor* (B. & McD.)
   – Most primary setae normal or inconspicuously tined (Fig. 9); secondary setae not bifurcate, setae normal, spatulate, cone-shaped, or slightly expanded, rarely bifurcate . . . . . 2

2. – Secondary setae on verrucae spicate or barbed (Fig. 28), tips normal; a few secondary setae not on verrucae; cuticle with visible naked areas . . . . . *Exelastis pumilio* (Zell.)
   – Secondary setae on verrucae not spicate or barbed, tips usually modified; many secondary setae not on verrucae; cuticle surface obscured by secondary setae . . . . . *Exelastis rhynchosiae* (Dyar)

## DISCUSSION

The chaetotaxy of the frontoclypeus, adfrontals, and stemmatal region of *E. cervinicolor, E. rhynchosiae*, and *E. pumilio* is nearly identical. Differences are only in relative lengths and forms of setae. In general, the head setae of *E. rhynchosiae* are longer than in the other two species. The arrangement, and relative diameters of stemmata also are similar among the three species. In all three species, stemma 1 is flattened and inconspicuous and stemma 3 is greatest in diameter. The arrangement of the labral setae is similar in the three species but in *E. pumilio*, seta M3 is ventral and posterior to M2 instead of directly ventrad of M2 as in *E. cervinicolor* and *E. rhynchosiae*. In *E. cervinicolor* and *E. rhynchosiae* the labral notch is acutely V-shaped while in *E. pumilio* it is more U-shaped. *Exelastis cervinicolor* and *E. rhynchosiae* both have a furrow from the labral base to a point between the bases of setae M1 and M2; there is no evidence of this furrow in *E. pumilio*. The mandibles of each species are similar in having 5 teeth but in *E. rhynchosiae* there is either reduction or considerable wear of tooth 1. *Exelastis pumilio* is unique in having a ridge subtending tooth 3 in addition to the main ridge of tooth 1.

The arrangement of primary setae and verrucae is similar in the three *Exelastis* species. Differences between the species include the number of setae per specific verruca, density of scattered secondary setae not on verrucae, and most importantly, the form of modified primary and secondary setae. Many plume moth larvae of the subfamilies Platyptiliinae and Pterophorinae have capitate (knob-tipped) secondary setae and unmodified primary setae, or both primary and secondary setae capitate, or glandular setae that exude sticky secretions. The setae of the three legume-feeding species studied are thick and blunt-tipped, spatulate, tined, bifurcate, and cone-tipped but not capitate or glandular. In *E. pumilio*, secondary setae on verrucae have normal tips but have barbed sides, while primary setae are normal with transverse striations (Fig. 28). Secondary setae of *E. pumilio* not on verrucae are apically thickened or blunt-tipped. Primary and long secondary setae on verrucae of *E. rhynchosiae* are unmodified and tined to minutely tined or forked. Most short secondary setae, not on verrucae, have triangular spatulate tips, many with receding middles that appear bifurcate (Fig. 22). Primary and secondary setae of *E. cervinicolor* are conspicuously bifurcate (Fig. 20, 25). In addition to setal characters, larvae of the three species differ in number of crochets per proleg. The prolegs of *E. pumilio* are considerably shorter than those of *E. cervinicolor* and *E. rhynchosiae* and there is a sclerotized dot in the center of the crochet mesopenellipse of *E. pumilio*.

The pupae of *Exelastis cervinicolor* and *E. rhynchosiae* have numerous spiculate processes or spine-like setae, most protruding from transverse ridges. Pupae of the two species can be distinguished by the mid-dorsal row of spicules in *E. rhynchosiae* and the long primary setae of *E. cervinicolor*. Although *E. pumilio* pupae have a similar arrangement of primary setae, transverse ridges, and a dorsal ridge bearing D-setae as in *E. cervinicolor* and *E. rhynchosiae*, they lack the short spine-like setae.

*Exelastis cervinicolor* and *E. rhynchosiae* share several immature characters not found in *E. pumilio*. These include the labral notch shape, median labral seta position, labral furrows, tined or bifurcate primary setae, and the spinule-like setae of the pupae. These characters, especially the tined or bifurcate setae that are apparent in Fletcher's illustrations (1914, 1920) of the type species *E. atomosa*, suggest *E. rhynchosiae* is congeneric with *E. cervinicolor*.

Adult characters supporting the placement of *E. rhynchosiae* in *Exelastis* can be found in the male genitalia although these look quite different from those of *E. atomosa* (Walsingham), the type-species of the genus. *Exelastis atomosa* is very closely related to *E. cervinicolor* as shown by the revolver shape of their aedeagus and by similarities in other male genitalia characters.

A thorough discussion of the male genitalia morphological features in support of this hypothesis is scheduled for a subsequent paper. In summary, with regards to similarities in the structure of the tegumen, uncus, valva, vinculum and associated modified sternite VIII, the placement of *E. rhynchosiae* in *Exelastis* is substantiated if one accepts the hypothesis that *E. rhynchosiae* is the most primitive species in relation to *E. pumilio, E. cervinicolor* and *E. atomosa.*

With regards to the female genitalia, no morphological features of phylogenetic significance are known to connect all four species. However, it can be demonstrated that *E. atomosa* and *E. cervinicolor* are closely related on the basis of the similar signa of the corpus bursae.

Wing venation (*E. atomosa* not studied) is the same in *E. pumilio, E. rhynchosiae* and *E. cervinicolor* except that in the forewing, $R_1$ is present only in *E. rhynchosiae*, which has larger forewing lobes. All four species have few markings on the forewing. The scales in the scale patches of the forewing are spatulate in *E. atomosa, E. cervinicolor* and *E. pumilio* but they are linear in *E. rhynchosiae*. The third hindwing lobe fringe is without scales in *E. pumilio* only. Scales in the third hindwing lobe fringe are present but narrow in *E. rhynchosiae*; the scales are spatulate in *E. atomosa* and *E. cervinicolor*. These wing features do not support the hypothesis that all four species are descended from a common ancestor. However, they do seem to indicate the closer phylogenetic relationship between *E. atomosa* and *E. cervinicolor* compared with the other two species.

*Exelastis* and *Marasmarcha* have received little attention in the past and need further study. In addition to other species, the monotypic genus *Tomotilus* Yano (1961) (type-species *T. saitoi* Yano) appears to be related to this legume-feeding group. Similarities can be found in the male genitalia and as in *E. atomosa* and *E. cervinicolor*, there are spatulate scales in the fringes of the hindwing third lobe. Yano (1963) illustrated larval characters including conspicuous bifurcate primary and secondary setae that, along with the leguminous host *Dunbaria villosa* Makino, further suggest this relationship. In addition to *Tomotilus*, Yano (1963) described the larvae and pupae of two other legume feeders, *Fuscoptilia emarginata* (Snellen) on *Lespedeza bicolor* Turcz. var. *japonica* Nakai and *L. cuneata* G. Don, and *Stenoptilia cretalis* (Meyrick) on *Desmodium racemosum* DC. The larva of *F. emarginata* is described by Yano (1963) as having long secondary setae with slightly forked tips. Yano (1963) placed both these species in the genus *Stenoptilia*. Arenberger (1991) later described the genus *Fuscoptilia*, making *F. emarginata* the type-species. The male genitalia of both *F. emarginata* and *S. cretalis* lack a cucullus on the valvae which is typical of true *Stenoptilia*. Known larvae of true *Stenoptilia* typically feed on species of Gentianaceae, not Fabaceae. Barnes and Lindsey (1921) regard *Marasmarcha* and *Exelastis* as phylogenetic descendants of *Stenoptilia* and several authors have placed these three genera closely together in classifications. Based on genitalia, larval morphology, and host preference, it is unlikely that *Stenoptilia* and *Exelastis* are closely related. As more information becomes available on the immature stages, *Exelastis, Tomotilus, Marasmarcha, Fuscoptilia*, and *Stenoptilia*, as well as all pterophorid genera should be examined further using cladistics. The species mentioned in this paper represent all the known legume feeding Pterophoridae found in published literature. As shown in this paper, larvae and pupae have many morphological characters of taxonomic significance.

## ACKNOWLEDGMENTS

The authors wish to thank Robin L. Goodson and J. Howard Frank for reviewing the manuscript. Terry A. Lott and Judy Gillmore assisted in the field. Harvey Cromroy and William Carpenter provided valuable instruction in SEM operation and specimen preparation. Florida Agricultural Experiment Station Journal Series No. R-03475.

## LITERATURE CITED

**Arenberger, E.**
1991. Pterophoridae aus Korea (Lepidoptera). *Zeit. Arbeitgemein. Österr. Ent.* (Vienna), 43(1/2):33-42.

**Barnes W., and W. Lindsey**
1921. The Pterophoridae of America, north of Mexico. *Contrib. Nat. Hist. Lepid. N. Amer.* (Decatur), 4:281-483.

**Bigot, L., and J. Picard**
1983. Lépidoptères Ptérophoridés du département des Bouches-du-Rhône et de la région de la Sainte-Baume (supplément au catalogue de P. Siépi). *Bull. Mus. Hist. Nat. Marseille*, 43:53-69.

**Buszko, J.**
1979. Pterophoridae. In *Klucze do Oznaczania Owadów Polski. 27. Lepidoptera*, 44:9-140. Warsaw: Polskie Towar. Ent. [In Polish]

**Cassani, J., D. H. Habeck, and D. L. Matthews**
1990. Life history of a plume moth *Sphenarches anisodactylus* (Lepidoptera: Pterophoridae). *Florida Ent.* (Gainesville), 73:257-266.

**Dyar, H. G.**
1898. Six new or little known larvae of Pterophoridae. *Psyche* (Cambridge, Ma.), 8:249-250.

**Fletcher, T. B.**
1914. *Some South Indian Insects and Other Animals of Importance considered Especially from an Economic Point of View*, 444-445, pl. xxxviii. Madras: Minist. Agric.
1920. Life-histories of Indian insects, Microlepidoptera, I. Pterophoridae. *Mem. Dept. Agric. India* (Calcutta), 6(1):1-31.
1921. Report of the Imperial entomologist. *Sci. Rep. Agric. Res. Inst.* (Pusa), 1920-21:41-59.
1931. *Catalogue of Indian Insects, Part 20. Alucitidae (Pterophoridae).* Calcutta: Govt. of India. 61pp.

**Gielis, C.**
1988. Provisional checklist and atlas of the plume moth fauna of Spain (Lepidoptera: Pterophoridae). *SHILAP Rev. Lepid.* (Madrid), 16(64):271-296.

**Heinrich, C.**
1916. On the taxonomic value of some larval characters in the Lepidoptera. *Proc. Ent. Soc. Washington*, 18:154-164.

**Kimball, C. P.**
1965. The Lepidoptera of Florida: an annotated checklist. *Arthropods of Florida and Neighboring Land Areas*, 1:1-363. Gainesville: Florida Dept. Agric.

**Landry, B., and C. Gielis**
1992. A synopsis of the Pterophoridae (Lepidoptera) of the Galá

gos Islands, Ecuador. *Zool. Verh.* (Leiden), 276:1-42.

**Matthews, D. L., D. H. Habeck, and D. W. Hall**

1990. Annotated checklist of the Pterophoridae (Lepidoptera) of Florida including larval food plant records. *Florida Ent.* (Gainesville), 73:613-621.

**Meyrick, E.**

1886. On the classification of the Pterophoridae. *Trans. Ent. Soc. London*, 1886:1-21.

1907. Descriptions of Indian Microlepidoptera, III. *J. Bombay Nat. Hist. Soc.* (Bombay), 18:730.

1910. Lepidoptera Heterocera. Fam. Pterophoridae. In *Genera Insectorum*, 100:1-23. Brussels.

**Murtfeldt, M. E.**

1880. New plume moths (Pterophoridae). *Amer. Ent.* (St. Louis), 3:235-236.

**Razowski, J.**

1988. *Motyle (Lepidioptera) Polski. 20. Pterophoridae i Carposinidae.* Warsaw: Panst. Wydawnictwo Nauk. 140pp.

**Stehr, F. W.** (ed.)

1987. Order Lepidoptera. *In* F. W. Stehr (ed.), *Immature Insects* [1], 288-596. Dubuque: Kendall/Hunt.

**Wolcott, G. N.**

1936. Insectae borinquenses. A revised annotated check-list of the insects of Puerto Rico. *J. Agric. Univ. Puerto Rico* (Mayaguez), 20(1):1-600.

**Yano, K.**

1961. A new genus of Pterophoridae from Japan (Lepidoptera). *Mushi* (Fukuoka), 35(12):87-90.

1963. Taxonomic and biological studies of Pterophoridae of Japan (Lepidoptera). *Pacific Ins.* (Honolulu), 5:65-209.