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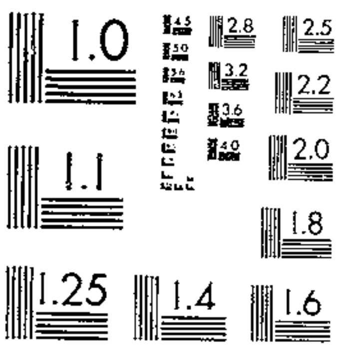

MICROCOPY RESOLUTION TEST CHART
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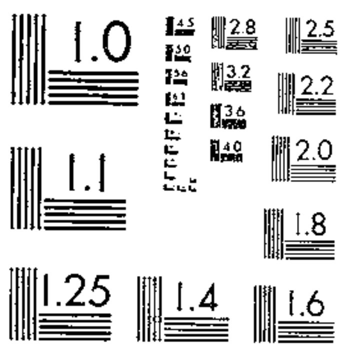

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SYSTEMATICS OF IMMATURE PHYCITINES (LEPIDOPTERA: PYRALIDAE) ASSOCIATED WITH LEGUMINOUS PLANTS IN THE SOUTHERN UNITED STATES

By

H. H. NEUNZIG

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CONTENTS

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SYSTEMATICS OF IMMATURE PHYCITINES (LEPIDOPTERA: PYRALIDAE) ASSOCIATED WITH LEGUMINOUS PLANTS IN THE SOUTHERN UNITED STATES

By H. H. Neunzig[1]

The family Fabaceae (sensu lato) contains many plants that are hosts of phycitine larvae. Approximately 20 percent of the food plants listed by Heinrich (*1956*),[2] in his revision of the American species of Phycitinae, are leguminous. This association is most apparent in the warmer parts of the Western Hemisphere where both the Phycitinae and Fabaceae are especially abundant. The Southern United States, with its warm temperate climate and its southernmost, subtropical extremities, has a number of phycitines associated with leguminous plants. Several of these are of economic importance, including the limabean pod borer (*Etiella zinckenella* (Treitschke)), the limabean vine borer (*Monoptilota pergratialis* (Hulst)), the lesser cornstalk borer (*Elasmopalpus lignosellus* (Zeller)), the Caribbean pod borer (*Fundella pellucens* Zeller), the locust leafroller (*Nephopterix subcaesiella* (Clemens)), the navel-orange worm (*Amyelois transitella* (Walker)), and the carob moth (*Spectrobates ceratoniae* (Zeller)).

This bulletin gives information on the appearance of the larval stage, and for most species the pupal stage, of 21 phycitines feeding as larvae on leguminous plants in the Southern United States. Keys are included to facilitate identification. In addition, notes on hosts, habits, and other aspects of biology are presented.

LITERATURE REVIEW

The rather extensive literature on the appearance of the larvae and pupae of phycitine species associated with leguminous plants in the Southern United States includes the following references: *Amyelois transitella* (Walker)—Glick (*1922*), Essig (*1958*), Ebeling (*1959*), Wade (*1961*), Aitken (*1963*), Capps (*1963*); *Ancylostomia stercorea* (Zeller)—Bennett (*1959*); *Elasmopalpus lignosellus* (Zeller)—Chittenden (*1900*), Fracker (*1915*), Luginbill and Ainslie (*1917*), Plank (*1928*), Watson (*1931*), Hayward (*1943*), Craighead (*1950*), Peterson (*1956*), Essig (*1958*), King et al. (*1961*), Capps (*1963*), Baker (*1972*), Guagliumi (*1973*); *Etiella zinckenella* (Treitschke)—Chittenden (*1909*), Hyslop (*1912*), Forbes (*1923*), Wolcott (*1933, 1936*), Hinton (*1943*), Schad and Guignard (*1943*), Miller and Rezac (*1953*), Peterson (*1956*), Essig (*1958*), Abul-Nasr and Awadalla (*1959*), Hasenfuss (*1960*), Capps (*1963*), Stone (*1965*), Janarthanan and Bucker (*1968*), Sandhu and Verma (*1968*), Issiki et al. (*1969*); *Fundella pellucens* Zeller—Wolcott (*1933, 1936*), Capps (*1963*); *Monoptilota pergratialis* (Hulst)—Chittenden (*1900, 1902*), Forbes (*1923*), Peterson (*1956*); *Nephopterix* spp.—Comstock (*1881*), Beutenmüller (*1890*), Hulst (*1890*), Fracker (*1915*), Forbes (*1923*), McDunnough (*1946*), Craighead (*1950*), Baker (*1972*), Doerksen and Neunzig (*1975*); *Spectrobates ceratoniae* (Zeller)—Balachowsky and Mesnil (*1935*), Agenjo (*1959*), Aitken (*1963*), Capps (*1963*); *Tlascala reductella* (Walker)—Comstock (*1881*), Hulst (*1890*), Packard (*1890*); *Ulophora groteii* Ragonot—Yip (*1936*), Bissell (*1940*).

However, most of this information is of limited diagnostic value because of inadequate descriptions and drawings or photographs with insuf-

[1] Department of Entomology, North Carolina State University, Raleigh 27650.

[2] The year in italic after authors' names refers to Literature Cited, p. 61.

ficient detail. The only reports providing detailed treatments, keys, or both for some of these species are those of Fracker (*1915*), Glick (*1922*), Hinton (*1943*), Miller and Rezac (*1953*), Agenjo (*1959*), Hasenfuss (*1960*), Capps (*1963*), Aitken (*1963*), Janarthanan and Bucker (*1968*), and Doerksen and Neunzig (*1975*). Apparently no one has published on the appearance of the immatures of *Adelphia petrella* (Zeller), *Anabasis ochrodesma* (Zeller), *Caristanius decoloralis* (Walker), *C. minimus* Neunzig, *Fundella argentina* Dyar, *Metephestia simplicula* (Zeller), *Pima albiplagiatella occidentalis* Heinrich, *P. granitella* (Ragonot), and *Ufa rubedinella* (Zeller).

References on the biology of immature phycitines feeding on leguminous plants include the following: *Amyelois transitella* (Walker)—Glick (*1922*), Mote (*1922*), Hixson (*1934*), Bissell (*1940*), Heinrich (*1956*), Essig (*1958*), Ebeling (*1959*), Michelbacher and Davis (*1961*), Wade (*1961*), Allen (*1971*); *Anabasis ochrodesma* (Zeller)—Bruner et al. (*1945*), Martorell (*1945*), Heinrich (*1956*); *Ancylostomia stercorea* (Zeller)—Lima (*1949*), Heinrich (*1956*), Bennett (*1959*); *Caristanius* spp.—Heinrich (*1956*), Neunzig (*1977*); *Elasmopalpus lignosellus* (Zeller)—Chittenden (*1900*), Luginbill and Ainslie (*1917*), Plank (*1928*), Stahl (*1930*), Watson (*1931*), Snyder (*1936*), Sauer (*1939*), Hayward (*1943*), Isely and Miner (*1944*), Bruner et al. (*1945*), Lima (*1949*), Craighead (*1950*), Heinrich (*1956*), Essig (*1958*), King et al. (*1961*), Bennett (*1962*), Walton et al. (*1964*), Dupree (*1965*), Genung and Green (*1965*), Fewkes (*1966*), Leuck (*1966*), Stone (*1968*), Baker (*1972*), French and Morgan (*1972*), Guagliumi (*1973*), Biezanko et al. (*1974*); *Etiella zinckenella* (Treitschke)—Chittenden (*1909*), Hyslop (*1912*), Sakharov (*1923*), Pilyugin (*1925*), Larson (*1926*), Flanders (*1930, 1932*), Leonard and Mills (*1931*), Mills and Leonard (*1931*), Wolcott (*1933, 1934, 1936*), Bruner (*1935*), Golding (*1935*), Lhomme (*1935*), Roark (*1937*), Viktorov (*1938*), Klinkowski (*1939*), Scott (*1940*), Cheu (*1943*), Couturier (*1943*), Schad and Guignard (*1943*), Bruner et al. (*1945*), Swezey (*1946*), Lima (*1949*), Parker (*1951*), Middlekauff and Stevenson (*1952*), Miller and Rezac (*1953*), Heinrich (*1956*), Popova (*1957*), Essig (*1958*), Abul-Nasr and Awadalla (*1959*), Hasenfuss (*1960*), Naito (*1961*), Vasantharaj et al. (*1961*), Kruel (*1963*), Gentry (*1965*), Stone (*1965*), Peiu (*1967*), Oatman (*1967*), Sandhu and Verma (*1968*), Palmoni (*1969*), Cruz (*1970*), Singh and Dhooria (*1971*), Whalley (*1973*), Biezanko et al. (*1974*), Srivastava and Singh (*1974*); *Fundella* spp.—Wolcott (*1933, 1934, 1936*), Scott (*1940*), Heinrich (*1945, 1956*), Bruner et al. (*1945*), Lima (*1949*); *Metephestia simplicula* (Zeller)—Heinrich (*1956*); *Monoptilota pergratialis* (Hulst)—Chittenden (*1900, 1902*), Brannon (*1934, 1945*), Heinrich (*1956*); *Nephopterix* spp.—Beutenmüller (*1890*), Snyder (*1936*), McDunnough (*1946*), Craighead (*1950*), Heinrich (*1956*), Schaffner (*1959*), Prentice (*1965*), Baker (*1972*), Doerksen and Neunzig (*1976*); *Pima* spp.—Heinrich (*1956*); *Spectrobates ceratoniae* (Zeller)—Bodenheimer (*1930*), Balachowsky and Mesnil (*1935*), Heinrich (*1956*), Agenjo (*1959*), Gothilf (*1964, 1969*a, *1970*), Gentry (*1965*), Palmoni (*1969*); *Tlascala reductella* (Walker)—Comstock (*1881*), Packard (*1890*), Heinrich (*1956*), Prentice (*1965*); *Ufa rubedinella* (Zeller)—Heinrich (*1956*), Stone (*1968*); *Ulophora groteii* Ragonot—Dyar (*1904*), Yip (*1936*), Roark (*1937*), Bissell (*1940*), Heinrich (*1956*).

Many of these reports merely list the host plant(s). Also, as is apparent, over half the references apply to only two species—*Elasmopalpus lignosellus* and *Etiella zinckenella*. Biological information is very fragmentary or nonexistent in the literature on *Adelphia petrella*, *Anabasis ochrodesma*, *Caristanius* spp., *Fundella argentina*, *Metephestia simplicula*, *Pima* spp., *Tlascala reductella*, *Ufa rubedinella*, and *Ulophora groteii*.

MATERIALS AND METHODS

Most of the immatures used in preparing the descriptions and keys were obtained on several collecting trips in the Southern United States. The study area included approximately that part of the conterminous United States below 36° latitude—essentially southern North Carolina in the east to southern California in the west. Because the study was based in North Carolina, the Eastern States of this region were more thoroughly surveyed than the Western States.

Leguminous plants were examined for phycitine larvae. If last-stage larvae were found, about one-third were fixed and preserved in KAAD (a mixture of kerosene, alcohol, acetic acid, and dioxane) and 80-percent alcohol, respectively, and the remainder kept alive to obtain pupae and associated adults. Smaller larvae found were reared in 1-pint paper enclosures, which contained 2 to 3 cm of moist sand and a small part of the host plant.

Genitalia slides were prepared of representatives of all reared adults, and identifications were accomplished using Heinrich (*1956*). Some reared adults differed from all previously described phycitines. Based on these adults, a new species of *Caristanius* has been described (Neunzig, *1977*), and the appearance of the immature stages and biology of this species are included in this bulletin.

Some immatures were obtained through generous loans by the U.S. National Museum of Natural History and the Florida State Collection of Arthropods. In addition to supplementing reared material of some species, these loans made possible the inclusion of two species that occur in the Southern United States but were not collected in the field during the study.

Descriptions of larvae are of the last stage unless stated otherwise. Colors given under larval descriptions are for preserved larvae, with additional information in parentheses on the color of the living insect. Since there is little change in color of the pupa with preservation, colors given under pupal descriptions usually apply to both preserved and living pupae.

All measurements were obtained using preserved specimens. Width of the overall larva was measured at the widest point of the body, usually across the third or fourth abdominal segment. Width of the head was taken across the widest point of the head capsule. Length of the head included the distance from the dorsal margin of the epicranium to the distal margin of the clypeus. Measurements of the pupal length excluded the cremastral "spines." Pupal width was taken across the widest part of the mesothorax. Illustrations of the larvae and pupae were made with the aid of a camera lucida.

Biological data are based primarily on notes taken in the field; pertinent information in the literature is also included. Parasitoids reared from immature phycitines were sent to specialists of the Systematic Entomology Laboratory, Agricultural Research Service, for identification.

Most plant names included in the sections Larval Hosts and Index to Leguminous Host Plants were taken from Adams (*1972*), Correll and Johnston (*1970*), Kearney and Peebles (*1951*), Little and Wadsworth (*1964*), Little et al. (*1974*), Long and Lakela (*1971*), Munz (*1974*), and Radford et al. (*1968*). Some plant names, mainly European species, follow the "Index Kewensis."

MORPHOLOGY AND TERMINOLOGY

Last-Stage Larvae

Larvae of the Pyralidae have two prespiracular (L)[3] setae on each side of the prothorax and have the crochets of the ventral prolegs in the form of circles, mesopenellipses, or transverse bands.

Within the Pyralidae, most phycitine larvae can be separated from larvae of the other subfamilies in that they possess distinct, sclerotized, pigmented rings or partial rings embracing the SD1 setae on the mesothorax, and usually they also have a second pair of rings around the SD1 setae on the eighth abdominal segment (figs. 13, 14, *r*).[4] There is, however, considerable variation in the appearance of these rings. Many are dark and broad, enclosing a distinct pale center. Others are weakly pigmented, incomplete, or thin, or they are robust but have very minute pale centers and resemble pinacula. Sometimes ringed setae have a barlike or rodlike neural connection associated with the ring of the alveolus of the seta (fig. 12, *nc*).

In general, there appears to be a direct correlation between the development or distinctiveness of the SD1 rings and the basal diameter and length of the SD1 setae. Those rings that are

[3] The setal terminology for the larvae in this bulletin (figs. 1-5) follows Hinton (*1946*).

[4] These rings should not be confused with the small, narrow, uniform rings immediately adjacent to the alveoli of all setae.

well sclerotized, pigmented, and broad, with a very evident pale center have distinctly enlarged setae. For example, *Salebriaria* spp., possessing distinct rings, have SD1 setae on the mesothorax that are three to four times as long and approximately two times the basal diameter of the SD1 setae on the metathorax. Other phycitines, such as some species of *Dioryctria*, that possess mesothoracic SD1 rings with barely perceptible, irregular, pale centers have the SD1 setae on the mesothorax the same size or only very slightly larger than those on the metathorax.

The development of some of the SD1 setae into dominant tactile organs is not an adaptation restricted, within the Pyralidae, to the phycitines, although this modification appears to be more apparent and to have evolved much more consistently in this subfamily. The epipaschiines and the pyralines have evolved SD1 rings and enlarged setae but only on the eighth abdominal segment. Also in other subfamilies, at least in some species, either the SD1 setae of the mesothorax, the eighth abdominal segment, or both are slightly or distinctly enlarged, even though rings are not associated with these setae. An example of this is *Diaphania nitidalis* (Stoll) of the Pyraustinae, which possesses SD1 setae on the mesothorax that are about one-half again as long as the SD1 setae on the metathorax.

Among the phycitine larvae in this study, most have distinct rings and enlarged SD1 setae on the mesothorax and also on the eighth abdominal segment. Actually, *S. ceratoniae* and *A. transitella* also usually have similar, but more weakly developed, rings embracing the SD1 setae on abdominal segments 1–7 (figs. 16, 17); the SD1 setae of the metathorax also at times have vague, incipient rings in these species (figs. 15, 18). A few leguminous feeding phycitines, however, either have very weakly developed rings or completely lack these distinctive structures. American species of *Pima*, at least those whose immatures are known, have very weakly developed rings in late instars. Species that completely lack rings are found in *Etiella* and *Ulophora*.[5] Phycitines that have very weakly developed rings or lack rings apparently can be separated from other pyralids in which SD1 rings are absent in that the former have three L setae on each side of abdominal segment 9 and the crochets of abdominal segments 3–6 form circles.

Identification of the various species of the Phycitinae is frequently possible by examining such features as overall size, head width and texture, size and shape of the prothoracic shield, pigmentation, number of setae, setal arrangement, relative size of setae, and appearance of the trophi. Of these, the characters of greatest diagnostic value seem to be pigmentation and appearance of the trophi.

Phycitine larvae, in general, either are rather uniformly pigmented (with the major exception that the head sometimes is darker or paler than the body) or possess a series of pigmented body stripes (sometimes fragmented) with pigmented or nonpigmented areas between the stripes (head sometimes also maculated). In general, species whose larvae feed on foliage and are at times exposed have irregular stripes and interstripe areas or spots, which apparently camouflage the insect and make it difficult to be seen by predators, whereas internal feeders are more uniformly pigmented.

The overall color exhibited by the larva of a particular species is a complex combination of pigments associated with various cellular layers or structures of the head or body. Hasenfuss (*1960*) recognized three color contributing components: The color of internal fluids, organs, and muscles; the color resulting from the various pigments deposited in the epidermis; and the color contributed by the melanin deposited in the chitin.

The internal contents in the head of living larvae impart a greenish white. In some species having very small amounts of cuticular and epidermal pigment, the internal color is the predominant one. In most larvae, however, the internal structures and fluids merely provide a base color that blends with, and is usually strongly masked by, the more external, darker pigments.

Epidermal color of the head is white, yellow, or red. As with internal color, epidermal pigmentation is usually of less importance than the cuticular pigments.

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[5] Heinrich (*1956*) stated that this character is absent in the following phycitine genera that occur in the Americas: *Etiella*, *Oryctometopia*, *Ulophora*, *Rotruda*, *Rhagea*, and *Unadilla*.

The most distinctive color of the head usually results from the small, platelike structures in the cuticle associated with the attachment of muscles. Singularly or in groups these frequently form, entirely or in part, pigmented areas on the head and at times pigmented spots or areas on the body. In previous publications on immature phycitines, these have been referred to as muscle attachments (Neunzig et al., *1964*; Neunzig, *1972*; Doerksen and Neunzig, *1975*). It is probably more accurate to associate these modifications of the integument with the tonofibrillae mentioned by Snodgrass (*1935*). He defined tonofibrillae as "cuticular fibrils connecting the muscle fibers with the inner surface of the cuticula." He also indicated, however, that frequently the tonofibrillae penetrate to the outer part of the cuticula. The term adopted for these platelike structures in this bulletin is tonofibrillary platelets (tf pl).

Doerksen and Neunzig (*1975*) suggested that these tonofibrillary platelets form natural groups on the head capsule. The following terminology proposed by these authors is used in this bulletin: Middorsal group (md), subdorsal group (sd), subdorsal club (sd cl), lateral group (l), subventral group (sv), and ventral group (v) (figs. 6, 7).

Also on the head the mandibles contribute to the overall color. These structures can vary from yellowish white to black. Frequently they are the most heavily pigmented part of the head.

Pigmentation of the body is more complex than that of the head. Internal fluids and structures, including numerous organs as well as muscle tissue, usually contribute a base color. Epidermal pigmentation is common and frequently is more noticeable on the dorsal aspects of the body. Lightly to heavily pigmented tonofibrillary platelets occur in the cuticle and are particularly evident in most species on the thoracic shield and prespiracular plate of the prothorax and on the anal plate. For example, in *E. zinckenella*, the usually heavily pigmented tonofibrillary platelets distinctly contrast with the rest of the integument of the shield and thereby produce the characteristic color pattern of the shield of this species. Since it appears useful, particularly on the prothoracic shield, to be able to refer easily to these platelets, two groups are recognized, the dorsal (d) and the subdorsal (sd) (fig. 11).

The tonofibrillary platelets on the softer parts of the body are usually less strongly pigmented than those on the shield and plates. There are exceptions, however; for example, in a few phycitines (some *Dioryctria*) these platelets are very heavily pigmented (black) and form a very characteristic feature of the larva. Also on abdominal segments 3–6 of many phycitines, a tonofibrillary platelet (the postspiracular platelet)[6] is relatively distinct, even though other platelets on the body are pale or the same color as the surrounding integument. All known legume-feeding phycitines have weakly to only moderately pigmented platelets on the less sclerotized parts of the body.

In many phycitine species, the dominant body color is contributed by the so-called stripes. The following terminology, slightly modified from Gerasimov (*1952*) and Hasenfuss (*1960*), is used for these longitudinally arranged pigmented areas: Middorsal (fig. 13, *md*), subdorsal (fig. 13, *sd*), suprastigmatal (figs. 13, 14, *sst*), epistigmatal (figs. 13, 14, *est*), stigmatal (figs. 13, 14, *st*), hypostigmatal (figs. 13, 14, *hst*), supraventral (fig. 14, *sv*), midventral (fig. 14, *mv*).

In general, the stripes are the result of either cuticular pigmentation (sometimes with an additional roughening of the integument) (gray to black stripes), hypodermal pigmentation (red, green, yellow, or white stripes), or a combination of cuticular and hypodermal pigmentation (maroon stripes, for example, produced by a combination of gray cuticular pigments underlaid with pink or red hypodermal pigments). On a particular species, the md, sd, sst, and est stripes (those above the spiracles) are all cuticular; or all are a combination of cuticular plus hypodermal; or some are cuticular, some a combination of cuticular plus hypodermal, and some hypodermal. St stripes and the more ventral stripes (with the possible exception of mv) usually are entirely hypodermal. Stripes resulting from cuticular pigmentation or a combination of cuticular plus hypodermal pigmentation are usually most pronounced on the thoracic segments. Stripes due to hypodermal pigments only are usually most pronounced on the more caudal segments.

In many species the body stripes extend

[6] Hasenfuss (*1960*) has given the term grübchen to this structure.

anteriorly in a fragmented fashion onto the prothoracic shield. As with the pattern formed by well-pigmented tonofibrillary platelets in some species, the shape of these fragmented stripes on the prothoracic shield is very characteristic of many species.

The interstitia or intervals between stripes are sometimes almost as distinctive as the stripes. Contrasting pigments of white or yellow are particularly striking.

Although not contributing as much as stripes to the overall color and appearance of many larvae, the pigmentation and resulting shape of the SD1 rings, mentioned earlier as characteristic of most phycitines, are important. For example, in phycitine larvae associated with legumes, the U-shaped pigmentation of the rings of *S. ceratoniae* and *A. transitella* is characteristic. *E. lignosellus* and closely related species have characteristically elongate pigmented rings. Also in some species like *A. petrella* and *T. reductella*, where the stripes, stripe intervals, or both intersect the ring, distinctly marked structures result.

Of the appendages that make up the trophi, the mandibles are the most useful for species identification. The general shape itself, including distinctiveness and size of the distal teeth, is often characteristic. Of particular use are retinacula on the inner surface. In the phycitines that feed on leguminous plants, these extra "teeth" vary from small dentiform structures (*Fundella*) (figs. 41, 42) to large transverse ridges (*Nephopterix*) (fig. 8), which are a major feature of the mandibles. It should be remembered that the appearance of the distal teeth and retinacula can be altered by wear. Furthermore, retinacula occasionally break off or are completely abraded.

The external surface of the mandibles is also sometimes characteristically modified. Two strong "outer" carinae are evident in some species. One extends distally from near the preartis of the mandible to tooth 2. Sometimes just before reaching the distal teeth the carina divides and runs to both tooth 1 and tooth 2. The second ridge extends from the condyle, or postartis, of the mandible to tooth 1. The mandibular setae lie in the sulcus between the two carinae. This modification can be clearly seen in the mandibles of *U. rubedinella* (fig. 56).

Hinton (*1943*) noted that the sensilla styloconica of the maxillae of some phycitine larvae are bifurcate (fig. 9, *sen sty*), whereas in other pyralids they are unbranched. The diverse appearance of these structures was further studied by Hasenfuss (*1960*), who listed the condition of these receptors in 20 species. Among phycitines that feed on leguminous plants, the sensilla styloconica are simple, bifurcate, or possess several "teeth." In general, in each species the appearance of these sensilla is relatively uniform and a useful diagnostic feature. However, variation occurs, and sometimes these structures have two or more teeth on one specimen and are simple on another. A particular specimen may also have simple sensilla styloconica on one maxilla and more complex ones on the other maxilla. Variation on each maxilla also sometimes occurs. In addition, these receptors abrade or sometimes partially break off as the insect feeds.

The spinneret of the hypopharyngeal complex (fig. 10) of the labium shows considerable differences in length among species of phycitine larvae. This is very evident among the species feeding on leguminous plants. Larvae of *S. ceratoniae* and *A. transitella*, for example, have spinnerets that are less than one-half as long as the spinnerets of most other species (figs. 79, 80). The spinnerets of *Pima* larvae are also noticeably abbreviated (figs. 87, 88).

The number and position of most of the setae on larvae of the phycitines that feed on leguminous plants are relatively constant. However, some species exhibit important differences. Reduction in number of setae occurs. For example, in larvae of *M. pergratialis*, a decrease in the number of subventral setae on the caudal abdominal segments from the usual two on each side to one on each side is consistently diagnostic. Differences in location of setae are particularly evident with regard to the prespiracular setae on the prothorax. In most phycitines that feed on leguminous plants and most phycitine larvae in general, these setae are arranged in a vertical or approximately vertical configuration. However, in *E. zinckenella* and *U. groteii* (figs. 103, 105), these setae are horizontally arranged or approach a horizontal position.

Pupae

According to Mosher (*1916*), pyralid pupae usually have the following combination of characters: Epicranial suture present, antennae long (at least seven-eighths the length of the wings), labial palpi visible as small triangular or polygonal areas, pilifers present, maxillae reaching the caudal margin of the wings, maxillary palpi present, prothoracic legs one-half to three-fourths the length of the wings with the femur exposed, mesothoracic legs extending to the caudal margin of the wings, and abdominal segments without spines (smooth or punctate).

A characterization of phycitine pupae is impossible at this time because sufficient material has not been studied within the Phycitinae, as well as in other pyralid subfamilies. The combination of features given by Mosher (*1916*) does not seem adequate to set this group apart, such as a suture on the dorsum of the abdomen (or tubular thoracic spiracles where the suture is absent) between the 9th and 10th segment, the presence of maxillary palpi, and the usual presence of the epicranial suture.

In those phycitine pupae that have been studied, morphological features usually exist that make possible generic placement. Determination of species is frequently difficult or apparently impossible. In general, identification usually is relatively simple, at least to genus, with species whose pupae occur on the host or in trash on the soil surface. Species whose pupae transform in the soil are more uniform than their above-soil counterparts and much more difficult to separate.

Generally the caudal segments of phycitine pupae offer the best diagnostic characters (fig. 19). The appearance of the cremastral "spines" and the presence or absence of the gibba (and the gibba's appearance when present) are the features of greatest taxonomic value. The cremastral "spines" are apparently the modified dorsal setae (D2, SD1, SD2)[7] of the 10th abdominal segment. The typical number in phycitine pupae appears to be six. Usually the inner four "spines" are slender and similar in appearance and the outer two are usually more robust. Their relative length, curvature, and position are frequently diagnostic.

Above-soil pupae sometimes have caudal setae, in addition to the six cremastral "spines," that are modified to assist the "spines" in anchoring the pupa. For example, in *Acrobasis indigenella* (Zeller), two long, hooked setae project posteriorly from the dorsum of segment 9. Also among phycitines feeding on leguminous plants, the pupae of *S. ceratoniae, A. transitella, P. albiplagiatella occidentalis,* and *P. granitella* are replete with modified setae on the caudal segments, and their number, location, and appearance are very useful in identification.

The cremaster itself in phycitine pupae does not appear to be strongly developed, but in some species, such as *Acrobasis minimella* Ragonot (Neunzig, *1972*) and the leguminous-plant feeding *Nephopterix* spp. (Doerksen and Neunzig, *1975*), the 10th abdominal segment is abruptly constricted to form a distinct cremaster. The more typical situation, however, is a weak, vague cremaster formed by a gradual posterior tapering of the 10th segment.

The gibba is a raised, rounded, transverse protuberance, extending across some or all of the anterior dorsum of segment 10 (Neunzig and Merkel, *1967*). It appears to be strongly developed in all phycitine pupae transforming in the soil and present or absent in those developing above the soil. The width-length ratio and general shape of the gibba are sometimes characteristic. In some of the phycitines feeding on leguminous plants, such as *A. petrella, Caristanius* spp., *E. lignosellus,* and *U. rubedinella,* the gibba appears "pinched" at the meson, being slightly elevated at its midpoint and slightly produced anteriorly. The posterior margin of the gibba is also frequently diagnostic, being distinct or vaguely delineated and slightly to very irregular. Also in some pupae a series of punctures is associated with the caudal margin of the gibba.

Mosher (*1916*) established that the thoracic spiracles of phycitine pupae (fig. 19, *th sp*) are occasionally useful in separating taxa. In pupae of most species that feed on leguminous plants, the development and appearance of these spiracles are very similar; however, there are several species in which these structures are absent (fig. 126).

The pupa of the leguminous plant feeder *S. ceratoniae* has, in addition to very characteristic structures on the caudal segments, a remarkable thoracic crest (figs. 118, 122) and dorsal, spinous

[7]The terminology for the pupal setae (fig. 19) is based on Neunzig and Merkel (*1967*).

processes on abdominal segments 1–7. However, such vivid structural modifications of the pupa were not found in other species that feed on leguminous plants and generally appear to be rare in the Phycitinae.

KEYS

Last-Stage Larvae[8]

1a Mesothorax (figs. 12, 13, 96–102, 106, 108–116) and at least eighth abdominal segment (fig. 14) with pigmented rings[1] embracing SD1 setae (rings not necessarily complete or completely pigmented); rings on eighth abdominal segment sometimes more distinct than those on mesothorax; with lightly pigmented specimens, all rings pale, requiring careful examination to detect; sometimes small rodlike or barlike structure (fig. 12, *nc*) can be seen) 5

1b Mesothorax (figs. 103–105, 107) without detectable pigmented SD1 rings or partial rings 2

2a On anterior abdominal segments, D1 setae about one-half as long, to almost as long, as D2 setae; each side of abdominal segment 8 with horizontal diameter of spiracle distinctly less than distance between L1 and L2; adfrontals reach or almost reach cervical triangle (figs. 27, 30) 3

2b On anterior abdominal segments, D1 setae only about one-sixth to one-third as long as D2 setae; each side of abdominal segment 8 with horizontal diameter of spiracle greater than, to slightly less than, distance between L1 and L2; adfrontals distinctly separated from cervical triangle (figs. 28, 29) 4

3a D1 setae on anterior abdominal segments about one-half as long as D2 setae; in legumes of goatsrue (*Tephrosia* spp.); Southeastern United States .... *Ulophora groteii* Ragonot

3b D1 setae on anterior abdominal segments almost as long as D2 setae; in legumes of many plants, but common in Southern United States on lima bean (*Phaseolus lunatus* L.), rattlebox (*Crotalaria* spp.), and lupines (*Lupinus* spp.); Southeastern and Southwestern United States (also Central and South America and warmer parts of Eastern Hemisphere) .... *Etiella zinckenella* (Treitschke)

4a Sensilla styloconica of maxillae forked (fig. 67); irregular, fragmented stripes on body chalky white in live larva, sometimes faintly suffused with red or brownish red; in legumes (possibly also blossoms) of locoweed (*Astragalus* spp.) .... *Pima albiplagiatella occidentalis* Heinrich

4b Sensilla styloconica of maxillae simple (fig. 66); irregular, fragmented stripes on body distinctly pink, red, purple, or brownish red in live or recently preserved larva; in legumes (possibly also blossoms) of locoweed (*Astragalus* spp.) and possibly rattlebox (*Crotalaria* spp.) .... *Pima granitella* (Ragonot)

5a Gena of each side of head with brown to black stripe(s) or patch(es), principally between paler l group and dorsal arm of sv group of tonofibrillary platelets (figs. 97, 98); abdominal segments 1–7 usually with incomplete pigmented rings associated with SD1 setae (figs. 16, 17) (rings sometimes very incomplete and indistinct, appearing as just a broad, dark smudge, or with lightly pigmented specimens impossible to detect); sensilla styloconica of maxillae simple (figs. 58, 59) 6

5b Gena of each side of head without stripe(s) or patch(es) between paler tonofibrillary platelets (figs. 96, 99–102, 106, 108–116); abdominal segments 1–7 without any trace of pigmented rings associated with SD1 setae; sensilla styloconica of maxillae usually forked (figs. 57, 60–63, 68–77) 7

[1] These rings should not be confused with the small, narrow, uniform rings immediately adjacent to the alveoli of all setae.

[8] Penultimate stage larvae (largest larvae on host plant) of *Pima* spp.

6a Head reddish brown, more or less uniformly pigmented except for genae (figs. 21, 97); partial SD1 rings on abdominal segments 1–7 distinct, crescent- or arc-shaped, close to (but usually not touching) posterior margin of rings of alveoli (fig. 17);[2] in legumes of tamarind (*Tamarindus indica* L.), carob (*Ceratonia siliqua* L.), and other Fabaceae (also in fruits of some nonleguminous plants); southern Florida (also Central and South America, southern Europe, North Africa, and southern Asia) .... *Spectrobates ceratoniae* (Zeller)

6b Head brown to dark brown, more irregularly pigmented (figs. 22, 98), sometimes with dark suffusions in addition to those on genae; SD1 ring fragments on abdominal segments 1–7 indistinct to relatively distinct, usually not clearly crescent- or arc-shaped, sometimes touching posterior margin of rings of alveoli (fig. 16); in legumes of honeylocust (*Gleditsia triacanthos* L.) and other Fabaceae (also in fruits of some nonleguminous plants); Southeastern and Southwestern United States (also Central and South America) .... *Amyelois transitella* (Walker)

7a Inner surface of each mandible with large, transverse retinaculum (fig. 8) 8

7b Inner surface of mandible not as above (figs. 40–44, 49–55) 10

8a Shield and prespiracular plate of prothorax entirely dark, or with extensive dark markings (figs. 106, 110); remainder of prothorax, including prothoracic legs, also usually with some pigmentation (figs. 106, 110) 9

8b Shield and prespiracular plate of prothorax almost entirely pale, with few dark tonofibrillary platelets (fig. 111); remainder of prothorax, including prothoracic legs, pale (fig. 111); on foliage of black locust (*Robinia pseudoacacia* L.) and possibly other *Robinia* spp. .... *Nephopterix virgatella* (Clemens)

9a Head bicolored, with posterior distinctly darker than rest of head (fig. 106); prothoracic shield paler anteriorly (fig. 106); pigmentation on body in form of irregular blotches (fig. 106); on foliage of false indigo (*Amorpha herbacea* Walter) .... *Nephopterix dammersi floridensis* Heinrich

9b Head more uniformly pigmented (fig. 110); prothoracic shield more uniformly pigmented (fig. 110); pigmentation of body more consolidated (fig. 110); on foliage of black locust (*Robinia pseudoacacia* L.), other *Robinia* spp., and wisteria (*Wisteria frutescens* (L.) Poiret) .... *Nephopterix subcaesiella* (Clemens)

10a Inner surface of each mandible with distinct dentiform retinaculum (similar to distal teeth) at base of tooth 1 (figs. 41, 42) 11

10b Inner surface of mandible not as above (figs. 40, 43, 44, 49–55) 12

11a SD1 setae on mesothorax over twice as long as SD1 setae on metathorax; D1 setae on anterior abdominal segments approximately one-third as long as D2 setae; mostly in legumes of *Cassia* spp. .... *Fundella argentina* Dyar

11b SD1 setae on mesothorax about 1.5 times as long as SD1 setae on metathorax; D1 setae on anterior abdominal segments approximately one-fourth as long as D2 setae; in legumes of cowpea (*Vigna* sp.), lima bean (*Phaseolus lunatus* L.), sword bean (*Bauhinia* spp.), and many other Fabaceae (occasionally *Cassia* spp.) .... *Fundella pellucens* Zeller

12a One SV seta on each side of abdominal segment 8; in stem galls, mostly of lima bean (*Phaseolus lunatus* L.) .... *Monoptilota pergratialis* (Hulst)

12b Two SV setae on each side of segment 8 (fig. 14) 13

13a Prothoracic shield entirely pale (fig. 116), or with small amount of dark pigmentation located as in figure 96; small species (average length entire larva about 10 mm) 14

13b Prothoracic shield more or less completely pigmented (fig. 113), or with relatively large patches of pigmentation (figs. 102, 108, 109, 114, 115), or with little pigmentation as in figure 112 (very occasionally, entirely pale); usually larger larvae (average length about 15 to 22 mm) 15

[2] Aitken (*1963*) stated that *A.* (*Paramyelois*) *transitella* can be distinguished from *S.* (*Ectomyelois*) *ceratoniae* by the following characters: "(1) the absence of any definite crescent-shaped marks above setae ρ (SD1) on abdominal segments 1–7; (2) the incomplete ring around ρ (SD1) on the 8th abdominal segment; and (3) the nearness of setae ϵ (SD2) to the 8th abdominal spiracle." The present study, for the most part, confirms the diagnostic value of the first character, but the other two do not appear to hold for large series of the two species.

14a Prothoracic shield entirely pale, without distinct maculation (fig. 116); dorsal alveoli rings of living larva dark, contrasting with surrounding integument; on foliage of indigo (*Indigofera* spp.) .... *Metephestia simplicula* (Zeller)

14b Prothoracic shield mostly pale, but with characteristic, dark, fused spots on each side at SD1 and SD2 (fig. 96), and usually a very small dark patch surrounding D2; dorsal alveoli rings sometimes dark, but usually not particularly distinct; on foliage of candlestick (also known as king-of-the-forest, or ringworm senna) (*Cassia alata* L.), sicklepod (also known as sickle senna) (*Cassia obtusifolia* L.), and other *Cassia* spp. .... *Anabasis ochrodesma* (Zeller)

15a Prothoracic shield usually with small amounts of pigmentation (fig. 112) (sometimes completely pale); inner surface of each mandible usually with low, relatively long retinaculum associated with inner ridge leading to tooth 2 (fig. 49) (retinaculum only slightly elevated or missing on some specimens because of wear); on foliage of honeylocust (*Gleditsia triacanthos* L.) .... *Tlascala reductella* (Walker)

15b Prothoracic shield with more extensive pigmentation (figs. 102, 108, 109, 113–115); mandible without retinaculum (figs. 44, 50, 51, 54, 55), or if retinaculum present (fig. 53) not as above 16

16a Abdominal segments 3–6 with distance on each side between D1 and D2 considerably less than distance between D1 and SD1; mostly in legumes of pigeon pea (*Cajanus cajan* (L.) Huth) .... *Ancylostomia stercorea* (Zeller)

16b Abdominal segments 3–6 with distance on each side between D1 and D2 greater (sometimes considerably greater) than distance between D1 and SD1 17

17a Most setae on head with pale area surrounding alveoli rings (figs. 34, 113); prothoracic shield almost entirely black, or brown with darker maculae (fig. 113); in stems and other plant parts of many leguminous hosts including snap and lima bean (*Phaseolus* spp.), soybean (*Glycine max* (L.) Merrill), peanut (*Arachis hypogaea* L.); also in stems of many nonleguminous plants, particularly Poaceae. (Larva sometimes in the tube attached to host just below soil surface.) .... *Elasmopalpus lignosellus* (Zeller)

17b Cranial setae without distinct pale region surrounding rings of alveoli (figs. 31, 32, 35, 36, 108, 109, 114, 115); shield, in general, less pigmented, with distinct, contrasting pale and dark areas (figs. 108, 109, 114, 115) 18

18a Inner surface of each mandible with two low, arc-shaped retinacula (fig. 53); usually in soil tube attached to foliage of cowpea (*Vigna* spp.) and lima bean (*Phaseolus lunatus* L.) where leaves are in contact with soil or near soil surface .... *Ufa rubedinella* (Zeller)

18b Mandibles not as above (figs. 50, 51, 55) 19

19a Mesothoracic SD1 rings incompletely pigmented (interrupted by pale interval between stripes) (fig. 114); usually in tube attached just below soil surface to stems or foliage of partridge pea (*Cassia fasciculata* Michaux), wild sensitive plant (*Cassia nictitans* L.), other *Cassia* spp., and other Fabaceae .... *Adelphia petrella* (Zeller)

19b Mesothoracic SD1 rings more completely pigmented (figs. 108, 109) 20

20a Tonofibrillary platelets of head more or less uniformly pigmented (usually all pale, but at times all dark) (fig. 109); on foliage of partridge pea (*Cassia fasciculata* Michaux) and other species of *Cassia*; southeastern North Carolina to Florida and west to eastern Texas .... *Caristanius decoloralis* (Walker)

20b Tonofibrillary platelets of anterior of head distinctly darker than posterior platelets (fig. 108); on foliage of *Cassia keyensis* (Pennell) Macbride (sometimes larva in tube attached to host at soil surface); Florida Keys ...... *Caristanius minimus* Neunzig

Pupae[9]

1a Gibba absent (figs. 137, 138, 144, 145, 148); few to many setae on abdominal segment 9 (figs. 137, 138, 144, 145, 148); pupae occur in infested legumes, or associated with dead leaves or other debris on soil surface 2

1b Gibba present (figs. 19, 136, 139–143, 146, 147, 149–154); no setae on abdominal segment 9 (figs. 19, 136, 139–143, 146, 147, 149–154); pupae in soil 4

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[9]Pupae of *Ancylostomia stercorea* (Zeller) are not included in key because they were not available for study.

2a Two cremastral "spines" greatly enlarged (figs. 137, 144), or bases of all cremastral "spines" enlarged (figs. 138, 145); pupae not noticeably elongate (figs. 137, 138, 144, 145) ---------- 3

2b All cremastral "spines" slender (fig. 148); pupae distinctly elongate (fig. 148) ---------- *Pima albiplagiatella occidentalis* Heinrich, *P. granitella* (Ragonot)

3a Thorax with distinct middorsal carina (figs. 118, 122); abdominal segments 1–7 with dorsal spinose processes (figs. 137, 144); pupae abundant in southern Florida in tamarind (*Tamarindus indica* L.) legumes ---------- *Spectrobates ceratoniae* (Zeller)

3b Thoracic carina absent (fig. 119); abdominal segments without dorsal spinous processes (figs. 138, 145); pupae in Southeastern United States in legumes of honeylocust (*Gleditsia triacanthos* L.), in Southwestern United States mostly in fruits of nonleguminous plants (*Citrus*, almonds, walnuts, etc.) ---------- *Amyelois transitella* (Walker)

4a Thoracic spiracles absent (fig. 126) ---------- 5

4b Thoracic spiracles present (figs. 19, 117, 120, 121, 124, 125, 128, 130–135) ---------- 6

5a Punctures present on mesothorax (fig. 126) ---------- *Tlascala reductella* (Walker)

5b Punctures absent on mesothorax ---------- *Nephopterix dammersi floridensis* Heinrich, *N. subcaesiella* (Clemens), *N. virgatella* (Clemens)

6a Posterior margin of gibba very irregular (figs. 149–153); mesal part of gibba usually slightly produced dorsally and slightly anteriorly (figs. 149–153) ---------- 7

6b Posterior margin of gibba less irregular (figs. 136, 139–143, 146), sometimes not clearly delineated (fig. 154); gibba more or less evenly convex dorsally (figs. 136, 139–143, 146, 154) ---------- 10

7a Relatively large, robust species (approximate length 11 mm; approximate width 2.8 mm) (exception—*Caristanius minimus* Neunzig; however, this species apparently is restricted to the Florida Keys); outer pair of cremastral "spines" simple or only slightly hooked (figs. 149, 151, 153) ---------- 8

7b Pupae smaller, more slender (approximate length 8 mm; approximate width 2.2 mm); outer pair of cremastral "spines" usually distinctly hooked (figs. 150, 152) 9

8a Outer cremastral "spines" arising from distinct protuberances (figs. 149, 151) ---------- *Caristanius decoloralis* (Walker), *C. minimus* Neunzig

8b Outer cremastral "spines" associated with only slightly enlarged parts of the integument that are usually not visible from above (fig. 153) ---------- *Adelphia petrella* (Zeller)

9a Anterior margin of gibba with darkened, ovoid spot on each side of meson (fig. 150) ---------- *Elasmopalpus lignosellus* (Zeller)

9b No dark, ovoid spots associated with gibba (fig. 152) ---------- *Ufa rubedinella* (Zeller)

10a Large pupae (approximate length 13 mm; approximate width 4 mm); metathorax wrinkled (fig. 129); punctures on metathorax usually closely grouped with some fused and irregular (fig. 129) ---------- *Monoptilota pergratialis* (Hulst)

10b Smaller pupae (approximate length 5–10 mm; approximate width 1.5–2.5 mm); metathorax more uniform; punctures on metathorax loosely grouped, or some punctures closely grouped but not irregular ---------- 11

11a Punctures on metathorax numerous, most very closely grouped in slightly depressed anterior half of each side of meson (fig. 123) ---------- *Anabasis ochrodesma* (Zeller)

11b Punctures fewer and more loosely grouped on metathorax ---------- 12

12a Outer cremastral "spines" simple, inwardly curved (figs. 141, 143) ---------- *Fundella pellucens* Zeller, *F. argentina* Dyar

12b Outer cremastral "spines" hooked, outwardly or inwardly curved (figs. 139, 140, 146, 154) ---------- 13

13a Gibba about two to three times as wide as median length (fig. 154); caudal margin of gibba not clearly delineated (fig. 154) ---------- *Metephestia simplicula* (Zeller)

13b Gibba about four to five times as wide as median length (figs. 139, 140, 146); caudal margin of gibba distinct, delineated by row of small punctures (figs. 139, 140, 146) ---------- 14

14a Outer cremastral "spines" distinctly shorter than inner four "spines" (fig. 146); inner four "spines closely grouped (fig. 146) ---------- *Ulophora groteii Ragonot*

14b Outer cremastral "spines" about as long as inner four "spines" (figs. 139, 140); inner four "spines" more loosely grouped (figs. 139, 140) ---------- *Etiella zinckenella* (Treitschke)

SPECIES DESCRIPTIONS

Anabasis ochrodesma (Zeller)

Myelois ochrodesma Zeller, 1881: 209.

Description of Larva (figs. 20, 40, 57, 78, 96)

General.—Length 8.1-12.5 mm; width 1.1-1.6 mm.

Color.—Head pale whitish yellow (very pale brown in living larva); tonofibrillary platelets of head usually only slightly darker than surrounding integument; mandibles pale brown basally, becoming dark brown distally; hypostoma with narrow, dark brown to black lateral streak; spinneret pale brown.

Prothoracic shield pale whitish yellow (very pale brown in living larva) with contrasting brown to very dark brown (dark brown to black in living larva) spots on each half of shield at SD1, SD2 (est stripe), and usually at D2 (sst stripe) (spots at SD1 and SD2 frequently characteristically fused together along shield margin; less pronounced narrow fusion of SD2 and D2 spots sometimes evident along posterodorsal and posterior margin of shield); tonofibrillary platelets of thoracic shield inconspicuous.

Prespiracular plates whitish yellow with some brown (very pale brown with dark brown to black in living larvae), mostly along dorsal and posterior margins; tonofibrillary platelets of plates inconspicuous.

Remainder of prothorax pale yellowish white (pale green or yellowish green in living larva).

Mesothorax and metathorax usually pale yellowish white with faint brownish-gray md, sst, and est stripes; all stripes of mesothorax and metathorax broad; est stripes of mesothorax and metathorax usually not as complete as other stripes, partially fused to sst stripes (some recently preserved specimens with red or pink on dorsum) (mesothorax and metathorax of living larva usually with dark green or gray-green stripes, pale green to yellowish green or yellow between stripes, and venter green to pale green; mesothorax and metathorax of some living larvae with dark purplish stripes, reddish purple between stripes, and pink and yellow on venter).

Mesothoracic SD1 rings distinctly brown (dark brown to black in living larva) with pale posterior region.

Thoracic legs yellowish white.

Abdomen similar to mesothorax and metathorax.

Eighth abdominal segment SD1 rings usually pale brown (dark brown to black in living larva).

Anal shield pale whitish yellow dorsally, pale brown laterally (?sst stripes); tonofibrillary platelets pale dorsally, brown in darker parts of shield.

Peritreme of prothoracic spiracles dark brown anteriorly, pale brown posteriorly; peritreme of abdominal spiracles pale brown anteriorly, dark brown posteriorly.

Pinacula indistinct, pale brown (some living larvae with all pinacula above spiracles gray and relatively distinct).

Tonofibrillary platelets of remainder of body usually indistinct (more or less distinct pale yellow in purple larvae).

Head.—Width 0.89-0.99 mm; length 0.73-0.76 mm; surface slightly uneven; adfrontals reach approximately six-sevenths to seven-eighths distance to cervical triangle; AF2 setae below forking of epicranial suture; AF2 setae below imaginary line between P1 setae; P1 setae distinctly farther apart than P2 setae; labrum moderately emarginate; outer surface of mandibles without distinct carinae; inner surface of mandibles simple, or with indistinct tooth; sensilla styloconica of maxillae forked; spinneret long, about nine times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than distance between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than distance between SD1 and XD2, distance between D1 and D2 greater than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae on each side arranged in approximately a vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax well developed; SD1 setae on mesothorax about 1.4 times as long as SD1 setae on metathorax; SD1 and SD2 pinacula of metathorax fused; D1 and D2 pinacula of metathorax usually fused.

Abdomen.—D2 setae on anterior segments approximately 0.8 mm long; D1 setae on anterior segments approximately one-third as long as D2 setae; distance between D2 setae on segments 1–7 slightly less than distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 subequal to, or slightly less than, distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets triordinal, sometimes biordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 59–78, 60–72, 58–78, 60–70, and 48–56, respectively; spiracles on segment 8 at least 1.5 times larger than spiracles on segment 7; horizontal diameter of spiracle of each side of segment 8 slightly greater than distance between L1 and L2; SD1 rings of segment 8 well developed; SD1 setae of segment 8 about 1.3 times as long as SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 usually slightly greater than distance between D1 and SD1; D1, D2, and SD1 on each side of segment 9 on separate pinacula; usually 2 SV setae on each side of segment 9.

Description of Pupa (figs. 117, 123, 136)

General.—Length 4.8–6.8 mm; width 1.4–1.8 mm.

Color.—Yellowish brown with reddish-brown gibba and postgibba.

Head.—Smooth to slightly wrinkled; setae short.

Thorax.—Prothorax smooth to slightly wrinkled; spiracles present, relatively indistinct; mesothorax slightly wrinkled, without punctures; metathorax slightly wrinkled, with about 50 punctures very closely grouped in slightly depressed anterior half of each side of meson; setae short.

Abdomen.—Cephalic one-third to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 extending laterally to spiracles; punctures on segments 5–7 distinct and encircling segments; spiracles elliptical; segment 8 with short L2 setae; segment 9 with no setae; gibba about four times as wide as median length; caudal margin of gibba usually weakly outlined by slightly irregular row of shallow punctures; cremastral "spines" consisting of four centrally located, hooked, posteriorly directed "spines" and two outer, lateroposteriorly and slightly ventrally directed, hooked "spines;" outer "spines" about two-thirds to three-fourths length of inner "spines."

Material Examined[10]

FLORIDA—Coconut Grove, 2 larvae, ex *Cassia nodosa*, 1 May 1944, lot 44-12337, S.S. 14075 (USMN). Delray Gardens, 28 larvae, 31 pupae, *Cassia obtusifolia*, 9-IX-74, H. H. Neunzig (USNM); 20 larvae, 15 pupae, *Cassia obtusifolia*, 8-IX-75, H. H. Neunzig. Hobe Sound, 10 larvae, *Cassia obtusifolia*, 8-IX-75, H. H. Neunzig (USNM). Homestead, 25 larvae, 9 pupae, *Cassia obtusifolia*, 4-IX-75, H. H. Neunzig. Jensen Beach, 6 larvae, *Cassia alata*, 18-V-1955, G. W. Campbell (FSCA). Malabar, 7 larvae, *Cassia alata*, 31-V-1972, H. C. Levan (FSCA). Miami, 4 larvae, *Cassia tora* (in stem; on leaves), 27 Apr. 1944, 44-10783, S.S. 14836, Tuthill 1528 (USNM); 2 larvae, *Cassia tora*, 18-May-44, lot 44-13475, S.S. 15819 (USNM); 14 larvae, *Cassia* sp., 14-IV-1949, O. D. Link (FSCA); 1 larva, *Cassia longecharpus*, 12 July 60, 60-19918, Mi. 12871 (USNM). Perrine, 35 larvae, 20 pupae, *Cassia obtusifolia*, 8-IX-74, H. H. Neunzig (USNM); 5 larvae, *Cassia obtusifolia*, 7-IX-75, H. H. Neunzig. Sharpes, 12 larvae, *Cassia alata*, 22 XI 1965, H. C. Levan (FSCA).

Larval Hosts

Cassia spp. Very abundant in southern Florida on *Cassia obtusifolia* L. (*C. tora* of authors, not L.). The FSCA has a number of larvae collected from *C. alata* L. (candlestick, emperor's candlestick, king-of-the-forest, etc.), an ornamental grown in southern Florida. Heinrich (*1956*) and Kimball (*1965*) also listed *C. bahamensis* Miller, *C. fistula* (*fistulosa*) L., *C. javanica* (*nodosa*) L., and *C.* (*Sciacassia*) *siamea* Lamarck. Possibly also *Lysiloma* (Kimball, *1965*).

Distribution

Southern Florida. Also reported by Heinrich (*1956*) from Puerto Rico, Virgin Islands, Cuba,

[10] Many of the immatures and associated adults of each species have been deposited in the U.S. National Museum of Natural History of the Smithsonian Institution. These specimens have been designated (USNM), as are labeled specimens borrowed from the USNM. The remaining insects examined during the study are in the North Carolina State University Insect Collection or the Florida State Collection of Arthropods (FSCA).

Throughout this bulletin all information pertaining to material examined is given essentially as it appears on the insect labels.

Grenada, Jamaica, Trinidad, Mexico, Guatemala, Panama, and Colombia.

Biology

Based on data in Heinrich (*1956*) and Kimball (*1965*), *A. ochrodesma* has a series of generations each year. In southern Florida, the sequence of moth flight, oviposition, larval development, and pupation occurs almost uninterrupted throughout the year. Larvae have been found on hosts in February, April, May, July, August, September, November, and December.

Eggs are placed by the adult on the foliage, flowers, or other parts of hosts. On its most common host in southern Florida, *Cassia obtusifolia*, many of the small larvae upon hatching bore several millimeters into the terminal (fig. 155, *A*); the terminal leaflets eventually die. As the larvae become larger, they silk paired leaflets together into a flat shelter. As with many species of *Cassia* and other Fabaceae, the leaflets of *C. obtusifolia* move close together at night, facilitating their fastening by larvae. Where plants are heavily infested and tied leaflet shelters occur containing large larvae, or empty shelters exist from previous generations, early-stage larvae frequently enter these already made structures to feed, rather than initially boring into the rachis. Within the leaflet shelters, small to medium-sized larvae eat the inner epidermis and mesophyll of the leaflets.

Most large larvae on *C. obtusifolia* feed within tied leaflets (fig. 155, *B*). A silk path is laid down within the shelter, usually along the midrib of a leaflet. Frass is placed along the sides of the path. Selective layers of plant tissue or entire parts of leaflets are consumed. Typical shelters consist of brown terminal leaflets and partially necrotic, skeletonized basal leaflets with small scattered holes in the leaflets or along the leaflet margins (fig. 155, *C*). At times all six leaflets of a leaf are silked together.

Several large larvae, or large and small larvae, can occur together in a single shelter. Usually with such communal groups, frass is scattered within the structure as well as along the silk runways.

Infestations can become very heavy on *C. obtusifolia*, resulting in the destruction of all terminal leaflets. Larvae still developing on these plants bore into terminals up to several centimeters for sustenance or into legumes if they are present. Clusters of black frass usually extrude from the tunnels made by the larvae.

Pupation occurs in a silk case in the soil.

Parasitoids

No parasitoids have been reported in the literature as being associated with *A. ochrodesma*.

During this study the following parasitoid was reared from immatures of *A. ochrodesma*: Braconidae—*Phanerotoma* sp.

Spectrobates ceratoniae (Zeller)

Myelois ceratoniae Zeller, 1839: 176.

Description of Larva (figs. 15, 17, 21, 38, 59, 79, 97)

General.—Length 13.7-19.4 mm; width 2.1-3.5 mm.

Color.—Head yellowish brown, frequently darker dorsally; tonofibrillary platelets of head indistinct, only slightly darker than surrounding integument; brown to dark brown (dark brown to black in living larva) streak(s) on genae of head, principally between l tonofibrillary platelet group and dorsal arm of sv platelet group; mandibles reddish brown basally between preartis and postartis, becoming dark brown or black distally and dark brown or black along anterior and posterior margins; hypostoma with distinct dark brown to black markings; spinneret pale brown to brown.

Prothoracic shield yellowish brown to dark brown, usually slightly darker along lateral and posterior margins; d tonofibrillary platelets of thoracic shield pale brown to dark brown, indistinct to distinct; sd platelets of thoracic shield pale (sometimes paler than surrounding integument) to dark and distinct.

Prespiracular plates brown to dark brown; tonofibrillary platelets of plates sometimes distinct, darker than rest of plate.

Remainder of prothorax yellowish white (occasionally faintly pink in recently preserved larvae) (pink in living larvae).

Mesothorax and metathorax yellowish white (occasionally faintly pink in recently preserved larvae; pink in living larvae, slightly darker on dorsum).

Mesothoracic SD1 rings pale brown to dark brown.

Metathorax occasionally with small pale brown to dark brown rings that closely embrace SD1 setae.

Thoracic legs pale brown to brown.

Abdomen similar to mesothorax and metathorax; SD1 setae of abdominal segments 1–7 partially encircled with pale brown to dark brown rings (only dorsal or dorsoposterior arc of ring developed, but part present usually clearly delineated; with a few, very pale larvae, rings cannot be detected, but usually small, dark, barlike extensions of the alveoli rings of SD1 can be detected on segments 1–7).

Eighth abdominal segment SD1 rings pale brown to dark brown, usually complete and uniformly pigmented or only very slightly paler dorsally, dorsoposteriorly, or both.

Anal shield pale brown along meson, darker laterally; tonofibrillary platelets of anal shield pale whitish to dark brown.

Peritreme of spiracles of prothorax and abdominal segments brown.

Pinacula pale brown to dark brown, usually relatively distinct dorsally, faint to absent on venter.

Tonofibrillary platelets of remainder of body pale, indistinct, about same color as surrounding integument.

Head.—Width 1.25–1.49 mm; length 0.99–1.27 mm; surface slightly uneven; adfrontals reach, or almost reach, cervical triangle; AF2 setae below forking of epicranial suture; AF2 setae below, or slightly above, imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum shallowly emarginate; outer surface of mandibles without distinct carinae; inner surface of mandibles simple; sensilla styloconica of maxillae entire, usually somewhat falcate, directed mesally; spinneret short, about five times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than distance between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than distance between SD1 and XD2, distance between D1 and D2 distinctly greater than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae on each side arranged in vertical or approximately vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax mostly well developed, weak dorsally; SD1 setae on mesothorax about 1.2 times as long as SD1 setae on metathorax; SD1 and SD2 pinacula of metathorax fused or separate; D1 and D2 pinacula of metathorax separate or slightly fused.

Abdomen.—D2 setae on anterior segments about 0.9 mm long; D1 setae on anterior segments one-half to two-thirds as long as D2 setae; distance between D2 setae on segments 1–7 greater than distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 distinctly less than distance between D1 and SD1; SD1 setae of segments 1–7 with partial, but usually distinct basal rings (rings about one-half size of those on mesothorax); crochets usually biordinal, sometimes irregularly triordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 44–56, 48–58, 42–58, 34–58, and 32–38, respectively; spiracles on segment 8 only slightly larger than spiracles on segment 7; horizontal diameter of spiracle of each side of segment 8 subequal, to slightly greater than, distance between L1 and L2; SD1 rings of segment 8 well developed; SD1 setae of segment 8 only slightly longer than SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly greater than distance between D1 and SD1; D1 and SD1 on each side of segment 9 usually on fused pinacula; 2 SV setae on each side of segment 9.

Description of Pupa (figs. 118, 122, 137, 144)

General.—Length 6.9–11.4 mm; width 1.9–2.9 mm.

Color.—Yellowish brown to reddish brown dorsally with dark brown to black middorsal carina, spinous processes on abdomen, and enlarged cremastral "spines."

Head.—Wrinkled; setae relatively long.

Thorax.—Prothorax usually rugose, with distinct middorsal irregular carina; spiracles distinct; mesothorax rugulose to rugose, without punctures, with middorsal, irregular carina; metathorax rugulose to rugose, with middorsal carina and usually about 25 loosely grouped punctures on each side of carina (punctures more distinct near carina); setae relatively long, 2 on prothorax, 6 on mesothorax, and 6 on metathorax.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures (punctures most apparent along meson and not reaching spiracles); punctures on segments 5–7 distinct, but usually limited to dorsum; segments 1–7 with dorsal spinous processes; spiracles elliptical; segment 8 usually with D1, D2, SD1, L1, L2, L3, SV1, and SV2 present and relatively long, and hooked; segment 9 with relatively long, hooked D1, D2, SD1, L1, L2, and usually several other more ventral setae; gibba absent; segment 10 with two large, stout, dorsocaudally located hooks (cremastral "spines"); (probably modified bases of D1 setae), four lateral, slender, relatively unmodified, hooked setae (?cremastral "spines") and usually several other more ventral setae.

Material Examined

FLORIDA—Big Pine Key, 2 larvae, 1 pupa, *Tamarindus* legumes, 10-V-73, H. H. Neunzig (USNM). Homestead, 2 larvae, *Eriobotrya japonica*, 26 Apr. '44, lot 44-12386, S.S. 15582 (USNM). Islamorada, 21 larvae, 10 pupae, *Tamarindus* legumes, 5-IX-74, H. H. Neunzig (USNM); 5 larvae, 2 pupae, *Tamarindus* legumes, 5-IX-75, H. H. Neunzig. Key West, 1 larva ex tamarind, Mar. 27, 1945, lot 45-7943, S.S. 24850 (USNM). Miami, 6 larvae, 1 pupa, *Tamarindus indica*, 31-III-1949, O. D. Link (FSCA); 1 larva, *Tamarindus indica*, 6-XI-1958, L. J. Daigle (FSCA). Sumerlin Key, 3 larvae, *Tamarindus*, 11-VI-1953, L. S. Light (FSCA).

Larval Hosts

According to Heinrich (*1956*), *S.* (*Ectomyelois*) *ceratoniae* (the carob moth) is "primarily a leguminous feeder." The favored host in the Mediterranean region of Europe, where the insect is abundant, is *Ceratonia siliqua* L. (carob). Also in southern Europe and North Africa, it occurs on *Acacia farnesiana* (L.) Willdenow.

In the Southern United States it feed primarily on *Tamarindus indica* L. (tamarind). There are also larvae of *S. ceratoniae* in the USNM collected in Florida from *Eriobotrya japonica* (Thunberg) Lindley of the Rosaceae.

Other hosts include *Amygdalus communis* L. (almond), *Castanea sativa* Miller (chestnut), *Citrus* spp., *Cydonia oblonga* Miller (quince), *Ficus carica* L. (fig), *Malus pumila* Miller (apple), *Phoenix dactylifera* L. (date), *Punica granatum* L. (pomgranate), and *Ziziphus spina-christi* (L.) Willdenow (Bodenheimer, *1930*; Balachowsky and Mesnil, *1935*; Agenjo, *1959*; Palmoni, *1969*; Gothilf, *1970*; Roesler, *1973*).

Distribution

Southern Florida. Also reported by Heinrich (*1956*) from Central America, South America, and the Mediterranean area of Europe, Africa, and Asia. (Since this insect occurs in dried or partially dried fruit, it also is transported to cooler regions of the world where it may exist temporarily.)

Biology

Several generations occur each year. In Israel, Gothilf (*1970*) reported that *S. ceratoniae* passes the winter in the larval stage. In southern Florida, there appears to be no definite period when development is arrested, although some slowing of development may occur with cool temperatures; adults are found throughout the year (Kimball, *1965*).

Adults oviposit on fruits of the host. In southern Florida, the principal plant attacked appears to be *Tamarindus indica.* Eggs are placed in cracks or fissures in the host legumes or on their surface. Larvae upon hatching enter the legumes through the cracks or fissures or through holes made by other insects in the capsule wall. Mature legumes remaining on the trees or fallen legumes are selected for oviposition. Small, developing legumes of *T. indica* are not oviposited on or eaten by larvae of *S. ceratoniae.* In Israel, Gothilf (*1970*) reported that with most hosts, females definitely prefer fungus- or insect-damaged fruits.

Small *S. ceratoniae* larvae within legumes of *T. indica* feed initially on the pulp between the seeds. Larger larvae feed on both the pulp and the seeds (fig. 156, *A*). Frass and some sparse silk partially fill the feeding sites of the larvae. Frequently several larvae can be found in each legume.

Pupation takes place within the legume (fig. 156, *B*). An elongate pupal chamber of silk is made by the larva that connects with a silked-over opening to the outside (fig. 156, *C*).

Parasitoids

The following parasitoids have been reported in the literature as being associated with *S. ceratoniae*: Bethylidae—*Goniozus gallicola* Fouts (Gothilf, *1969b*); *Parasierola emigrata* (Rohwer) (Bridwell, *1919a*; Thompson, *1946*; Gothilf, *1969b*). Braconidae—*Apanteles lacteus* (Nees) (Gothilf, *1969b*); *A. myeloenta* Wilkinson (Gothilf, *1969b*); *Apanteles* spp. (Gothilf, *1969b*); *Bracon brevicornis* Wesmael (Thompson, *1946*; Gothilf, *1969b*); *B. mellitor* Say (Bridwell, *1919b*; Thompson, *1946*; Gothilf, *1969b*); *Phanerotoma dentata* (Panzer) (Thompson, *1946*; Gothilf, *1969b*); *P. flavitestacea* Fischer (Gothilf, *1969b*); *Phanerotoma* sp. (Thompson, *1946*; Gothilf, *1969b*); *Rogas testaceus* (Fabricius) (Gothilf, *1969b*). Chalcididae—*Antrocephalus mitys* (Walker) (Gothilf, *1969b*); *Brachymeria aegyptiaca* Masi (Gothilf, *1969b*). Ichneumonidae—*Gelis* sp. (Gothilf, *1969b*); *Herpestomus arridens* (Grav.) (Gothilf, *1969b*); "*Horogenes*" sp. (?*Diadegma*) (Gothilf, *1969b*); *Pristomerus vulnerator* Panzer (Gothilf, *1969b*). Perilampidae—*Perilampus tristis* Mayr (Gothilf, *1969b*). Pteromalidae—*Anisopteromalus calandrae* (Howard) (as *A. mollis* Ruschka) (Gothilf, *1969b*). Trichogrammatidae—*Trichogramma* sp. (Gothilf, *1969b*).

No parasitoids were obtained from *S. ceratoniae* immatures during this study.

Amyelois transitella (Walker)

Nephopteryx transitella Walker, 1863: 54.

Description of Larva (figs. 16, 18, 22, 39, 58, 80, 98)

General.—Length 11.9–23.5 mm; width 2.0–4.8 mm.

Color.—Head pale brown to dark brown; tonofibrillary platelets of head pale brown, pale orange, or black, usually not distinctly contrasting with ground color; frequently other indistinct pigmentation in addition to, and overlaying platelets, gives head a mottled appearance; brown to dark brown streak(s) on genae of head (black in living larva), principally between l tonofibrillary platelet group and dorsal arm of sv platelet group; mandibles very dark reddish brown between preartis and postartis, becoming black distally and black along anterior and posterior margins; hypostoma with dark brown to black markings; spinneret brown.

Prothoracic shield pale brown to brown; d and sd tonofibrillary platelets of thoracic shield pale brown to dark brown, frequently unevenly suffused with brown pigmentation.

Prespiracular plates pale brown to brown, darker near spiracles; tonofibrillary platelets of plates usually dark brown.

Remainder of prothorax yellowish white (occasionally recently preserved larva with some faint pink) (partly pink in living larva); usually with pale brown to brown patches of pigmentation anterior to prothoracic shield (one patch arising on each side from area extending from meson to XD1, and a second patch anterior to XD2 and SD1).

Mesothorax and metathorax yellowish white (recently preserved larva faintly pink) (living larva yellowish white suffused with pink, pink particularly noticeable at intersegmental folds of mesothorax and metathorax).

Mesothoracic SD1 rings pale brown to dark brown.

Metathorax occasionally with small pale brown to dark brown rings that closely embrace SD1 seta.

Thoracic legs pale brown to brown and yellowish white.

Abdomen similar to mesothorax and metathorax; SD1 setae of abdominal segments 1–7 partially encircled with pale brown to dark brown ring fragments (only dorsal or dorsoposterior part of ring developed and usually not clearly delineated, although occasionally distinctly crescent shaped; ring fragments sometimes in form of small, broad, dark smudge that extends inward touching alveoli rings; with a few very pale larvae, ring fragments cannot be detected, but usually small, dark barlike extensions of alveoli rings of SD1 can be found with careful examination of segments 1–7).

Eighth abdominal segment SD1 rings pale brown to dark brown, usually incomplete (when complete, dorsal, posterodorsal, or both part(s) pale).

Anal shield pale brown to brown; tonofibrillary platelets of anal shield pale to dark brown.

Peritreme of prothorax and abdominal segments brown.

Pinacula pale brown to brown, usually more distinct on anterior segments of body.

Tonofibrillary platelets of remainder of body pale, indistinct, about same color as surrounding integument.

Head.—Width 1.42–1.82 mm; length 1.16–1.42 mm; surface smooth to slightly uneven: adfrontals reach, or almost reach, cervical triangle; AF2 setae slightly below, to distinctly below, forking of epicranial suture; AF2 setae above or at imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum shallowly emarginate; outer surface of mandibles without distinct carinae; inner surface of mandibles simple; sensilla styloconica of maxillae entire, usually somewhat falcate, and directed mesally; spinneret short, about five times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than distance between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than to less than distance between SD1 and XD2, distance between D1 and D2 distinctly greater than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae on each side arranged in vertical to approximately vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax mostly well developed, weak dorsally; SD1 setae on mesothorax about 1.2 times as long as SD1 setae on metathorax; SD1 and SD2 pinacula on each side of metathorax slightly fused to separate; D1 and D2 pinacula on each side of metathorax usually separate.

Abdomen.—D2 setae on anterior segments about 1.0 mm long; D1 setae on anterior segments one-half to two-thirds as long as D2 setae; distance between D2 setae on segments 1–7 distinctly greater than distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 very distinctly less than distance between D1 and SD1; SD1 setae of segments 1–7 usually with faint basal rings (rings considerably smaller, incomplete, and much less distinct than those on mesothorax); crochets usually biordinal, sometimes irregularly triordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 39–55, 38–52, 38–54, 37–60, and 25–42, respectively; spiracles on segment 8 only slightly larger than spiracles on segment 7; horizontal diameter of spiracle on each side of segment 8 subequal to slightly greater than distance between L1 and L2; SD1 rings of segment 8 well developed, appearing weak dorsally or posterodorsally because of lack of pigment; SD1 setae of segment 8 only slightly longer than SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly greater than distance between D1 and SD1; D1 and SD1 on each side of segment 9 sometimes on fused pinacula; 2 SV setae on each side of segment 9.

Description of Pupa (figs. 119, 138, 145)

General.—Length 9.0–12.5 mm; width 2.4–3.5 mm.

Color.—Yellowish brown.

Head.—Slightly wrinkled; setae short.

Thorax.—Prothorax slightly wrinkled; spiracles moderately distinct; mesothorax slightly wrinkled, without punctures or other modifications; metathorax slightly wrinkled, with about 25 loosely grouped punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous distinct punctures; punctures on segment 4 extending laterally almost to spiracles; punctures on segments 5–7 encircling segment (punctures distinct dorsally becoming faint ventrally); spiracles elliptical; hooked, relatively long D1, D2, SD1, L1, L2, and SV2 usually present on segment 8 (L3, SV1, and V1 setae also sometimes present); segment 9 usually with hooked, relatively long D1, D2, SD1, L1, L2, and SV2 (L3 also sometimes present); gibba absent; setae of segment 10 that usually form cremastral "spines" arising from just before apex of short, slightly curved, conical protuberances; setae of segment 10 hooked distally.

Material Examined

CALIFORNIA—Riverside, 7 larvae, *Placentia* walnut seed, 28 Nov. 1945, lot 45-19809, E. Q. 090290 (USNM).

NORTH CAROLINA—Cary, 15 larvae, *Gleditsia*, 11-III-70, J. R. Baker and T. R. Weaver; 4 larvae, 2 pupae, *Gleditsia*, 15-IX-72, T. R. Weaver. Raleigh, 2 larvae, 1 pupa, *Gleditsia triacanthos*, 25-II-74, D. L. Stephan (USNM); 20 larvae, 9 pupae, *Gleditsia triacanthos*, XI-75, D. L. Stephan (USNM). Troy, 2 larvae, *Gleditsia*, 26-II-70, H. H. Neunzig and T. R. Weaver (USNM).

TEXAS—Brownsville, 1 larva, in mummified grapefruit, 28 Nov. 1928, F. H. Benjamin (USNM).

Larval Hosts

One of the major leguminous hosts of *A. transitella* (the navel-orange worm) in the Southern United States is *Gleditsia triacanthos* L. (honeylocust). Other leguminous hosts include *Acacia farnesiana* (L.) Willdenow, *Cassia grandis* L. f., *Pithecellobium flexicaule* (Bentham) Coulter, and *Robinia* (Heinrich, *1956*). Nonleguminous hosts include *Amygdalus persica* L. (peach), *Citrus paradisi* Macfarlane (grapefruit), *C. sinensis* (L.) Osb. (orange), *Ficus carica* L. (fig), *Malus pumila* Miller (apple), *Phoenix dactylifera* L. (date), and others (Wade, *1961*). *A. transitella* is an important pest of *Juglans regia* L. (walnut) and *Amygdalus communis* L. (almond) in California (Wade, *1961*; Michelbacher and Davis, *1961*).

Distribution

Throughout the Southern United States, from North Carolina to California. Heinrich (*1956*) also included Cuba, Dominican Republic, Mexico, Panama, Colombia, and Brazil. (Since this insect occurs in dried or partially dried fruits, it also is transported to cooler regions of the world where it may exist temporarily.)

Biology

A. transitella is multivoltine. The number of generations each year depends on the climate of a particular location. In tropical regions, development is apparently continuous. In the northern part of its range, however, development ceases or is slowed during the cooler months of the year (Wade, *1961*). In eastern North Carolina, *A. transitella* overwinters as a late-stage larva or to a lesser extent as a pupa.

One of its common leguminous hosts in the Southeastern United States is *Gleditsia triacanthos* L. (honeylocust). Oviposition and larval behavior are very similar to that reported for *Spectrobates ceratoniae*. A bruchid (*Amblycerus robiniae* (F.)) frequently infests honeylocust legumes, and entrance and exit holes made by this insect provide access to the legume interior for many of the small larvae of *A. transitella*. Other *A. transitella* larvae enter through cracks that develop as the legume dries. Inasmuch as honeylocust legumes are relatively large, a larva of *A. transitella* on this host usually eats and destroys only a small part of the legume to complete its development. The seeds and surrounding pulp are used as food. Frass and small amounts of silk are associated with the feeding site (fig. 157, *A*).

Pupation occurs in a silken tube within the damaged legume (fig. 157, *B*). Emergence of the adult takes place through a small opening made by the larva (fig. 157, *C*) or through a naturally occurring fissure in the legume (fig. 157, *D*).

Parasitoids

The following parasitoids have been reported in the literature as being associated with *A. transitella* (as *Paramyelois transitella*): Bethylidae—*Parasierola breviceps* (Krombein) (Krombein, *1954*; Wade, *1961*; Michelbacher and Davis, *1961*). Braconidae—*Bracon hebetor* Say (as *Microbracon hebetor*) (Ortega, *1950*; Michelbacher and Davis, *1961*). Ichneumonidae—*Mesostenus gracilis* Cresson (Wade, *1961*; Michelbacher and Davis, *1961*).

No parasitoids were obtained from *A. transitella* immatures during this study.

Fundella pellucens Zeller

Fundella pellucens Zeller, 1848: 866.

Description of Larva (figs. 24, 41, 60, 83, 101)

General.—Length 9.0–15.6 mm; width 1.4–2.5 mm.

Color.—Head whitish yellow to pale brown (living larva with green undertones at adfrontals); tonofibrillary platelets of head usually pale brown and indistinct (some specimens with moderately distinct platelets and other brown suffusions); mandibles brownish yellow basally between preartis and postartis, becoming reddish brown distally and reddish brown along anterior and posterior margins; hypostoma whitish yellow to pale brown; spinneret brown to dark brown.

Prothoracic shield whitish yellow to pale brown; tonofibrillary platelets of thoracic shield brown and indistinct (shield of living larva with green or purple undertones).

Prespiracular plate whitish yellow to pale brown; tonofibrillary platelets pale brown and indistinct.

Remainder of prothorax yellowish white (occasionally recently preserved larvae slightly pink) (remainder of prothorax of living larva green or purple on dorsum with green venter).

Mesothorax and metathorax yellowish white (occasionally recently preserved larva slightly pink on dorsum; living larva with mesothorax and metathorax entirely green or green and purple on dorsum with venter green; larvae having purple pigmentation on mesothorax and metathorax have green particularly noticeable between segments; dark green md stripe present on mesothorax and metathorax in some larvae).

Mesothoracic SD1 rings usually very pale brown, sometimes brown (pale brown on living larva) (difficult to see on most specimens).

Thoracic legs pale whitish yellow to pale brown (pale brown with brown markings in living larva).

Abdomen similar to mesothorax and metathorax (abdomen of living larva similar to mesothorax and metathorax, but with color more intense; larvae having purple and green on dorsum of thorax have more purple on dorsum of abdomen).

Eighth abdominal segment SD1 rings cannot be detected in most specimens (pale brown in living larva).

Anal shield usually about same color as surrounding integument, sometimes pale brown; tonofibrillary platelets of anal shield indistinct.

Peritreme of prothoracic and abdominal spiracles usually pale brown.

Pinacula cannot be detected.

Tonofibrillary platelets of remainder of body usually indistinct, about same color as surrounding integument (living larvae with purple pigmentation have moderately distinct platelets).

Head.—Width 1.16–1.35 mm; length 0.89–0.99 mm; surface smooth to slightly irregular; adfrontals reach, or almost reach, cervical triangle; AF2 setae at or below forking of epicranial suture; AF2 setae slightly above, or at, imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum moderately emarginate; outer surface of mandibles without distinct carinae; inner surface of mandibles with small dentiform retinaculum at base of tooth 1; sensilla styloconica of maxillae forked; spinneret moderately long, about eight times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than distance between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than distance between SD1 and XD2, distance between D1 and D2 distinctly greater than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae on each side arranged in a vertical or approximately vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax weak to moderately well developed; SD1 setae of mesothorax about 1.5 times as long as SD1 setae of metathorax.

Abdomen.—D2 setae on anterior segments about 0.8 mm long; D1 setae on anterior segments approximately one-fourth as long as D2 setae; distance between D2 setae on segments 1–7 greater than distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 distinctly less than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets usually triordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 55–60, 57–59, 55–59, 49–56, and 35–43, respectively; spiracles on segment 8 slightly larger than spiracles on segment 7; horizontal diameter of spiracle of each side of segment 8 greater than distance between L1 and L2; SD1 rings of segment 8 weak to moderately well developed; SD1 setae of segment 8 slightly less than twice as long as SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly greater than distance between D1 and SD1; usually 2 SV setae on each side of segment 9.

Description of Pupa (figs. 120, 141)

General.—Length 5.0–9.5 mm; width 1.6–2.5 mm.

Color.—Yellowish brown with gibba and postgibba reddish brown.

Head.—Slightly wrinkled; setae short.

Thorax.—Prothorax slightly wrinkled; spiracles small, but relatively distinct; mesothorax slightly wrinkled, without punctures or other modifications; metathorax slightly wrinkled, with about 40 loosely grouped punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 extending laterally to or beyond spiracles; punctures on segments 5–7 distinct and encircling segments; spiracles elliptical; segment 8 with short D1 and L2; segment 9 without setae; gibba distinct, about four times as wide as median length; caudal margin of gibba only slightly irregular, with row of very small punctures; cremastral "spines" consisting of four centrally located, posteriorly projecting, hooked "spines" and two characteristic, outer, inwardly curved, simple "spines;" all cremastral "spines" about same length.

Material Examined

FLORIDA—Coral Gables, 1 larva, *Bauhinia variegata*, April 1946 (USNM). Delray Gardens, 2 larvae, *Vigna* legumes, 9-IX-74, H. H. Neunzig (USNM). Fort Lauderdale, 5 pupae, cowpeas, 1 June 1945, Griswold (USNM). Lake Worth, 9 larvae, 4 pupae, *Abrus*, 9-IX-74, H. H. Neunzig (USNM); 4 larvae, 1 pupa, *Abrus*, 8-IX-75, H. H. Neunzig. Riviera Beach, 5 larvae, 1 pupa, *Vigna* legumes, 12-V-73, H. H. Neunzig (USNM); 3 larvae, 2 pupae, *Vigna* legumes, 9-IX-74, H. H. Neunzig.

Larval Hosts

F. pellucens (the Caribbean pod borer) was collected during this study from *Abrus precatorius* L. and *Vigna luteola* (Jacquin) Bentham. Other hosts reported in the literature include *Acacia* sp., *Bauhinia albiflora* (*alba*) Britton and Rose, *B. purpurea* L., *B. variegata* L., *Caesalpinia pulcherrima* (L.) Swartz, *Cajanus cajan* (*indicus*) (L.) Huth (pigeon pea), *Canavalia ensiformis* (L.) de Candolle, *C. gladiata* (Jacquin) de Candolle, *C. maritima* (Aublet) Thouars, *Cassia fasciculata* Michaux, *C. occidentalis* L., *Phaseolus lunatus* L. (lima bean), *Phoradendron* sp., *Tamarindus indica* L., and *Vigna unguiculata* (L.) Walpers (cowpea, black-eyed pea) (Wolcott, *1933*, *1934*, *1936*; Scott, *1940*; Bruner et al., *1945*; Heinrich, *1945*, *1956*; Kimball, *1965*).

Distribution

Southern Florida. Also Barbados, Haiti, Montserrat, Cuba, Virgin Islands, Puerto Rico, Brazil, and Bolivia (Heinrich, *1956*).

Biology

F. pellucens has several generations each year. Scott (*1940*) reported that this species is present throughout the year in the Tropics. In southern Florida, it also appears to be present almost every month of the year.

Wolcott (*1933*) and Scott (*1940*) reported that eggs are deposited on or near the flowers and flower buds of hosts. Under these circumstances, the small larvae initially feed on the flowers, causing the blossoms to dehisce. As the larvae grow, they eventually move to immature legumes to feed. There is also evidence that eggs are placed directly on legumes and that larvae feed only on legumes throughout their entire development. Species of *Vigna* are among the favorite hosts of this species. In southern Florida, legumes of *Vigna luteola* are frequently infested. They are produced in clusters, and the larvae prefer to bore into the host at a point near where the legumes come in contact with each other. Frass, loosely held together by silk, characteristically is extruded externally (fig. 158, *A* and *B*). Sometimes the legumes are silked together by the insect to form a loose shelter.

F. pellucens also frequently occurs on *Abrus precatorius* in southern Florida. Infested legumes of this host also have characteristic external masses of frass (fig. 158, *C*).

Scott (*1940*) indicated that the stems of some hosts are attacked, particularly with large populations of *F. pellucens*.

Pupation occurs in a silk cocoon in the soil.

Parasitoids

The following parasitoid has been reported in the literature as being associated with *F. pellucens*: Bethylidae—*Parasierola* sp., probably *cellularis* (Say) (Wolcott, *1933*).

During this study the following parasitoid was reared from immatures of *F. pellucens*: Tachinidae—*Dejeaniopalpus* sp. near *tenuirostris* James.

Fundella argentina Dyar

Fundella pellucens Zeller (in part, "var. b"), 1848: 867.

Description of Larva (figs. 23, 42, 62, 82, 99)

General.—Length 9.1–14.9 mm; width 1.4–2.4 mm.

Color.—Head pale whitish yellow to pale brown; tonofibrillary platelets of head usually indistinct, pale brown (at times larva with brown platelets); mandibles pale brown between preartis and postartis, becoming reddish brown distally and reddish brown along anterior and posterior margins.

Prothoracic shield pale whitish yellow to pale brown; tonofibrillary platelets of thoracic shield pale brown and indistinct; occasionally larva with d platelets of shield and dorsum of shield suffused with brown.

Prespiracular plates pale whitish yellow to pale brown; tonofibrillary platelets of plates pale brown and indistinct.

Remainder of prothorax pale yellowish white.

Mesothorax and metathorax pale yellowish white.

Mesothoracic SD1 rings usually very pale brown; thoracic rings sometimes slightly darker (difficult to see on many specimens).

Thoracic legs pale whitish yellow to pale brown.

Abdomen similar to mesothorax and metathorax.

Eighth abdominal segment SD1 rings cannot be detected on most specimens; pale brown on some larvae.

Anal shield usually about same color as surrounding integument; shield sometimes pale brown; tonofibrillary platelets of anal shield indistinct.

Peritreme of prothoracic and abdominal spiracles usually pale brown.

Pinacula cannot be detected.

Tonofibrillary platelets of remainder of body indistinct, about same color as surrounding integument.

Head.—Width 1.12–1.32 mm; length 0.86–0.99 mm; surface smooth to slightly irregular; adfrontals reach, or almost reach, cervical triangle; AF2 setae below forking of epicranial suture; AF2 setae slightly below, at, or slightly above imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum moderately emarginate; outer surface of mandibles without distinct carinae; inner surface of mandibles with small dentiform retinaculum at base of tooth 1; sensilla styloconica of maxillae forked; spinneret moderately long, about eight times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than distance between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than distance between SD1 and XD2, distance between D1 and D2 distinctly greater than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae on each side arranged in a vertical, or approximately vertical, configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax weak to moderately well developed; SD1 setae on mesothorax about 2.1–2.4 times as long as SD1 setae on metathorax.

Abdomen.—D2 setae on anterior segments about 0.5 mm long; D1 setae on anterior segments approximately one-third as long as D2 setae; distance between D2 setae of segments 1–7 greater than distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 distinctly less than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets mostly triordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 46–63, 50–56, 50–59, 48–60, and 38–44, respectively; spiracles on segment 8 slightly larger than spiracles on segment 7; horizontal diameter of spiracle of each side of segment 8 greater than distance between L1 and L2; SD1 rings of segment 8 weak to moderately well developed; SD1 setae of segment 8 slightly greater than twice as long as SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly greater than distance between D1 and SD1; usually 2 SV setae on each side of segment 9.

Description of Pupa (figs. 121, 143)

General.—Length 6.3–8.6 mm; width 1.9–2.4 mm.

Color.—Yellowish brown with gibba and postgibba reddish brown.

Head.—Slightly wrinkled; setae short.

Thorax.—Prothorax slightly wrinkled; spiracles small, but relatively distinct; mesothorax slightly wrinkled, without punctures; metathorax slightly wrinkled, with about 45 loosely grouped punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 extending laterally to or beyond spiracles; punctures on segments 5-7 distinct and encircling segments; spiracles elliptical; segment 8 with short D1 and L2 setae; segment 9 without setae; gibba distinct, about four times as wide as median length; caudal margin of gibba only slightly irregular, with row of very small punctures; cremastral "spines" consisting of four centrally located, posteriorly projecting, hooked "spines" and two characteristic, outer, inwardly curved, simple "spines;" all cremastral "spines" about same length.

Material Examined

FLORIDA—Stock Island, 1 larva, 2 pupae, *Cassia corymbosa*, March 26, 1945, lot 45-8864, S.S. 25321 (USNM); 6 larvae, *Cassia stahlii*, March 26, 1945, lot 45-7801, S.S. 24856 (USNM).

Larval Hosts

Apparently primarily *Cassia* spp. Bruner et al. (*1945*), Heinrich (*1945, 1956*), and Kimball (*1965*) listed *Caesalpinia gilliesii* (Wallich ex Hooker) Bentham, *Canavalia gladiata* (Jacquin) de Candole, *Cassia bicapsularis* L., and *C. corymbosa* Lamarck.

Distribution

Southern Florida and southern Texas. Also Mexico, Cuba, Puerto Rico, Haiti, Virgin Islands, Jamaica, Venezuela, Brazil, and Argentina (Heinrich, *1956*).

Biology

No information is available on the details of the biology of *F. argentina* in the literature, and it was not possible to investigate the biology of this species during this study. There appear to be some differences in regard to host species attacked by *F. argentina* and *F. pellucens*, and there might also be behavioral differences.

Parasitoids

No parasitoids have been reported in the literature as being associated with *F. argentina*.

Monoptilota pergratialis (Hulst)

Nephopteryx pergratialis Hulst, 1886: 162.

Description of Larva (figs. 25, 43, 61, 81, 100)

General.—Length 17.5–24.5 mm; width 2.8–4.4 mm.

Color.—Head yellow brown (brown in living larva); indistinct pale brown (brown to dark brown in living larva) tonofibrillary platelets; mandibles yellow brown to brown between preartis and postartis, becoming dark reddish brown distally and dark reddish brown along anterior and posterior margins; hypostoma pale brown with dark brown streak laterally; spinneret pale brown.

Prothoracic shield yellow brown, usually paler than head; frequently thoracic shield suffused with brown, particularly along lateral and latero-posterior margins (suffusions brown to black in living larva); tonofibrillary platelets of thoracic shield pale brown and indistinct.

Prespiracular plates yellow brown to brown, darker toward spiracles (sometimes black in living larva); tonofibrillary platelets of plates usually pale brown (darker in living larva).

Remainder of prothorax mostly pale yellowish white; brownish gray around prothoracic spiracular plates and lateral to, and posterior to, prothoracic shield. (In living larva, prothorax, other than shield, blue,[11] suffused with purple.)

Mesothorax and metathorax with protuberant integumental folds of dorsum brownish gray; remainder of dorsum, pleural region, and venter of mesothorax and metathorax pale yellowish white. (Living larva with mesothorax and metathorax blue, usually strongly suffused with purple.)

Mesothoracic SD1 rings very pale brown (slightly darker in living larva), indistinct, appearing incomplete mesally; in some larvae thoracic rings cannot be detected, their location marked only by pale areas surrounding SD1 setae.

Thoracic legs yellowish brown, sometimes with brown markings.

Abdomen similar to mesothorax and metathorax.

[11] Parts of body of living larvae are only blue when larvae are two-thirds grown or larger. Body is gray when in early instars.

Eighth abdominal segment SD1 rings pale brown (brown to dark brown in living larva), appearing open posteriorly.

Anal shield yellowish brown, usually darker along anterolateral margins; tonofibrillary platelets of anal shield pale brown, indistinct.

Peritreme of prothoracic and abdominal spiracles brown to dark brown.

Pinacula narrow, pale brown, usually only somewhat well developed at base of SD1 setae on abdomen.

Tonofibrillary platelets of remainder of body yellowish white, more or less readily detected on dorsum, contrasting somewhat with brownish gray of surrounding integument.

Head.—Width 1.98–2.28 mm; length 1.65–1.85 mm; surface slightly uneven; adfrontals reach approximately four-fifths to five-sixths distance to cervical triangle; AF2 setae below forking of epicranial suture; AF2 setae below imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum moderately emarginate; outer surface of mandibles without distinct carinae; inner surface of mandibles simple; sensilla styloconica of maxillae forked; spinneret long, about 10 times as long as median breadth.

Prothorax.—On shield, distance between D1 setae distinctly less than between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than distance between SD1 and XD2, distance between D1 and D2 distinctly greater than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae on each side arranged in approximately a vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax weak to moderately well developed; SD1 setae on mesothorax about 1.3 times as long as SD1 setae on metathorax; SD1 and SD2 pinacula on each side of metathorax separate; D1 and D2 pinacula of each side of metathorax separate.

Abdomen.—D2 setae on anterior segments about 1.2 mm long; D1 setae on anterior segments one-third to one-fourth as long as D2 setae; distance between D2 setae on segments 1–7 distinctly greater than distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 distinctly less than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets usually biordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 36–43, 39–47, 37–42, 39–42, and 26–30, respectively; spiracles on segment 8 slightly larger than spiracles on segment 7; horizontal diameter of spiracle of each side of segment 8 slightly less, or subequal to, distance between L1 and L2; SD1 rings of segment 8 weak to moderately well developed; SD1 setae of segment 8 only very slightly longer than SD1 setae of segment 7; 1 SV seta on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly less than distance between D1 and SD1; 1 SV seta on each side of segment 9.

Description of Pupa (figs. 124, 129, 142)

General.—Length 12.3–13.8 mm; width 3.5–4.4 mm.

Color.—Yellowish brown to reddish brown with gibba and postgibba darker.

Head.—Slightly wrinkled; setae short.

Thorax.—Prothorax slightly wrinkled to rugulose; spiracles small and somewhat indistinct; mesothorax slightly wrinkled to rugulose, without punctures; metathorax slightly wrinkled to rugulose, with 2 groups of about 50 punctures on each side of meson (punctures mostly closely grouped with some fused and irregular); setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 extending laterally to or beyond spiracles; punctures on segments 5–7 distinct and encircling segments; spiracles elliptical and distinct; short L2 setae usually present on segment 8; no setae on segment 9; gibba about five to six times as wide as median length; caudal margin of gibba slightly irregular with a series of punctures; cremastral "spines" consisting of four centrally located, hooked, posteriorly directed "spines" and two outer, posterolaterally and slightly ventrally directed, simple, or slightly curved, stouter "spines;" outer "spines" about two-thirds as long as inner "spines."

Material Examined

ALABAMA—Auburn, 2 larvae, lima bean and *Dahlia* stems, 14 Sept. 62, 62-24489, R. J. Ledbetter (USNM).

NORTH CAROLINA—Burgaw, 1 larva, lima bean stems, 28-VI-69, W. F. Walker. Pink Hill, 2 larvae, *Phaseolus vulgaris,* 21-VI-73, H. H. Neunzig and T. R. Weaver (USNM); 12 larvae, 5 pupae, *Phaseolus lunatus,* 28-VIII-73, H. H. Neunzig and T. R. Weaver (USNM); 6 larvae, black-eyed pea vines, 28-VIII-73, H. H. Neunzig and T. R. Weaver. Wilson, 5 larvae, lima bean stems, 5-IX-72, H. H. Neunzig and T. R. Weaver; 20 larvae, lima bean stems, 8-IX-72, H. H. Neunzig and T. R. Weaver; 11 pupae, soil under lima beans, 8-IX-72, H. H. Neunzig and T. R. Weaver; 8 larvae, *Phaseolus lunatus,* 18-VI-73, T. R. Weaver (USNM); 10 larvae, *Phaseolus lunatus,* 27-VI-73, T. R. Weaver.

Larval Hosts

Phaseolus lunatus L. (lima bean) is the principal host of *M. pergratialis* (the limabean vine borer). Its occurrence on other plants is rare. This insect has been collected during this study almost entirely from lima bean. A few larvae were reared from vines of *Phaseolus vulgaris* L. (snap bean) and *Vigna unguiculata* (L.) Walpers (black-eyed pea), but these plants were growing adjacent to heavily infested lima bean plants. Apparently *Dahlia* also can be a host (see Alabama under Material Examined); again, though, only when grown close to infested lima bean. The host of *M. pergratialis* in the Southwestern United States is unknown.

Heinrich (*1956*) suggested that because the "Arizona localities are mostly out of the range of lima bean cultivation" there is another host, "probably a wild legume." Heinrich, however, did not take into consideration that the lima bean apparently originated in Central America, was brought by Indians into the Southwestern and Southeastern United States, and is still grown in the Southwest by Indians (Mackie, *1943*). In all likelihood, therefore, the host of *M. pergratialis* in Arizona is lima bean. It possibly is associated with wild lima bean plants that have escaped and established themselves in favorable locations, or perhaps the insect occurs on lima bean grown by Arizona Indians.

Distribution

East Central and Southeastern United States (Maryland, south along Coastal Plain to Florida and west to Alabama) and Southwestern United States (Arizona).

Biology

M. pergratialis has about two generations each year in the northern part of its range (Maryland and Virginia) (Chittenden, *1900, 1902*; Brannon, *1934, 1945*), approximately three generations each year in eastern North Carolina, and more than three generations farther south.

Overwintering takes place as a prepupa in the soil.

Eggs are deposited mainly on the host stems. Usually they are placed singly in naturally occurring depressions of the stem (fig. 159, *A*). Brannon (*1945*) reported that eggs are also placed on leaves. Larvae hatching from the eggs either feed on leaves (Brannon, *1945*) or bore into the stem. Whitish or yellowish-white frass and silk accumulate as the larva feeds. Presumably the larvae that attack the leaves feed only briefly on foliage and in a short time bore into the stem. As the larva feeds and makes a cavity in the host, the stem gradually swells. This hypertrophy of the stem is difficult to detect with small larvae (fig. 159, *B*) but becomes very obvious with large larvae (figs. 159, *C*; 160, *B*).

Galls become somewhat fusiform, with maximum dimensions of about 70 mm long by 20 mm in circumference. Galls on hosts other than lima bean differ in shape; for example, on snap bean they are more globular. As the gall develops, its external surface changes from green to a grayish brown. In conjunction with this color change, the texture alters from relatively soft to a woody consistency. Internally the walls of the galls also darken. All or most of the frass is extruded through an opening in the side of the gall. This opening apparently is enlarged as the larva grows. The frass is silked to the outside of the stem at the opening, forming a loose, short, frass tube or hemispherical covering over the opening.

Galls are usually formed just above or just below the nodes of the host stems; many, however, occur at various points between nodes or at the node. The more mature parts of host stems appear to be preferred, with most galls appearing on the lower two-thirds of the host. Occasionally galls may be at soil level, with the larva boring shallowly into the root zone; but most larvae attack the aboveground parts of the plant.

Host plants apparently are infrequently killed completely. Most damage is a general weakening of the plant and a decrease in yield. Also some loss of vine occurs, where internal feeding weakens nodes and the wind detaches a part of the plant.

During the summer and fall, with heavy infestations, eggs are deposited on the galls (fig. 160, *A*), as well as on other noninfested parts of the hosts. Larvae hatching from eggs attached to galls frequently enter the existing gall and feed. Under these circumstances, several larvae of various sizes can be found in a single gall. No cannibalism has been observed with *M. pergratialis.* Usually where two or more larvae occupy a single shelter, the larvae partition the gall using silk and frass to at least partially isolate themselves.

When larvae complete their development, they leave the gall and enter the soil. At a depth of one-half to several centimeters they form a silken cocoon in which to transform.

In eastern North Carolina, spring emergence of adults is from late April to mid-May. Larvae are present on hosts from May to October.

Information on the biology of *M. pergratialis* in the Southwestern United States is not available.

Parasitoids

The following parasitoids have been reported in the literature as being associated with *M. pergratialis*: Eulophidae—*Euderus lividus* (Ashmead) (Chittenden, *1900*; Peck, *1951*). Ichneumonidae—*Mesostenus thoracicus* Cresson (Townes and Townes, *1951*).

During this study the following parasitoid was reared from immatures of *M. pergratialis*: Tachinidae—*Lydella* sp.

Ancylostomia stercorea (Zeller)

Myelois stercorea Zeller, 1848: 873.

Description of Larva (figs. 26, 44, 63, 84, 102)

General.—Length 10.3–17.9 mm; width 1.9–2.5 mm.

Color.—Head pale brownish yellow; tonofibrillary platelets of head pale brown to reddish brown, usually moderately distinct, all groups about equally pigmented; mandibles brown between preartis and postartis, becoming dark brown to black distally and dark brown to black along anterior and posterior margins; hypostoma mostly pale brown; spinneret pale brown.

Prothoracic shield pale brownish yellow; tonofibrillary platelets of thoracic shield pale brown to dark brown, not forming major color pattern of shield; usually a series of other brown patches or streaks form the dominant pattern on thoracic shield (darkest patches, and sometimes only ones present, located on each side posterior of SD1 setae (est stripes); other patches usually along dorsum of shield (md stripe), and on each side between XD1 and XD2, running posterior to, or just below, D2 (sst stripes); these patches or streaks on thoracic shield very broad in some specimens).

Prespiracular plates pale brownish yellow; tonofibrillary platelets of plates usually only slightly darker; dorsal and posterior margins usually brown to dark brown.

Remainder of prothorax yellowish white, with brown or gray streaks of md, sst, and est sometimes evident anterior of shield.

Mesothorax and metathorax yellowish white; stripes of mesothorax and metathorax usually very difficult to detect, most larvae appearing more or less uniform in color; a few specimens with very pale gray md, sst, and very occasionally fragmented est stripes on mesothorax and metathorax.

Mesothoracic SD1 rings usually pale brown dorsally, becoming dark brown ventrally; pale white within thoracic rings.

Thoracic legs mostly pale brownish yellow.

Abdomen yellowish white, more or less uniform in color; abdomen of some larvae with broad pale gray md stripe, pale gray, less distinct sst stripes, which apparently are not continuous in that they are very indistinct or missing posterior to D2 setae and near anterior and posterior intersegmental folds, and pale gray, usually fragmented est stripes, which usually are only detectable anterior of SD1 setae.

Eighth abdominal segment SD1 rings pale brown to dark brown.

Anal shield indistinct, about same color as surrounding integument or slightly darker, usually with brown markings; tonofibrillary platelets of anal shield pale brown to brown.

Peritreme of prothoracic and abdominal spiracles brown.

Pinacula pale brown to brown.

Tonofibrillary platelets of remainder of body usually indistinct, about same color as surrounding integument.

Head.—Width 1.12–1.39 mm; length 0.86–1.09 mm; surface slightly uneven; adfrontals reach about four-fifths to five-sixths distance to cervical triangle; AF2 setae slightly above, to slightly below, forking of epicranial suture; AF2 setae slightly above imaginary line between P1 setae; P1 setae slightly farther apart than P2 setae; labrum moderately emarginate; outer surface of mandibles rugulose to rugose, with weakly developed carina running from preartis of each mandible to tooth 2, and region between postartis of each mandible and tooth 1 not noticeably expanded; inner surface of mandibles simple; sensilla styloconica of maxillae forked; spinneret long, about 10 times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than distance between XD1 setae; on each side of shield, distance between SD1 and SD2 subequal to, or greater than, distance between SD1 and XD2, distance between D1 and D2 distinctly greater than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae arranged on each side in approximately a vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothrax moderately well to well developed; SD1 setae on mesothorax about 1.5 times as long as SD1 setae on metathorax; SD1 and SD2 pinacula on each side of metathorax fused; D1 and D2 pinacula on each side of metathorax fused.

Abdomen.—D2 setae on anterior segments about 0.5 mm long; D1 setae on anterior segments approximately one-half to two-thirds as long as D2 setae; distance between D2 setae on segments 1–7 distinctly greater than distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 distinctly less than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets mostly triordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 46–55, 45–59, 46–53, 47–57, and 36–50, respectively; spiracles on segment 8 slightly larger than spiracles on segment 7; horizontal diameter of spiracle of each side of segment 8 greater than distance between L1 and L2; SD1 rings of segment 8 moderately well to well developed; SD1 setae of segment 8 about 1.7 times as long as SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 considerably greater than distance between D1 and SD1 (D2 setae sometimes on same pinaculum); usually 2 SV setae on each side of segment 9.

Material Examined

FLORIDA—Miami, 4 larvae, *Cajanus cajan*, 8-II-1949, O. D. Link (FSCA); 5 larvae, *Cajanus cajan*, 23-II-1956, F. J. Formibella (FSCA).

Larval Hosts

Cajanus cajan (L.) Huth (pigeon pea) is the principal host. Heinrich (*1956*) mentioned *Cicer* (chickpea) and *Dolichos* as occasional hosts. The FSCA also has *A. stercorea* larvae collected from *Pisum* in Jamaica.

Distribution

Southern Florida and southern Texas (Heinrich, *1956*; Blanchard, *1970*). Also reported by Heinrich (*1956*) and Bennett (*1959*) from Cuba, Haiti, Dominican Republic, Virgin Islands, Jamaica, Bahamas, Grenada, St. Kitts, Trinidad, Mexico, Guatemala, Costa Rica, Panama, Colombia, French Guiana, Brazil, Guyana, Dominica, Montserrat, and Antigua.

Biology

According to Bennett (*1959*), a continuous series of generations of *A. stercorea* occurs each year, sometimes with a brief diapause in the pupal stage.

Eggs are laid on young legumes or occasionally on the sepals of flowers. Under normal circumstances, one to two eggs are placed on each legume or flower.

After the larva hatches from the egg, it moves over the exterior of the legume, feeding on the surface trichomes before boring into the seed cavity. A small mound of frass and silk covers the entrance hole (fig. 160, *C*). Within the legume the larva feeds on the developing seeds.

Unless the legume is abnormally small, sufficient food is usually available in one seed capsule for the larva to complete its development (fig. 160, *D*). When two or more larvae start feeding within a legume, the depletion of food as the larvae grow causes one or all larvae to move to another legume. When other than first-stage larvae enter legumes, the entrance hole is sealed with a silk mat.

Pupation occurs in the soil or infrequently in surface trash.

Parasitoids

The following parasitoids have been reported in the literature as being associated with *A. stercorea*: Bethylidae—*Parasierola* sp. (Bennett, *1959*). Braconidae—*Apanteles etiellae isolatus* Muesebeck (Bennett, *1959*); *Bracon cajani* Muesebeck (Bennett, *1959*); *B. thurberiphagae* (Muesebeck) (Bennett, *1959*); *Phanerotoma bennetti* Muesebeck (Bennett, *1959*). Ichneumonidae—*Eiphosoma dentator* (F.) as *E. annulatum* Cresson (Bennett, *1959*).

Etiella zinckenella (Treitschke)

Phycis zinckenella Treitschke, 1832: 201.

Description of Larva (figs. 27, 46, 64, 85, 103)

General.—Length 11.3–18.5 mm; width 2.0–3.0 mm.

Color.—Head pale brownish yellow, sometimes suffused with brown, particularly along posterior margins (living larva with head usually pale brown, partially transparent, with some green showing through integument); tonofibrillary platelets of head slightly darker than rest of head, usually relatively indistinct; brown (dark brown to black in living, or recently preserved larva) within arc of ocelli; mandibles pale brown along anterior and posterior margins; hypostoma pale brown; spinneret brownish yellow.

Prothoracic shield pale whitish yellow, sometimes suffused with brown (shield of living larva somewhat transparent, yellowish brown, with green to purple undertones); d and sd tonofibrillary platelets of thoracic shield pale brown to dark brown, usually forming a very distinctive feature, sometimes suffused with brown (platelets frequently black in living larva, sometimes suffused with dark brown).

Prespiracular plates yellowish white, indistinct anteriorly to pale brown and more distinct near spiracles (plates somewhat transparent, yellowish brown to dark brown with green undertones in living larva); tonofibrillary platelets of plates indistinct.

Remainder of prothorax yellowish white (occasionally faintly pink in recently preserved larva) (remainder of prothorax of living larva greenish to greenish blue with pale purple to purple around thoracic shield).

Mesothorax and metathorax yellowish white; stripes (md, sst, and est) usually very difficult to detect; most specimens more or less uniform in color with no apparent stripes on mesothorax and metathorax (sometimes pink on dorsum in recently preserved larvae) (mesothorax and metathorax in living larva with pale green, dark greenish-gray or pink md stripe; mesothorax and metathorax of some larvae with pink to reddish-brown sst stripes, with indistinct boundaries, and incomplete pink to reddish-brown est stripes; stripes of mesothorax and metathorax interspersed with greenish white to pale pink; sometimes white blotches also apparent at SD setae of mesothorax and metathorax; other larvae with mesothorax and metathorax darker and more uniform in color, without discernible stripes, mostly purple or reddish purple; venter greenish white to bluish green).

Thoracic legs mostly yellowish brown (white or greenish white with brown and dark brown in living larva).

Abdomen similar to mesothorax and metathorax (abdomen of living larva similar to mesothorax and metathorax, except with striped larvae sst and est stripes on abdomen slightly oblique, extending on each segment more or less from an anterior dorsal to a posterior ventral site; fragmentary pink hst stripes also sometimes present on abdomen; color of abdomen usually more intense than on thorax; venter of abdomen usually with more pink or purple than on venter of thorax).

Anal shield brownish yellow (pale brown with green, pink, or purple in living larva); tonofibrillary platelets of anal shield slightly darker.

Peritreme of prothoracic and abdominal spiracles brown to dark brown.

Pinacula indistinct.

Tonofibrillary platelets of remainder of body usually indistinct (more or less distinct in living dark purple larvae).

Head.—Width 1.09–1.52 mm; length 0.83–0.99 mm; surface slightly irregular; adfrontals reach, or almost reach, cervical triangle; AF2 setae below forking of epicranial suture; AF2 setae below imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum shallowly emarginate; outer surface of mandibles with weakly developed carina running from preartis of each mandible to tooth 2, and region between postartis of each mandible and tooth 1 slightly enlarged; inner surface of mandibles simple; sensilla styloconica of maxillae usually shallowly forked, sometimes simple; spinneret long, approximately nine times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than distance between XD1 setae; on each side of shield, distance between SD1 and SD2 less than distance between SD1 and XD2, distance between D1 and D2 distinctly greater than distance between D1 and XD1, and XD2, SD1, and SD2 usually form a right angle; L setae on each side arranged in a horizontal or approximately horizontal configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax absent; SD1 setae on mesothorax equal to, or only very slightly longer than, SD1 setae on metathorax.

Abdomen.—D2 setae on anterior segments about 1.2 mm long; D1 setae on anterior segments almost as long as D2 setae; distance between D2 setae on segments 1–7 distinctly greater than distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 very distinctly less than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets mostly biordinal, number on prolegs 3, 4, 5, 6, and anal segment 30–48, 32–48, 30–45, 33–48, and 22–37, respectively; spiracles on segment 8 slightly larger than spiracles on segment 7; horizontal diameter of spiracle of each side of segment 8 distinctly less than distance between L1 and L2; SD1 rings of segment 8 absent; SD1 setae of segment 8 only slightly longer than SD1 setae of segment 7; usually 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly greater than distance between D1 and SD1; 1 SV seta on each side of segment 9.

Description of Pupa (figs. 125, 139, 140)

General.—Length 8.1–10.8 mm; width 2.1–2.6 mm.

Color.—Brownish yellow to yellowish brown with gibba and postgibba reddish brown.

Head.—Slightly wrinkled; setae short.

Thorax.—Prothorax slightly wrinkled; spiracles relatively distinct; mesothorax slightly wrinkled, at times with few faint punctures; metathorax slightly wrinkled, with about 35 punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 extending laterally to, or beyond, spiracles; punctures on segments 5–7 distinct and encircling segments; spiracles moderately large, elliptical; short L2 usually present on segment 8; no setae on segment 9; gibba distinct, about four to five times as wide as median length; caudal margin of gibba distinct, delineated by slightly irregular row of punctures; cremastral "spines" consisting of four centrally located, posteriorly or posterolaterally directed "spines" and two outer, almost as long, posterolaterally directed, hooked "spines;" base from which spines arise sometimes enlarged.

Material Examined

CALIFORNIA—San Diego, 10 larvae, 1 pupa, *Lupinus arboreus*, 7-IX-73, H. H. Neunzig. Upper Ojai, 2 larvae, *Astragalus*, locoweed, (no date), S. E. Flanders Colr. (USNM). Ventura, 20 pupae, in lima bean, Apr. 1940, through Truck Crop Div. Insects (USNM); 6 larvae, 2 pupae, lima bean legumes, 7-IX-73, H. H. Neunzig.

FLORIDA—Big Pine Key, 1 larva, *Crotalaria*, 9-V-73, H. H. Neunzig (USNM). Boca Raton, 20 larvae, 12 pupae, *Crotalaria*, 8-IX-75, H. H. Neunzig (USNM). Delray Gardens, 28 larvae, 5 pupae, *Crotalaria*, 8-IX-74, H. H. Neunzig. Fort Pierce, 29 larvae, 16 pupae, *Crotalaria*, 11-IX-74, H. H. Neunzig. Hypoluxo, 8 larvae, *Crotalaria*, 14-V-73, H. H. Neunzig (USNM). Long Key, 2 larvae, *Galactia spiciformis*, 28-III-74, H. H. Neunzig (USNM). Lower Matecumbe Key, *Galactia spiciformis*, 5-IX-75, H. H. Neunzig. Perrine, 15 larvae, 6 pupae, *Crotalaria*, 12-V-73, H. H. Neunzig; 2 larvae, *Crotalaria* sp., 6-IX-75, H. H. Neunzig; 8 larvae, 2 pupae, *Crotalaria*, 6-IX-75, H. H. Neunzig. Port Salerno, 15 larvae, 9 pupae, *Crotalaria*, 8-IV-75, H. H. Neunzig

(USNM). Riviera Beach, 32 larvae, 17 pupae, *Crotalaria*, 13-V-73, H. H. Neunzig; 5 larvae, *Crotalaria*, 9-IX-74, H. H. Neunzig (USNM).

NORTH CAROLINA—Fayetteville, 1 larva, *Crotalaria*, 4-IX-70, H. H. Neunzig (USNM); 2 larvae, 1 pupa, *Crotalaria*, 26-VI-71, H. H. Neunzig; 1 larva, *Baptisia*, 13-VI-73, H. H. Neunzig.

Larval Hosts

E. zinckenella (the limabean pod borer) occurs on a large number of leguminous plants. During this study *E. zinckenella* was collected from *Baptisia cinerea* (Rafinesque) Fernald and Schubert, *Crotalaria angulata* Miller, *C. incana* L., *C. lanceolata* Ernst Meyer, *C. mucronata* Desvaux, *C. spectabilis* Roth, *Galactia spiciformis* Torrey and Gray, *Lupinus arboreus* Sims, and *Phaseolus lunatus* L. (lima bean).

Schad and Giugnard (*1943*), Parker (*1951*), Naito (*1961*), Stone (*1965*), and Singh and Dhooria (*1971*) listed many other hosts belonging to the following genera: *Astragalus, Cajanus, Calycotome, Caragana, Cicer, Citrullus, Colutea, Coronilla, Crotalaria, Cytisus, Dolichos, Dorycnium (Bonjeannia), Glycine, Isomeris, Lathyrus, Lens, Lotus, Lupinus, Pachyrhizus, Phaseolus, Pisum, Robinia, Sesbania, Spartium, Tephrosia, Vicia,* and *Vigna.* With the exception of *Citrullus* and *Isomeris,* the genera belong to the Fabaceae.

Distribution

Throughout the warmer parts of the Southern United States, from southeastern North Carolina to California. A very widely distributed species, occurring in most tropical and warm temperate countries or regions of the world (Whalley, *1973*).

Biology

In warm temperate areas, development is arrested or slowed with cool temperatures (Flanders, *1930*; Schad and Guignard, *1943*; Popova, *1957*; Abul-Nasr and Awadalla, *1959*; Stone, *1965*; Peiu, *1967*; Singh and Dhooria, *1971*); this dormant period is usually passed as a last-stage larva. In the tropical parts of its range, although their numbers decrease during certain months, development is rather continuous, with larvae of all instars present throughout the year (Wolcott, *1933, 1934*; Scott, *1940*).

Eggs of *E. zinckenella* are deposited on or near buds, blossoms, or legumes of the host. With some hosts, apparently rather definite places on the host are usually selected. For example, with *Crotalaria* legumes, Wolcott (*1934*) reported that eggs are usually placed in the dorsal depression of the seed capsule, with a few fastened to the lateral and ventral surface of the legumes. Also Abul-Nasr and Awadalla (*1959*) and Singh and Dhooria (*1971*) reported that with *Vigna unguiculata, Pisum sativum,* and *Lens culinaris* the eggs are deposited under the calyx or close to the calyx of the legumes.

Larvae, upon hatching, feed on blossoms, small legumes, or relatively large legumes. According to Scott (*1940*), feeding by the larvae on blossoms or small legumes causes these plant parts to abort. With legumes, the larva usually forms a very small protective covering of silk, legume fragments, and frass on the surface of the legume at the site where it enters the capsule (Wolcott, *1934*; Abul-Nasr and Awadalla, *1959*; Singh and Dhooria, *1971*). Within the legume, the larva feeds on the developing seeds. With lima bean, most *Crotalaria* spp., and other hosts with large legumes, usually enough, or more than enough, food material is present in one legume to nourish the larva throughout its larval life (fig. 161, *A*). With other hosts, such as *Cicer arietinum, Lens culinaris,* and similar plants with small legumes and seeds, the larva has to attack several legumes to obtain adequate sustenance. Also with large legume species, the larva is able to use the legume as a shelter while it feeds internally. The only indication usually that the larva is present, other than the very small callus formed where the larva initially entered the legume, is that as a considerable part of the seeds is eaten, frass accumulates within the legume, imparting a slight color change externally where it touches the legume wall. As reported by Sandhu and Verma (*1968*) and by Singh and Dhooria (*1971*), small legumes do not individually provide adequate shelter, particularly with late-stage larvae, and the insect webs together two or more legumes for concealment.

With large populations, where several larvae utilize a single, large legume for food and shelter, the legume usually provides adequate shelter, but all the seeds at times are consumed before all the larvae complete their development. Under these circumstances, some larvae move to other legumes, leaving circular exit holes in the damaged legume. Usually a conspicuous entrance hole has to be made in the legume that the larva selects to complete its development. However, once the larva is inside, it silks over the opening, presumably as a protective measure.

Upon completion of larval development, the larva crawls to the soil to form a slightly elongate silk cocoon in which it pupates. Relatively large exit holes are evident in legumes where larvae have left host plants (fig. 161, *B*).

According to Stone (*1965*), there are three to five generations each year in southern California. Emergence of adults from overwintering larvae starts in January and continues into September, with most moths emerging in May and June. Larvae start to become dormant in preparation for overwintering as early as July, with most ceasing development in the fall.

In southeastern North Carolina, most adults emerge from late April to early May. Several generations follow with larvae on hosts from May through October. Most larvae enter the soil and become inactive in September.

Parasitoids

The following parasitoids have been reported in the literature as being associated with *E. zinckenella*: Bethylidae—*Parasierola cellularis* (Say) (Oatman, *1967*). Braconidae—*Apanteles clavatus* (Provancher) (Muesebeck, *1967*); *A. etiellae* Viereck (Hyslop, *1912*; Thompson, *1945*; Muesebeck and Walkley, *1951*; Parker, *1951*; Stone, *1965*); *Ascogaster quadridentata* Wesmael (Parker, *1951*; Stone, *1965*); *Bracon gelechiae* Ashmead (Flanders, *1930*; Thompson, *1945*; Parker, *1951*; Stone, *1965*); *B. hyslopi* (Viereck) (Hyslop, *1912*; Muesebeck and Walkley, *1951*; Parker, *1951*; Stone, *1965*); *B. junicola* Ashmead (Muesebeck and Walkley, *1951*); *B. pectoralis* Wesmael (Parker, *1951*; Stone, *1965*); *B. piger* Wesmael (Parker, *1951*; Stone, *1965*); *B. platynotae* (Cushman) (Oatman, *1967*); *B. spartiellae* Rondani (Parker, *1951*); *B. tychii* (Muesebeck) (Flanders, *1930*; Thompson, *1945*; Muesebeck and Walkley, *1951*; Parker, *1951*; Stone, *1965*); *Cardiochiles saltator* (F.) (Parker, *1951*); *Chelonus inanita* (L.) (Stone, *1965*); *Heterospilus etiellae* Rohwer (Thompson, *1945*; Parker, *1951*); *Phanerotoma planifrons* (Nees) (Parker, *1951*; Stone, *1965*). Elasmidae—*Elasmus atratus* Howard (Parker, *1951*; Stone, *1965*). Eulophidae—*Euplectrus bicolor* (Swederus) (Sakharov, *1923*; Thompson, *1945*; Parker, *1951*; Stone, *1965*). Eupelmidae—*Eupelmus urozonus* Dalman (Sakharov, *1923*; Thompson, *1945*; Parker, *1951*; Stone, *1965*). Eurytomidae—*Eurytoma* sp. (near *tylodermatis* Ashmead) (Flanders, *1930*; Stone, *1965*); *Eurytoma appendigaster* (Swederus) (Parker, *1951*; Stone, *1965*). Ichneumonidae—*Agrotherentes solitarius* (Tschek) as *A. zygaenarum* (Thomson) (Parker, *1951*); *Agrypon stenostigma* Thomson (Pilyugin, *1925*; Thompson, *1945*; Parker, *1951*; Stone, *1965*); *Campoplex fusciplica* (Thomson) sometimes as *Omorgus fusciplicus* Thomson (Pilyugin, *1925*; Thompson, *1945*; Parker, *1951*; Stone, *1965*); *C. tricolaripes* (Schmiedknecht) sometimes as *Omorgus tricoloripes* Schmiedknecht (Parker, *1951*; Stone, *1965*); *Corcygominus spurius* (Gravenhorst) as *Pimpla strigipleuris* Thomson (Thompson, *1945*; Parker, *1951*); *Cryptus albitarsis rufovinctus* (Pratt) as *Trachysphyrus albitarsis rufovinctus* (Pratt) (Townes and Townes, *1951*, *1962*); "*C. armatorius* (F.)" (Parker, *1951*); *Diadegma* spp. (=*Angita*; =*Horogenes* auctorum, nec Foerster) (Stone, *1965*); "*Ichneumon ignotus* Fonscolombe" (Stone, *1965*); *Meringopus tejonensis* (Cresson) as *Cryptus tejonensis* (Cresson) (Stone, *1965*); *Pimpla strigipleuris* Thomson (Thompson, *1945*); *Pristomerus vulnerator* (Panzer) (Thompson, *1945*; Parker, *1951*; Stone, *1965*); *Scambus* sp. (Parker, *1951*; Stone, *1965*); *S.* (*Scambus*) *aplopappi* (Ashmead) sometimes as *Pimpla aplopappi* Ashmead (Flanders, *1930*; Thompson, *1945*; Parker, *1951*; Townes and Townes, *1951*; Stone, *1965*); *S.* (*Scambus*) *brevicornis* (Gravenhorst) as *Pimpla brevicornis* (Gravenhorst), *P. nigriscaposa* Thomson, and *P. punctiventris* Thomson (Pilyugin, *1925*; Thompson, *1945*; Parker, *1951*; Stone, *1965*); *S.* (*Scambus*) *elegens* (Woldstedt) as *S. albicrus* Rondani (Parker, *1951*); *S.* (*Scambus*) *planatus* Hartig as *Pimpla ventricosa* Tschek (Sakharov, *1923*; Thompson, *1945*; Stone, *1965*); *S. vescicarius* (Ratzburg) (Parker, *1951*); *Sinophorus fuscicarpus* (Thomson) sometimes as *Campoplex fuscicarpus* (Thomson) (Parker, *1951*; Stone, *1965*); *Theroscopus hemip-*

terus (F.) as *Aptesis hemipterus* (F.) (Parker, *1951*); *Trichomma maceratum* (Cresson) (Flanders, *1930*; Thompson, *1945*; Parker, *1951*; Townes and Townes, *1951*; Stone, *1965*); *Troctocerus elegans* Woldstedt (Parker, *1951*). Pteromalidae—*Cyrtoptyx lichtensteini* (Masi) (Stone, *1965*); *Zatropis tortricides* Crawford (Flanders, *1930*; Thompson, *1945*; Parker, *1951*; Peck, *1951*; Stone, *1965*; Oatman, *1967*). Tachinidae—*Aphria longirostris* (Meigen) (Parker, *1951*); *Erynnia tortricis* (Coquillett) (Stone, *1965*); *Nemorilla floralis* (Fallen) (Parker, *1951*); *Pseudoperichaeta nigrolineata* (Walker) as *Zenillia roseanae* (Brauer and Bergenstamm) (Parker, *1951*; Stone, *1965*); *Zenillia libatrix* (Panzer) (Thompson, *1945*). Trichogrammatidae—*Trichogramma minutum* Riley (Thompson, *1945*; Parker, *1951*).

During this study the following parasitoids were reared from immatures of *E. zinckenella*: Braconidae—*Heterospilus etiellae* Rohwer, *Phanerotoma* sp. Tachinidae—*Nemorilla* sp.

Ulophora groteii Ragonot

Ulophora groteii Ragonot, 1890: 7.

Description of Larva (figs. 30, 45, 65, 86, 105)

General.—Length 8.8–15.0 mm; width 1.6–2.3 mm.

Color.—Head pale brown to brown usually with whitish yellow (pale blue undertones in living larva)[12] surrounding adfrontals, beneath P setae, and extending laterally to near A3 setae; tonofibrillary platelets of head slightly darker than surrounding integument, usually indistinct; mandibles reddish brown basally between preartis and postartis, becoming darker distally and along anterior and posterior margins; hypostoma pale brown to brown; spinneret pale brown to brown.

Prothoracic shield pale yellowish brown; md and sd tonofibrillary platelets of thoracic shield usually pale brown (living larva with shield pale brown, indistinct, partially transparent with bluish undertones).

Prespiracular plates similar to surrounding integument, indistinct, very pale brown (partially transparent with bluish undertones in living larva).

Remainder of prothorax yellowish white (blue in living larva).

Mesothorax and metathorax yellowish white (blue, usually lightly suffused with purple dorsally in living larva).

Thoracic legs usually yellowish brown.

Abdomen yellowish white (mostly purple or bluish purple dorsally becoming blue ventrally in living larvae; dark blue md stripe also usually distinct on abdominal segments and whitish malpighian tubules evident dorsally near middle of abdomen).

Anal shield yellowish brown, without distinct markings.

Peritreme of prothoracic and abdominal spiracles dark brown.

Pinacula absent.

Tonofibrillary platelets of remainder of body obscure, white to yellowish white.

Head.—Width 0.92–1.12 mm; length 0.92–0.99 mm; surface slightly uneven; adfrontals reach, or almost reach, cervical triangle; AF2 setae below forking of epicranial suture; AF2 setae below imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum shallowly emarginate; outer surface of mandibles without distinct carinae; inner surface of mandibles simple; sensilla styloconica of maxillae shallowly forked; spinneret long, about 10 times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than distance between XD1 setae; on each side of shield, distance between SD1 and SD2 usually less than distance between SD1 and XD2, distance between D1 and D2 less than, or subequal to, distance between D1 and XD1, and XD2, SD1, and SD2 form a right angle; L setae on each side arranged in a horizontal, or approximately horizontal, configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax absent; SD1 setae on mesothorax equal to, or only very slightly longer than, SD1 setae on metathorax.

Abdomen.—D2 setae on anterior segments about 0.6 mm long; D1 setae on anterior segments about one-half as long as D2 setae; distance between D2 setae on segments 1–7 distinctly greater than distance between D1 setae; distance between D1 and D2 on each side of seg-

[12] Parts of head and body of living larvae are only blue in late instars; live early-stage larvae are whitish and have parts of integument somewhat transparent.

ments 3–6 very distinctly less than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets usually biordinal, number on prolegs of 3, 4, 5, 6, and anal segment 32–40, 36–40, 34–42, 30–40, and 23–32, respectively; spiracles on segment 8 slightly larger than spiracles on segment 7; horizontal diameter of spiracle of each side of segment 8 distinctly less than distance between L1 and L2; SD1 rings of segment 8 absent; SD1 setae of segment 8 only slightly longer than SD1 setae of segment 7; usually 1 (sometimes 2) SV seta(e) on each side of segment 8; distance between D1 and D2 on each side of segment 9 slightly less, to slightly greater, than distance between D1 and SD1; 1 SV seta on each side of segment 9.

Description of Pupa (figs. 128, 146)

General.—Length 4.8–7.5 mm; width 1.4–2.3 mm.

Color.—Yellowish brown with gibba and postgibba usually brown.

Head.—Slightly wrinkled; setae short.

Thorax.—Prothorax smooth to slightly irregular; spiracles distinct; mesothorax smooth to slightly irregular, without punctures; metathorax smooth to slightly irregular, with 2 groups of about 35 loosely grouped punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 extending laterally to, or beyond, spiracles; punctures on segments 5–7 distinct and encircling segments; spiracles elliptical; short L2 usually present on segment 8; no setae on segment 9; gibba about five times as wide as median length; caudal margin of gibba slightly irregular, distinctly demarcated by row of punctures; cremastral "spines" consisting of four centrally located, closely grouped, hooked, posteriorly directed "spines" and two outer, distinctly shorter, hooked, posterolaterally and slightly ventrally directed "spines;" outer "spines" enlarged at base.

Material Examined

NORTH CAROLINA—Clayton, 1 larva, *Tephrosia*, 8-VIII-71, H. H. Neunzig (USNM). Fayetteville, 5 larvae, 5 pupae, *Tephrosia*, 28-VII-71, H. H. Neunzig (USNM); 2 larvae, *Tephrosia*, 4-VIII-75, H. H. Neunzig. Jacksonville, 3 larvae, *Tephrosia*, 9-VIII-72, H. H. Neunzig. Southern Pines, 1 larva, 3 pupae, *Tephrosia virginiana*, 8-VII-70, H. H. Neunzig, T. R. Weaver, and J. D. Wellborn; 2 larvae, *Tephrosia*, 15-VII-70, H. H. Neunzig, T. R. Weaver, and J. D. Wellborn (USNM).

TEXAS—Tyler, 15 larvae, 2 pupae, *Tephrosia* sp. legumes, 8-IX-73, H. H. Neunzig.

Larval Hosts

Tephrosia spp. Reared during this study from *Tephrosia florida* (Dietrich) C. E. Wood and *T. virginiana* (L.) Persoon. Bissell (*1940*) also has reared *U. groteii* from *T.* (*Cracca*) *spicata* (Walter) Torrey and Gray.

Distribution

Southeastern United States (west to eastern Texas). Also north to New Jersey (Heinrich, *1956*).

Biology

U. groteii apparently has two or more generations each year. Overwintering occurs in the pupal stage in a silk cocoon in the soil.

The oviposition site is unknown. It seems likely, however, that eggs are usually placed on fully expanded legumes with small partially developed seeds. First-stage larvae almost invariably bore into the distolateral region of the legumes. Whitish frass is initially deposited to one side of the excavation or around the hole. Sometimes a thin silk covering is added. As the larva bores more deeply, slightly yellowish castings are expelled and formed into a small, rough tube or mound at the entrance (fig. 161, *C*). On gaining access to the interior of the legume, the larva feeds on the tissue that surrounds the developing seeds. Usually the insect moves slowly toward the base of the legume, still feeding on the tissue around the seeds until it reaches about the center of the seed capsule. This movement within the legume usually takes about a week and the larva molts at least once. Then several seeds are eaten, and moist, compacted frass eventually partially fills the legume (fig. 162, *A*). Each larva during its development consumes three to six seeds and usually damages several others (fig. 162, *B*).

Large larvae feed entirely within the legumes. They usually can obtain enough food within a single legume so that they do not need to move to other legumes. In some areas, competition for food occurs because of more than one *Ulophora* larva in each legume or *Apion* weevils. Cannibalism apparently occurs where more than one *Ulophora* are present, and this usually results in adequate food even with multiple infestations. Last-stage larvae and adults vary considerably in size. Possibly this indicates that, despite a food shortage or poor condition of the food, at least some larvae, although small, are able to pupate and complete development.

With completion of larval development, an exit hole is bored in the lateral face of the infested legume. Pupation takes place in the soil.

In southeastern North Carolina, adults of the overwintering population appear in late May and June. Larvae of various sizes are present in host legumes through September.

Parasitoids

The following parasitoids have been reported in the literature as being associated with *U. groteii*: Braconidae—*Heterospilus* sp. (Bissell, *1940*). Eupelmidae—*Eupelmus cyaniceps amicus* Girault (Bissell, *1940*; Peck, *1951*).

During this study the following parasitoids were reared from immatures of *U. groteii*: Braconidae—*Cardiochiles apicalis* (Cresson). Ichneumonidae—*Pristomerus austrinus* Townes.

Pima albiplagiatella occidentalis Heinrich

Pima albiplagiatella occidentalis Heinrich, 1956: 103.

Description of Larva[13] (figs. 29, 47, 67, 87, 104)

General.—Length 13.1–20.5 mm; width 2.5–3.6 mm. (Last instar (in hibernaculum) length 8.1–12.9 mm; width 2.6–2.9 mm.)

Color.—Head pale brownish yellow (white in living or recently preserved larva); tonofibrillary platelets of head usually relatively indistinct, pale brown (green or greenish yellow in living larva); dark brown (dark brown to black in living larva) within arc of ocelli; mandibles usually pale yellow to pale brown basally between preartis and postartis, becoming brown to dark brown distally and dark brown along anterior and posterior margins; hypostoma pale; spinneret pale brown to brown. (Larva in hibernaculum (last instar) with sutures and anterior parts of head, including mandibles, darker and more distinct.)

Prothoracic shield usually yellowish white (greenish white to white in living larva), same color as, or but slightly darker than, remainder of body; d tonofibrillary platelets of thoracic shield pale brown to brown, small and relatively inconspicuous; sd platelets, particularly the more or less circular group on each side of the shield posterior or posterodorsal to XD2, brown to dark brown, usually distinct (this group sometimes black in living larva and very distinctive). (Larva in hibernaculum (last instar) paler, when alive, with greenish-yellow or green platelets on the thoracic shield.)

Prespiracular plates whitish (greenish white to white in living larva), essentially same color as surrounding integument.

Remainder of prothorax yellowish white (living larva with remainder of prothorax pale green, heavily overlaid with chalky white over most of segment, and pale green undertones showing through, mostly in folds).

Mesothorax and metathorax yellowish white (living larva with mesothorax and metathorax pale green, heavily overlaid with chalky white, pale green undertones showing through, mostly in the folds of the integument, and chalky white spots and patches sometimes forming vague, irregular md, sd, sst, and est stripes). (Larva in hibernaculum (last instar), when alive, or recently preserved, at times with indistinct red spots on dorsum of mesothorax and metathorax.)

Thoracic legs mostly yellowish white with small amounts of pale brown to brown markings.

Abdomen similar to mesothorax and metathorax (living larva almost entirely chalky white). (Larva in hibernaculum (last instar), when alive, or recently preserved, also occasionally with faint red or brownish-red spots or stripes on dorsum of abdomen.)

Anal shield but slightly darker than surrounding integument; tonofibrillary platelets of anal shield pale green, gray, or brown and inconspicuous.

Peritreme of prothoracic and abdominal spiracles brown to dark brown.

[13] Penultimate instar (largest feeding stage), unless otherwise stated.

Pinacula very indistinct.

Tonofibrillary platelets of remainder of body pale, sometimes moderately distinct, where surrounded by white hypodermal pigmentation.

Head.—Width 1.39–1.52 mm; length 0.99–1.16 mm. (Last instar, width 1.19–1.39 mm; length 0.96–1.02 mm); surface slightly uneven; adfrontals reach approximately three-fourths to four-fifths distance to cervical triangle; AF2 setae below, slightly above, or at forking of epicranial suture; AF2 setae slightly above imaginary line between P1 setae; distance between P1 setae subequal to, or slightly greater than, distance between P2 setae; labrum moderately emarginate; outer surface of mandibles without distinct carina extending from preartis of each mandible to tooth 2, and region between postartis of each mandible and tooth 1 only slightly enlarged; inner surface of mandibles simple; sensilla styloconica of maxillae forked; spinneret short, about five to six times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than distance between XD1 setae; on each side of shield, distance between SD1 and SD2 subequal to, or slightly greater than, distance between SD1 and XD2, distance between D1 and D2 greater than distance between D1 and XD1, and XD2, SD1, and SD2 form almost a right angle; L setae on each side sometimes arranged at about a 45° angle, sometimes in a more vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax very weakly developed (appear absent on most specimens); SD1 setae on mesothorax about 1.2 times as long as SD1 setae on metathorax.

Abdomen.—D2 setae on anterior segments about 0.8 mm long (D2 setae of last-stage larva (in hibernaculum) only about 0.3 mm long); D1 setae on anterior segments about one-fourth to one-third as long as D2 setae (last stage with D1 setae one-sixth to one-fourth as long as D2 setae); distance between D2 setae on segments 1–7 slightly greater than, or subequal to, distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 distinctly less than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets biordinal or triordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 40–46, 38–47, 41–45, 41–48, and 24–32, respectively (prolegs of last instar (in hibernaculum) very short, crochets mostly uniordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 13–15, 14–17, 14–18, 13–17, and 8–12, respectively); spiracles on segment 8 slightly larger than spiracles on segment 7; horizontal diameter of spiracle on each side of segment 8 slightly greater than, or subequal to, distance between L1 and L2 (last instar (in hibernaculum) with horizontal diameter of spiracles on each side of segment 8 slightly less than distance between L1 and L2);[14] SD1 rings on segment 8 very weakly developed (appear absent on most larvae); SD1 setae of segment 8 about 1.3 times as long as SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly greater than distance between D1 and SD1; usually 2 SV setae on each side of segment 9.

Description of Pupa

General.—Length 7.6–10.5 mm; width 2.0–2.4 mm. Pupa, in general, slender, with mesothorax abruptly enlarged so that it appears to have "shoulders."

Color.—Yellowish brown with reddish-brown caudal segments.

Head.—Slightly wrinkled; setae short.

Thorax.—Prothorax smooth to slightly wrinkled; spiracles distinct; mesothorax smooth to slightly wrinkled, without punctures; metathorax smooth to slightly wrinkled, with 2 groups of about 25 loosely grouped punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 not extending laterally to spiracles; punctures on segments 5–7 distinct and encircling segment; spiracles relatively large, elongate; D1, SD1, L2, and at times L1, or a few more ventral setae, or both present on segment 8; D1 and L2, and at times a few other more ventral setae present on segment 9; gibba absent; segment 10 with six well-separated, hooked, cremastral "spines;" all "spines" approximtely same length and diameter; other dorsal or ventral setae also sometimes present on segment 10.

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[14] All spiracles are narrower in last instar than in penultimate instar.

Material Examined

ARIZONA—Douglas, 10 larvae, 1 pupa, *Astragalus*, 25-IV-74, H. H. Neunzig.

NEW MEXICO—Alamogordo, 25 larvae, 5 pupae, *Astragalus*, 26-IV-74, H. H. Neunzig; 12 larvae, *Astragalus wootonii*, 26-IV-74, H. H. Neunzig (USNM). Lordsburg, 3 larvae, *Astragalus*, 25-IV-74, H. H. Neunzig (USNM); 2 larvae, *Astragalus allochrous*, 26-IV-75, H. H. Neunzig.

TEXAS—Marfa, 5 larva, *Astragalus wootonii*, 27-IV-75, H. H. Neunzig (USNM).

Larval Hosts

Astragalus spp. Reared during this study from *Astragalus allochrous* Gray, *A. thurberi* Gray, and *A. wootonii* Sheldon. Also, *Lathyrus* (Heinrich, *1956*).

Distribution

Southwestern United States, including the Trans-Pecos of Texas, New Mexico, Arizona, and California. Also reported by Heinrich (*1956*) from Colorado, Oregon, and Washington.

Biology

P. albiplagiatella occidentalis in Texas, New Mexico, and Arizona has one to two generations each year. Most of the population appears to have only one generation because of a dormant period in the last instar that delays development.[15] In the spring in the Southwestern United States, adults emerge in March and April (Heinrich, *1956*; Blanchard, *1970*). The oviposition site is unknown, but eggs are probably placed mostly on the developing legumes.

Larvae, upon hatching, usually bore into the developing legumes. McDunnough (*1935*) and Heinrich (*1956*) stated that *Pima* larvae feed in host flower buds and flowers, but this was not observed with *P. albiplagiatella occidentalis*. A site near the base of a legume is usually selected for the entrance hole. After gaining entrance, the larvae place a mat of white silk over the opening. Within the legume, they frequently do not stay near where they entered but move from one developing seed to another, partially eating a few of them. As they become larger, they eat entire seeds, and usually all the seeds of the first legume entered are eventually destroyed. The larvae then chew their way out of the legume, frequently by enlarging the silked-over entrance hole, and enter another nearby legume. The entrance hole into the second legume is silked over from within (fig. 163, *A*), and the second series of seeds are attacked.

Legumes with extensive destruction of seeds develop pale, translucent, or slightly brownish areas externally. Internally all that is left is a mass of wet frass, usually at one end of the legume. The entire contents, or most of the contents, of several legumes are eaten by each larva.

When the larvae reach their maximum size, they again bore out of the host legume and crawl or drop to the soil surface. Exit holes in the legumes, particularly relatively large openings made by late-stage larvae, are the most obvious indication that *Pima* larvae have been present on a particular host (fig. 162, *D*).

Many species of *Astragalus* in the Southwestern United States have legumes that are large enough so that larvae, even as late instars, can feed entirely within the seed capsule. With some host species, however, such as *A. thurberi*, that have relatively small legumes, large larvae have to feed with only part of the body within the legume. Under these circumstances, the larvae sometimes loosely silk several capsules together to form a crude shelter.

On the soil surface, after completion of feeding, the larvae crawl under debris. Here most individuals assume a U-shaped position and construct about themselves a hibernaculum in which they remain for 9 to 10 months. The hibernaculum (fig. 162, *C*) is a flattened hemisphere about 4 mm high and 6.5 mm in diameter. It is constructed usually entirely of silk. Soil, plant material, and so forth are usually not incorporated into the structure but sometimes adhere to the surface. Internally it is very smooth. By using a considerable amount of silk, the structure is relatively dense. On completion of the hibernaculum, the larva molts, and the cast exuvium is pushed into one end of the hibernaculum and lightly silked over. In the spring the larva chews an exit hole in the hibernaculum and usually moves to a new location under the debris

[15] McDunnough (*1935*) mentioned that some larvae of *Pima* (*Epischnia*) *albiplagiatella* (Packard) in eastern Canada also form hibernacula on completion of feeding rather than pupate. In addition, he referred to similar observations by European workers, probably relating to *P.* (*Epischnia*) *boisduvaliella* (Guénée).

to form an elongate silk cocoon in which it pupates.

A few larvae do not form a hibernaculum after completion of feeding but directly form an elongate cocoon and pupate. They emerge as adults about May in the Southwestern United States and oviposit on late developing hosts. No information is available, but presumably larvae hatching from these eggs feed, reach maximum size, and form hibernacula.

Parasitoids

No parasitoids associated with *P. albiplagiatella occidentalis* have been reported in the literature.

During this study the following parasitoid was reared from immatures of *P. albiplagiatella occidentalis*: Braconidae—*Chelonus* sp.

Pima granitella (Ragonot)

Epischnia granitella Ragonot, 1887: 9.

Description of Larva[16] (figs. 28, 48, 66, 88, 107)

General.—Length 14.4–22.5 mm; width 2.8–3.8 mm. (Last instar (in hibernaculum) length 10.6–17.4 mm; width 3.0–3.5 mm.)

Color.—Head usually pale brownish yellow (pale brown in living or recently preserved larva); tonofibrillary platelets of head usually distinct, brown (dark brown to black in living larva; usually pale brown to brown in larvae in hibernaculum (last instar)); dark brown (dark brown to black in living larva) within arc of ocelli; other parts of head occasionally suffused with brown; mandibles pale brown to reddish brown between preartis and postartis, becoming dark brown to dark reddish brown distally; hypostoma usually partially dark brown; spinneret brown (larva in hibernaculum (last instar) with sutures and anterior parts of head, including mandibles darker and more distinct).

Prothoracic shield whitish yellow (pale brown in living larva); d and sd tonofibrillary platelets of thoracic shield brown (brown to black in living larva, with sd group on each side fused into a more or less distinct, circular spot); entire thoracic shield or parts of shield frequently suffused with pale brown to brown. (Larva in hibernaculum (last instar) with platelets of thoracic shield paler, pale brown to brown.)

Prespiracular plates yellowish white (mostly greenish white in living larva), with only posterior margin distinct and brown; tonofibrillary platelets of plates usually brown, frequently indistinct.

Remainder of prothorax yellowish white anterior to shield; brown tonofibrillary platelets along meson just anterior to prothoracic shield; at times with gray spots or partial stripes just lateral of prothoracic shield (est) and at level of spiracles (st); sometimes other very irregular stripes below prothoracic spiracles (recently preserved larva with pink spots or stripes) (living larva with remainder of prothorax pale green with anterior of shield and lateral region strongly mottled with chalky white and pink or pale brown (pale green more distinct in folds and on venter), sometimes pink or pale brown spots form stripes or partial stripes on prothorax). (Larva in hibernaculum (last instar), when alive, or recently preserved, usually with remainder of prothorax darker, at times heavily suffused with purple.)

Mesothorax and metathorax yellowish white; at times with irregular gray md, sd, sst, and est mesothoracic and metathoracic stripes (all stripes fragmented, particularly est); partially gray st stripes also sometimes present on mesothorax and metathorax; numerous gray spots or blotches between mesothoracic and metathoracic stripes, sometimes including venter (recently preserved larvae with stripes sometimes pink rather than gray); some specimens with no apparent mesothoracic and metathoracic stripes. (Living larva with mesothorax and metathorax pale green, strongly mottled with chalky white and pink or pale brown, usually with irregular, fragmented pink to brownish-red md, sd, sst, and est stripes, and at times small fragments of reddish st stripes) (larva in hibernaculum (last instar), when alive, or recently preserved, usually with mesothorax and metathorax darkly colored, at times, heavily suffused with purple).

Thoracic legs yellowish white with pale brown to brown markings.

Abdomen similar to mesothorax and metathorax (living larva usually with green undertones more heavily suffused with pink to reddish brown and chalky white) (larva in hibernaculum (last instar), when alive or recently preserved, with abdomen usually more darkly pigmented, at times heavily suffused with purple).

[16]See footnote 13, p. 34.

Anal shield only slightly darker than surrounding integument; tonofibrillary platelets of anal shield gray or brown, inconspicuous.

Peritreme of prothorax and abdominal spiracles brown to dark brown.

Pinacula indistinct.

Tonofibrillary platelets of remainder of body pale, sometimes moderately distinct on living larvae with pink or gray stripes.

Head.—Width 1.25–1.58 mm; length 0.83–1.25 mm. (Last instar (in hibernaculum) width 1.19–1.52 mm; length 0.79–1.09 mm); surface slightly uneven; adfrontals reach approximately three-fourths to four-fifths distance to cervical triangle; AF2 setae slightly below, slightly above, or at forking of epicranial suture; AF2 setae slightly above, to on, imaginary line between P1 setae; distance between P1 setae subequal to, slightly greater than, or less than distance between P2 setae; labrum moderately emarginate; outer surface of mandibles without distinct carina extending from preartis of each mandible to tooth 2, and region between postartis of each mandible and tooth 1 not noticeably enlarged; inner surface of mandibles simple; sensilla styloconica of maxillae entire, more or less straight; spinneret short, about five to six times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than distance between XD1 setae; on each side of shield, distance between SD1 and SD2 subequal to, or slightly greater than, distance between SD1 and XD2, distance between D1 and D2 greater than distance between D1 and XD1, and XD2, SD1, and SD2 form almost a right angle; L setae on each side sometimes arranged in approximately a vertical configuration, sometimes positioned at about a 45° angle.

Mesothorax and Metathorax.—SD1 rings of mesothorax very weakly developed (appear absent); SD1 setae on mesothorax about 1.3 times as long as SD1 setae on metathorax.

Abdomen.—D2 setae on anterior segments about 0.7 mm long (D2 setae of last instar (in hibernaculum) only about 0.5 mm long); D1 setae on anterior segments about one-third as long as D2 setae (last stage (in hibernaculum) with D1 setae between one-fourth to one-third as long as D2 setae); distance between D2 setae on segments 1–7 slightly greater than, or subequal to, distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 distinctly less than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets usually biordinal, sometimes triordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 34–52, 32–56, 33–58, 35–54, and 20–34, respectively (prolegs of last instar (in hibernaculum) very short, crochets mostly uniordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 17–20, 17–23, 19–22, 19–23, and 13–15, respectively); spiracles on segment 8 slightly larger than spiracles on segment 7; horizontal diameter of spiracle on each side of segment 8 slightly greater than distance between L1 and L2 (last instar (in hibernaculum) with horizontal diameter of spiracles on each side of segment 8 slightly less than distance between L1 and L2);[17] SD1 rings of segment 8 very weakly developed (appear absent); SD1 setae of segment 8 about 1.3 times as long as SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly greater than distance between D1 and SD1; usually 1 SV seta on each side of segment 9.

Description of Pupa (figs. 127, 148)

General.—Length 8.8–12.3 mm; width 2.1–2.5 mm. Pupa, in general, slender with mesothorax abruptly enlarged so that it appears to have "shoulders."

Color.—Yellowish brown usually with some reddish brown dorsally, encircling anterior of abdominal segments 4–7, and on caudal segments.

Head.—Slightly wrinkled; setae short.

Thorax.—Prothorax smooth to slightly wrinkled; spiracles distinct; mesothorax smooth to slightly wrinkled, without punctures; metathorax smooth to slightly wrinkled, with 2 groups of about 25 loosely grouped punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 not extending laterally to spiracles; punctures on segments 5–7 distinct and encircling segment; spiracles relatively large, elongate; D1, SD1, L2, and at times L1, or a few more ventral setae, or both

[17] See footnote 14, p. 35.

present on segment 8; D1 and L2 and at times a few other more ventral setae present on segment 9; gibba absent; segment 10 with 6 well-separated, hooked, cremastral "spines;" all "spines" approximately same length and diameter; other dorsal or ventral setae also sometimes present on segment 10.

Material Examined

NEW MEXICO—Lordsburg, 10 larvae, *Astragalus*, 25-IV-74, H. H. Neunzig (USNM).

TEXAS—Fort Davis, 5 larvae, 2 pupae, *Astragalus*, 28-IV-74, H. H. Neunzig; 7 larvae, 2 pupae, *Astragalus mollissimus*, 27-IV-75, H. H. Neunzig. Marfa, 4 larvae, *Astragalus*, 28-IV-74, H. H. Neunzig (USNM).

Larval Hosts

Reared during this study from *Astragalus allochrous* Gray and *A. mollissimus* var. *earlei* (Rydberg) Tidestrom. Heinrich (*1956*) gave *Crotalaria* (*Crotolaria*) as a host.

Distribution

Southwestern United States, including the Trans-Pecos of Texas, New Mexico, Arizona, and California. Also Colorado, Utah, Nevada, and Washington (Heinrich, *1956*).

Biology

P. granitella in Texas, New Mexico, and Arizona has one to two generations each year. Most individuals are univoltine. As with *P. albiplagiatella occidentalis*, all but a few larvae on leaving the host form hibernacula, molt into the last instar, and become nonfeeding and quiescent during the summer, fall, and winter.

The seasonal occurrence and behavior of the larvae of *P. granitella* and of *P. albiplagiatella occidentalis* seem similar.

Feeding habits on *Astragalus* spp. that grow erect with large legumes are identical to those of *P. albiplagiatella occidentalis*. However, in west Texas, *P. granitella* occurs on *Astragalus mollissimus* var. *earlei* (fig. 163, *B*), a host where the distal, legume-bearing parts of the plant are decumbent and lie on the soil surface. Also frequently the legumes are covered or partially covered by more dorsal, younger leaflets of the plant. On *A. mollissimus* var. *earlei* the larvae modify their behavior in that they make no attempt to silk over entrance holes into legumes. Also some frass is extruded through the opening. This modification is apparently related to the more protected location of the legumes.

Parasitoids

No parasitoids have been reported in the literature as being associated with *P. granitella*.

During this study the following parasitoid was reared from immatures of *P. granitella*: Braconidae—*Chelonus* sp.

Nephopterix dammersi floridensis Heinrich

Nephopteryx dammersi floridensis Heinrich, 1956: 126.

Description of Larva (figs. 68, 106)

See Doerksen and Neunzig (*1975*) for description. Additional studies of the trophi have shown that the sensilla styloconica of the maxillae are forked (usually bifurcate, but at times with three or four processes).

Description of Pupa

See Doerksen and Neunzig (*1975*).

Larval Host

Amorpha herbacea Walter (Heinrich, *1956*; Kimball, *1965*; Doerksen and Neunzig, *1975*, *1976*).

Distribution

Southeastern North Carolina, Florida, and probably the Coastal Plain region of States between (Doerksen and Neunzig, *1975*).

Biology

See figure 163, *C*, and Doerksen and Neunzig (*1976*).

Parasitoids

See Doerksen and Neunzig (*1976*).

Nephopterix subcaesiella (Clemens)

Pempelia subcaesiella Clemens, 1860: 206.

Description of Larva (figs. 8, 69, 110)

See Doerksen and Neunzig (*1975*) for description. Additional studies of the trophi have shown that the sensilla styloconica of the maxillae are forked (usually bifurcate, but at times with three or four processes).

Description of Pupa

See Doerksen and Neunzig (*1975*).

Larval Hosts

Doerksen and Neunzig (*1975, 1976*) listed *Robinia hispida* L., *R. pseudoacacia* L. (black locust), *R. viscosa* Ventenat, and *Wisteria frutescens* (L.) Poiret as hosts of *N. subcaesiella* (the locust leafroller). Also collected during the present study from *R. nana* Elliott.

Distribution

Throughout much of North Carolina, South Carolina, Georgia, Alabama, and Mississippi. Particularly abundant in the higher elevations of these Southern States. Also Maine, New Hampshire, New York, Massachusetts, New Jersey, Pennsylvania, Maryland, District of Columbia, Virginia, Tennessee, Illinois, Iowa, Missouri, Arkansas, Nova Scotia, and Ontario (Prentice, *1965*; Doerksen and Neunzig, *1975*).

Biology

See figure 164, *A–C*, and Doerksen and Neunzig (*1976*).

Parasitoids

See Doerksen and Neunzig (*1976*).

Nephopterix virgatella (Clemens)

Pempelia virgatella Clemens, 1860: 205.

Description of Larva (figs. 70, 111)

See Doerksen and Neunzig (*1975*) for description. Additional studies of the trophi have shown that the sensilla styloconica of the maxillae are forked (with two, three, or four processes).

Description of Pupa

See Doerksen and Neunzig (*1975*).

Larval Host

Robinia pseudoacacia L. (black locust) (Doerksen and Neunzig, *1975, 1976*).

Distribution

The cooler parts of North Carolina and probably the higher elevations of a few other Southeastern States. Also District of Columbia, West Virginia, Pennsylvania, New Jersey, Massachusetts, Maine, Illinois, Missouri, Arkansas, Nova Scotia, and Ontario (Doerksen and Neunzig, *1975*).

Biology

See Doerksen and Neunzig (*1976*).

Parasitoids

See Doerksen and Neunzig (*1976*).

Tlascala reductella (Walker)

Nephopteryx reductella Walker, 1863: 63.

Description of Larva (figs. 33, 49, 71, 89, 112)

General.—Length 11.9–19.8 mm; width 2.0–3.1 mm.

Color.—Head whitish yellow (white in living larva); usually anterior part of sd cl and anterior of l group of tonofibrillary platelets of head brown to dark brown (black in living larva) with other platelets much paler; occasionally all platelets of head pale brown, or anterior of sd group and sd cl, anterior of l group, and anterior of sv group, dark brown, with other platelets paler brown; brownish (dark brown in living larva) patches sometimes associated with ocelli; mandibles reddish brown basally between preartis and postartis, becoming dark brown to black distally and dark brown to black along anterior and posterior margins; hypostoma mostly whitish yellow or pale brown; spinneret pale brown to brown.

Prothoracic shield whitish yellow (white in living larva); d and sd tonofibrillary platelets of thoracic shield pale brown (brown in living larva); at times brown streak extending posteriorly from SD1 on each side of thoracic shield along margin of shield (anterior extension of est stripe); thoracic shield of a few specimens on each side with additional small brown patches between D2 and SD2 (sst stripe) and brown suffusions at sd platelets; some specimens with thoracic shield completely pale, without brownish platelets or brown patches or suffusions.

Prespiracular plates whitish yellow (white in living larva) usually with pale brown to brown tonofibrillary platelets.

Remainder of prothorax yellowish white, at times with gray streaks (est stripes) adjacent to lateral margins of shield and extending anterior of SD1 setae (recently preserved larva occasionally faintly pink) (living larva with remainder of prothorax mostly pale yellowish white to greenish white, at times with gray or black streaks associated with shield; white or yellow below shield and around spiracles; a few larvae also marked with pink or red).

Mesothorax and metathorax yellowish white; very pale gray to dark gray sst and est mesothoracic and metathoracic stripes; some specimens without discernible mesothoracic and metathoracic stripes (recently preserved larva occasionally with pink or red pigmentation, particularly on dorsum; living larva with mesothorax and metathorax pale yellowish white becoming greenish white ventrally; about one-half of larvae have distinct mesothoracic and metathoracic stripes; when thoracic stripes present, md stripe gray or grayish green bordered by yellow, sd stripes pale brown, grayish brown, reddish brown, or greenish brown bordered by yellow above and white below, sst stripes pale brown, reddish brown, or greenish brown to dark brown or black bordered by white, est stripes pale brown to black bordered by white above and yellow below, and sometimes fragments of more ventral st and hst stripes bordered by yellow; many larvae have some thoracic stripes pale and indistinct, a few larvae with all stripes very faint; some larvae have mesothorax and metathorax with reddish cast).

Mesothoracic SD1 rings very pale brown to dark brown (brown to black in living larva), appearing incomplete, and most strongly pigmented ventrally.

Thoracic legs usually mostly yellowish brown.

Abdomen yellowish white usually with pale gray sst and est stripes; with some strongly pigmented individuals, fragments of md and sd stripes sometimes visible on caudal segments of abdomen; some specimens without any discernible abdominal stripes (recently preserved larvae occasionally with abdomen pink or red, particularly on dorsum) (living larva with abdomen similar to mesothorax and metathorax except st and hst stripes usually more pronounced; larvae with indistinct stripes on thorax also have indistinct stripes on abdomen; some larvae with all abdominal segments, or just caudal segments, with a reddish cast).

Eighth abdominal segment SD1 rings very pale brown to dark brown (gray to black in living larva), appearing incomplete, usually strongest posteriorly.

Anal shield whitish yellow with pale brown tonofibrillary platelets.

Peritreme of prothoracic and abdominal spiracles usually dark brown.

Pinacula mostly indistinct (very pale to dark brown in living larva).

Tonofibrillary platelets of remainder of body mostly about same color as surrounding integument (indistinct, gray, shiny in living larva); those associated with stripes, or postspiracular platelets on abdominal segments 3–6, pale brown.

Head.—Width 1.65–1.95 mm; length 1.49–1.65 mm; surface slightly uneven to rugulose; adfrontals reach approximately four-fifths to five-sixths distance to cervical triangle; AF2 setae at, or slightly above, forking of epicranial suture; AF2 setae slightly above, to slightly below, imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum moderately to strongly emarginate; outer surface of mandibles with weakly developed carina extending from preartis of each mandible to tooth 2 (does not reach tooth 1), and region between postartis of each mandible and tooth 1 slightly expanded; inner surface of each mandible with low retinaculum associated with inner ridge leading to tooth 2 (very low or missing on some specimens because of wear); sensilla styloconica of maxillae forked; spinneret long, about 12 times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than distance between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than distance between SD1 and XD2, distance between D1 and D2 distinctly greater than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae on each side arranged in approximately a vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax strongly developed (appear incomplete or weak because of partial pigmentation); SD1 setae on mesothorax about twice as long as SD1 setae on metathorax; SD1 and SD2 pinacula of each side of metathorax separate, and D1 and D2 pinacula of each side of metathorax separate (pinacula sometimes missing on lightly pigmented or faded specimens).

Abdomen.—D2 setae on anterior segments about 0.5 mm long; D1 setae on anterior segments about one-third to one-half as long as D2 setae; distance between D2 setae on segments 1–7 slightly greater than distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 distinctly less than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets usually triordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 60–79, 66–77, 64–79, 67–80, and 57–68, respectively; spiracles on segment 8 at least 1.5 times larger than spiracles on segment 7; horizontal diameter of spiracle of each side of segment 8 greater than, or subequal to, distance between L1 and L2; SD1 rings of segment 8 well developed; SD1 setae of segment 8 about 1.5 times as long as SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 slightly greater than distance between D1 and SD1; 2 SV setae on each side of segment 9.

Description of Pupa (figs. 126, 147)

General.—Length 7.4–10.6 mm; width 2.4–2.6 mm.

Color.—Reddish brown with darker dorsal longitudinal streak on thorax and abdomen; gibba and postgibba usually darker than rest of pupa.

Head.—Rugulose; setae short.

Thorax.—Rugulose; spiracles absent; mesothorax rugulose, with many shallow but relatively distinct punctures; metathorax rugulose, with 2 groups of about 40 loosely grouped punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segment 1–4 with numerous punctures; punctures on segment 4 extending laterally to or beyond spiracles; punctures on segments 5–7 distinct and encircling segments; spiracles relatively large, circular; short D1 and L2 usually present on segment 8; no setae on segment 9; gibba strongly developed, four to five times as wide as median length; caudal margin of gibba slightly irregular with distinct line of punctures; cremastral "spines" consisting of four centrally located, posteriorly directed, hooked "spines" and two outer, laterally or lateroposteriorly directed, much shorter, hooked "spines;" outer "spines" arising from small protuberances.

Material Examined

GEORGIA—Taccoa, 2 larvae, *Gleditsia*, 13-IX-73, H. H. Neunzig (USNM).

LOUISIANA—New Orleans, 10 larvae, 2 pupae, *Gleditsia*, 5-VI-72, H. H. Neunzig.

NORTH CAROLINA—Fayetteville, 15 larvae, 5 pupae, *Gleditsia*, 23-VI-70, H. H. Neunzig (USNM); 3 larvae, *Gleditsia*, 26-VI-73, H. H. Neunzig; 8 larvae, 2 pupae, *Gleditsia*, 9-VIII-74, H. H. Neunzig (USNM); 12 larvae, *Gleditsia*, 16-VIII-74, H. H. Neunzig (USNM); 5 larvae, *Gleditsia*, 4-VIII-75, H. H. Neunzig.

SOUTH CAROLINA—Anderson, 12 larvae, 1 pupa, *Gleditsia*, 6-IX-73, H. H. Neunzig (USNM). Greenville, 4 larvae, *Gleditsia*, 13-IX-73, H. H. Neunzig. Spartenburg, 2 larvae, *Gleditsia*, 13-IX-73, H. H. Neunzig.

Larval Host

Apparently occurs only on *Gleditsia triacanthos* L. (honeylocust).

Distribution

Southeastern United States (west to eastern Texas). Also District of Columbia, Maryland, Pennsylvania, Illinois, Iowa, Kansas, and Missouri (Heinrich, *1956*) and Ontario (Prentice, *1965*).

Biology

A few notes on the biology of *T. reductella* have been published by Comstock (*1881*) and Packard (*1890*).

Several generations of *T. reductella* occur each year. Overwintering takes place in the pupal stage in the soil.

Since eggs of *T. reductella* have not been found on the host, the exact oviposition site is unknown. First instars are found between two leaflets silked together to form a flat shelter. Usually adjacent leaflets on the same side of the rachis are chosen. The upper or lower epidermis and mesophyll are consumed. External evidence of larval feeding consists of small whitish or pale brown necrotic areas on the outer surface of the leaves forming the shelter. As the larva grows, more leaflets are incorporated into the structure (fig. 164, *D*). All leaflets, however, are still left attached to the rachis. At times a white silk tube with its base attached to the rachis and its distal parts fastened to the leaflets is formed partially exposed and partially within the leaf shelter.

Older larvae inhabit structures similar to those formed by earlier instars (fig. 165, *A*). Last-stage larvae usually add several dead, brownish leaflets that have been cut from the rachis (fig. 165, *B*). Also in the vicinity of shelters of large larvae, leaflets are missing, having been removed and eaten or used for construction by the larva. Small stubs of the leaflet petiolule remain attached, at least temporarily, to the rachis. Large larvae apparently also do not merely skeletonize the leaflets but eat all tissues, at times leaving scraps of leaflets silked to the shelter.

With heavy infestations, almost all the leaves of a host tree are eaten. The leaves remaining are mostly those that form the shelters of the larvae (fig. 165, *C*).

In southeastern North Carolina, small larvae first appear on host trees in April. Larvae of all stages continue to be present throughout the growing season. Most larvae in September enter the soil to pupate and overwinter.

Parasitoids

No parasitoids have been reported in the literature as being associated with *T. reductella*.

During this study the following parasitoid was reared from *T. reductella*: Ichneumonidae—*Seticornuta apicalis* (Cresson).

Caristanius minimus Neunzig

Caristanius minimus Neunzig, 1977: 555.

Description of Larva (figs. 32, 50, 72, 90, 108)

General.—Length 11.3–18.1 mm; width 1.8–2.1 mm.

Color.—Head yellowish white (white to greenish white in living larva); tonofibrillary platelets of head distinct, with md group brown to dark brown, sd cl and sd group mostly brown to dark brown, with lateroposterior parts of sd group pale, and l and sv groups mostly pale brown, with anterior part of l group usually dark brown; dark brown (dark brown to black in living larva) associated with arc of ocelli; mandibles yellowish white basally between preartis and postartis, becoming dark brown distally and dark brown along anterior and posterior margins; hypostoma pale; spinneret brown. (Most living larvae also have ocellus 6 surrounded by reddish spot, reddish patches at base of P setae and A2 setae and on adfrontal region and center of frons.)

Prothoracic shield yellowish white (white to greenish white in living larva); narrow pale brown to dark brown (black in living larva) patch along dorsum of thoracic shield (md stripe), a narrow pale to dark brown (black in living larva) patch on each side of shield at SD1 extending along shield margin (est stripes), and a distinct, broad pale brown to dark brown (black in living larva) patch on each side of shield (sst stripes) extending from between XD1 and XD2 posteriorly to between D2 and SD2 (patch usually broader posteriorly); sometimes a number of pale brown tonofibrillary platelets between pigmented patches on thoracic shield. (Living larva usually also has some faint reddish anterior extensions of sd stripes on thoracic shield.)

Prespiracular plates yellowish white (white in living larva); pale to dark brown tonofibrillary platelets on plates.

Remainder of prothorax mostly yellowish white with gray extensions of md, sst, and est stripes anterior of shield, sometimes fragmentary, gray hst stripes also present on prothorax (some recently preserved larvae with stripes, or other parts of integument of thorax, or both, red) (living larva with remainder of prothorax white, or greenish or yellowish white, and region anterior of shield with grayish-purple md, sst, and est stripes, pink or red sd stripes, and purple or red incomplete st and hst stripes).

Mesothorax and metathorax yellowish white with gray md, sst, and est stripes; sst and est of mesothorax and metathorax usually broad and partially fused; very pale gray sd stripes and fragments of hst stripes also sometimes present on mesothorax and metathorax (some recently preserved larvae with stripes, or other parts of integument of mesothorax and metathorax, or both, red) (living larva with mesothorax and metathorax white to yellowish white with purple md stripe, red sd stripes, and purple sst and est stripes; red or purple st and hst stripes also usually present on mesothorax and metathorax; blotchy, irregular, red and white areas below hst stripes extending to venter of mesothorax and metathorax).

Mesothoracic SD1 rings dark brown (black in living larva).

Thoracic legs white with pale to dark brown markings.

Abdomen similar to mesothorax and metathorax.

Eighth abdominal segment SD1 rings brown to dark brown (black in living larva).

Anal shield yellowish white (white or yellowish white mottled with red in living larva), with brown to dark brown (black in living larva) lateral margins (sst stripe); tonofibrillary platelets of anal shield small, pale to dark.

Peritreme of prothoracic and abdominal spiracles brown to dark brown.

Pinacula brown to dark brown or reddish brown, sometimes missing on some larvae.

Tonofibrillary platelets usually similar in color to surrounding integument; some platelets associated with stripes gray (greenish gray in living larva), more or less distinct.

Head.—Width 1.52–1.68 mm; length 1.22–1.29 mm; adfrontals reach approximately four-fifths to five-sixths distance to cervical triangle; AF2 setae below forking of epicranial suture; AF2 setae below imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum moderately to strongly emarginate; outer surface of mandibles with distinct, well-developed carina extending distally from preartis of each mandible to tooth 2 and tooth 1, and region between postartis of each mandible and tooth 1 noticeably expanded into a second carina; inner surface of mandibles simple; sensilla styloconica of maxillae forked (2 or 3 processes); spinneret long, about 11 to 12 times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than, or subequal to, distance between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than distance between SD1 and XD2, distance between D1 and D2 slightly less than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae on each side arranged in approximately a vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax strongly developed; SD1 setae on mesothorax slightly less than twice as long as SD1 setae on metathorax; SD1 pinaculum of each side of metathorax sometimes slightly enlarged, but not fused with SD2 pinaculum; D1 and D2 pinacula of each side of metathorax separate.

Abdomen.—D2 setae on anterior segments about 0.9 mm long; D1 setae on anterior segments about three-fourths as long as D2 setae; distance between D2 setae on segments 1–7 slightly greater than, or subequal to, distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 distinctly greater than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets usually triordinal, some biordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 68–75, 66–72, 66–74, 68–77, and 67–70, respectively; spiracles on segment 8 at least 1.5 times larger than spiracles on segment 7; horizontal diameter of spiracle on each side of segment 8 greater than distance between L1 and L2; SD1 rings of segment 8 strongly developed; SD1 setae of segment 8 about twice as long as SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly greater than distance between D1 and SD1; D1, D2, and SD1 on each side of segment 9 on separate pinacula; 2 SV setae on each side of segment 9.

Description of Pupa (figs. 130, 149)

General.—Length 7.5–9.9 mm; width 2.0–2.3 mm.

Color.—Yellowish brown with gibba, and sometimes postgibba reddish brown to dark reddish brown.

Head.—Slightly wrinkled; setae short.

Thorax.—Prothorax slightly irregular; spiracles distinct; mesothorax slightly irregular, without punctures; metathorax slightly irregular, with 2 groups of about 25 loosely grouped punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 extending laterally, usually to, or beyond, spiracles; punctures on segments 5–7 distinct and encircling segments; spiracles elliptical, distinct; short D1 and

L2 usually present on segment 8; no setae on segment 9; gibba about four to five times as wide as median length; caudal margin of gibba very irregular with two or more distinctive, posterior extensions; mesal region of gibba produced dorsally and slightly anteriorly; cremastral "spines" consisting of four centrally located, posteriorly directed, hooked "spines" and two outer, lateroposteriorly and slightly ventrally directed, slightly hooked, or simple "spines;" outer "spines" almost as long as inner "spines," arising from distinct protuberances.

Material Examined

FLORIDA—Big Pine Key, 4 larvae, 1 pupa, *Cassia keyensis*, 10-V-73, H. H. Neunzig (USNM); 4 larvae, 5 pupae, *Cassia keyensis*, 6-IX-74, H. H. Neunzig; 6 larvae, 1 pupa, *Cassia keyensis*, 4-IX-75, H. H. Neunzig; 2 larvae, *Cassia keyensis*, 4-IX-75, H. H. Neunzig (USNM).

Larval Host

Cassia keyensis (Pennell) Macbride. According to Long and Lakela (*1971*), *C. keyensis* is endemic to southern Florida.

Distribution

Southern Florida.

Biology

Data on seasonal occurrence are few. However, *C. minimus* apparently has several generations each year.

Much of the behavior of *C. minimus* appears to be similar to that of *C. decoloralis*. Eggs are laid on the host plant; if the plant has *C. minimus* shelters already on it, the eggs are concentrated on the silk and other parts of these structures. Although many larval shelters of *C. minimus* are constructed in the upper part of the host plants (fig. 166, *A* and *B*), some *C. minimus*, particularly the larger larvae, form shelters near the base of the host plant. These basal shelters are composed of soil, debris, and silk (fig. 166, *C*).

Pupation occurs in the soil in a silk case.

Parasitoids

No parasitoids have been reported in the literature as being associated with *C. minimus*.

During this study the following parasitoid was reared from immatures of *C. minimus*: Braconidae—*Apanteles* sp.

Caristanius decoloralis (Walker)

Trachonitis decoloralis Walker, 1863: 42.

Description of Larva (figs. 31, 51, 73, 91, 109)

General.—Length 17.3-24.0 mm; width 2.1-2.9 mm.

Color.—Head yellowish white (white to pale greenish white in living larva); usually with groups of tonofibrillary platelets pale brown and relatively inconspicuous; a few larvae with distinct dark brown platelets on head; dark brown (dark brown to black in living larva) arc at ocelli; head occasionally with brown (dark brown to black in living larva) ring encircling base of some setae; mandibles yellowish white to yellowish brown basally between preartis and postartis, becoming dark brown distally and dark brown along anterior and posterior margins; hypostoma pale brown; spinneret brown.

Prothoracic shield yellowish white (white in living larva); one to several pale brown to dark brown (dark brown to black in living larva) longitudinal patches on thoracic shield; most distinct, broadest stripes of shield extend on each side from between XD1 and XD2 to between D2 and SD2 (sst stripes); much narrower, less distinct lines or patches sometimes along dorsum of shield (md stripe) and along ventral margins of shield (est stripes); d and sd tonofibrillary platelets of thoracic shield usually pale brown (pale brown or pale green in living larva).

Prespiracular plates yellowish white (white in living larva), usually with a few pale brown to brown tonofibrillary platelets.

Remainder of prothorax yellowish white, sometimes with gray, or brownish gray, md, sd, sst, and est stripes anterior to shield (some recently preserved specimens with red or pink pigmentation; remainder of prothorax of living larva white to greenish white, sometimes with red, purple, or black md, sd, sst, and est stripes anterior to shield).

Mesothorax and metathorax yellowish white, usually with broad, partially fused grayish sst and est stripes; with some darkly pigmented specimens, pale gray, relatively narrow md, sd, and partial hst stripes are also present on mesothorax and metathorax (some recently preserved specimens with md, sd, st, and hst stripes pale pink, and sst and est stripes purplish gray) (living larva with mesothorax and metathorax white, yellowish white, or greenish white with red to pale purple md and sd stripes and dark purple sst and est stripes; at times additional pale purple st and hst stripes also on mesothorax and metathorax).

Mesothoracic SD1 rings brown to dark brown (black in living larva).

Thoracic legs usually whitish yellow, sometimes partially marked with brown or dark brown.

Abdomen similar to mesothorax and metathorax (living larva with abdomen similar to mesothorax and metathorax, but color of stripes usually more intense and delineation of stripes usually more distinct; intervals between stripes on abdomen usually slightly more yellowish dorsally and slightly more greenish ventrally; venter of abdomen pale greenish white, some segments at times with pink pigmentation).

Eighth abdominal segment SD1 rings brown to dark brown.

Anal shield yellowish white (white in living larva), with a few pale brown to brown tonofibrillary platelets and bordered laterally with broad brown (dark brown to black in living larva) patches (est stripes).

Peritreme of prothoracic and abdominal spiracles brown to dark brown.

Pinacula very pale to dark brown (dark brown to black in living larva, but narrow and relatively indistinct).

Tonofibrillary platelets of remainder of body pale yellowish white to gray within stripes with darkly pigmented specimens; postspiracular platelets brown (living larva with most platelets green, indistinct).

Head.—Width 1.72–1.82 mm; length 1.35–1.42 mm; surface slightly uneven to rugulose; adfrontals reach approximately three-fourths to five-sixths distance to cervical triangle; AF2 setae below forking of epicranial suture; AF2 setae below imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum moderately to strongly emarginate; outer surface of mandibles with distinct, well-developed carina extending distally from preartis of each mandible to tooth 2 (and usually to tooth 1), and region between postartis of each mandible and tooth 1 noticeably expanded into a second carina; inner surface of mandibles simple; sensilla styloconica of maxillae forked; spinneret long, about 11 to 12 times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than, or subequal to, distance between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than distance between SD1 and XD2, distance between D1 and D2 slightly less, to slightly greater, than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae on each side arranged in approximately a vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax strongly developed; SD1 setae on mesothorax slightly less than twice as long as SD1 setae on metathorax; SD1 pinaculum on each side of metathorax sometimes slightly enlarged, but not fused with SD2 pinaculum; D1 and D2 pinacula of each side of metathorax separate.

Abdomen.—D2 setae on anterior segments about 1.0 mm long; D1 setae on anterior segments approximately three-fourths as long as D2 setae; distance between D2 setae on segments 1–7 slightly greater than, or subequal to, distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 distinctly greater than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets usually triordinal, some biordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 66–71, 63–74, 66–73, 68–73, and 68–73, respectively; spiracles of segment 8 at least 1.5 times larger than spiracles of segment 7; horizontal diameter of spiracle of each side of segment 8 greater than distance between L1 and L2; SD1 rings of segment 8 strongly developed; SD1 setae of segment 8 slightly less than twice as long as SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly greater than distance between D1 and SD1; D1, D2, and SD1 on each side of segment 9 on separate pinacula; 2 SV setae on each side of segment 9.

Description of Pupa (figs. 134, 151)

General.—Length 8.8–12.8 mm; width 2.5–3.1 mm.

Color.—Reddish brown with gibba and postgibba dark reddish brown.

Head.—Slightly wrinkled to rugulose; setae short.

Thorax.—Prothorax rugulose; spiracles distinct; mesothorax rugulose, without punctures; metathorax rugulose, with 2 groups of about 60 punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 extending laterally to, or beyond, spiracles; punctures on segments 5–7 distinct and encircling segments; spiracles elliptical, distinct; short D1 and L2 usually present on segment 8; no setae on segment 9; gibba about four to five times as wide as median length; caudal margin of gibba very irregular, with two or more distinctive posterior extensions; mesal region of gibba produced dorsally and slightly anteriorly; cremastral "spines" consisting of four centrally located, posteriorly directed, hooked "spines" and two outer, lateroposteriorly and slightly ventrally directed, very slightly hooked, or simple "spines;" outer "spines" almost as long as inner "spines," arising from distinct protuberances.

Material Examined

FLORIDA—Boca Raton, 1 larva, *Cassia*, 8-IX-75, H. H. Neunzig (USNM). Fort Pierce, 1 larva, *Cassia*, 11-IX-74, H. H. Neunzig (USNM). Juno Beach, 1 larva, *Cassia*, 9-IX-74, H. H. Neunzig (USNM). Jupiter, 12 larvae, 3 pupae, *Cassia*, 13-V-73, H. H. Neunzig (USNM). Lake Worth, 2 larvae, *Cassia bahamensis*, 26-V-1949, L. S. Light (FSCA). Riviera Beach, 15 larvae, 4 pupae, *Cassia*, 13-V-73, H. H. Neunzig; 1 larva, *Cassia*, 9-IX-74, H. H. Neunzig. St. Augustine, 1 larva, *Cassia*, 3-IX-75, H. H. Neunzig (USNM).

NORTH CAROLINA—Fayetteville, 2 larvae, *Cassia*, 4-IX-70, H. H. Neunzig; 12 larvae, 4 pupae, *Cassia*, 26-VI-71, H. H. Neunzig; 5 larvae, 3 pupae, *Cassia*, 7-VIII-72, H. H. Neunzig; 3 larvae, *Cassia*, 11-VIII-75, H. H. Neunzig (USNM).

SOUTH CAROLINA—Florence, 3 larvae, *Cassia*, 2-IX-75, H. H. Neunzig.

Larval Hosts

Cassia spp. Has been collected during this study from *Cassia aspera* Muhlenberg ex Elliott, *C. deeringiana* (Small and Pennell) Macbride, and *C. fasciculata* Michaux. A specimen is in the FSCA with the host labeled *C. bahamensis* Miller. Also reported from *C. brachiata* (Pollard) Macbride by Heinrich (*1956*).

Distribution

Southeastern North Carolina, eastern South Carolina, eastern Georgia, Florida, and southern Texas.

Biology

C. decoloralis has several generations each year. In southern Florida, actively feeding larvae are present throughout the year. In southeastern North Carolina, the apparent northern limit of its range, this species overwinters as a pupa.

Eggs are placed singly on the leaflets, rachis, petiolules, or stems of the host plant. In southeastern North Carolina, the first eggs in the spring are placed on hosts in early May. Larvae hatching from the eggs silk together two or more leaflets for a shelter. First-stage larvae at first eat only part way through the leaflets (upper or lower epidermis and mesophyll) (fig. 167, *A*). However, after several days the small larvae eat all layers of tissues, making elongate holes between the veinlets.

When the larvae reach about the third instar, they draw the leaflets together to make a more distinct, tubelike structure. The tube is silked within and serves primarily as a shelter and not as food. Leaflets adjacent to the shelter are severed from the plant by the larvae, probably at night, and carried to the tube. Most of the leaflets are pulled within the shelter and entirely eaten. Some or parts of some are silked to the outside of the structure for added protection. Most of the shelters are constructed on the upper part of the host plants, although a few are made only a few centimeters above the soil surface.

Large larvae remove entire leaves, rather than leaflets, from sites near their shelters, and older leaf tubes typically have dead, brown, or brownish-red host leaves attached to the outside. Frequently silk paths extend from the shelter to parts of the plant that are harvested. Usually there are several larvae to a plant and at times several larvae in each structure. It is not unusual to find the host plants completely stripped of leaves. Older larvae sometimes leave their original shelter and form a new one on the same plant or on an adjacent host. These secondary structures are made by cutting off groups of leaflets and silking them to the sides of a stem (fig. 167, *B*).

Pupation occurs in the soil. After about 10 days, the adult emerges to continue the cycle. When infested plants are available to ovipositing adults, most eggs are placed on these plants. Under these circumstances, eggs are placed directly on the silk and dead or live leaflets and stems that form the larval shelters (fig. 167, *C*). First-stage larvae hatching from these eggs do not have to move far to find a convenient structure in which to feed and develop.

A few *C. decoloralis* larvae have been found in soil tubes at the base of host plants. Possibly these tubes were not constructed by *C. decoloralis* but by *Adelphia petrella*, another phycitine that also feeds on *Cassia* spp. in the Southern United States.

In southeastern North Carolina, most larvae completing their development during September and October enter the soil, form a silken case, pupate, and remain in the soil to overwinter.

Parasitoids

No parasitoids have been reported in the literature as being associated with *C. decoloralis*.

During this study the following parasitoids were reared from immatures of *C. decoloralis*: Braconidae—*Cardiochiles apicalis* (Cresson), *Macrocentrus delicatus* Cresson, *Meteorus* sp., *Yelicones delicatus* (Cresson). Ichneumonidae—*Pristomerus* sp. Perilampidae—*Perilampus fulvicornis* Ashmead. Tachinidae—*Lixophaga* sp.

Adelphia petrella (Zeller)

Pempelia petrella Zeller, 1846: 771.

Description of Larva (figs. 36, 55, 74, 93, 114)

General.—Length 14.4–22.8 mm; width 1.9–2.8 mm.

Color.—Head pale brown or yellowish white (white in living larva); md group, posterior of sd group, l group, sv group, and v group of tonofibrillary platelets of head pale brown (brown in living larva); platelets of anterior of sd group and sd cl brown to dark brown (dark brown to black in living larva); usually additional brown to dark brown pigmentation, in form of several spots, on anterior of head (this maculation red or black in living larva); dark brown (black, red, or both in living larva) at ocelli; mandibles yellowish white basally between preartis and postartis, becoming dark reddish brown, dark brown, or black distally and dark reddish brown to black along anterior and posterior margins; hypostoma yellowish white (white in living larva); spinneret pale brown to black.

Prothoracic shield brownish or yellowish white (mostly white, with some pale green, in living larva); also each side of thoracic shield with narrow brown to dark brown (black in living larva) patch posterior to D1, or including and extending slightly anterior of D1 (sd stripe); also broad brown to dark brown (black in living larva) elongate patch on each side of shield between D2 and SD2, which extends anteriorly almost to margin of shield (sst stripes); d and sd tonofibrillary platelets of thoracic shield brown to dark brown, sometimes partially incorporated into dark patches.

Prespiracular plates not clearly delineated, brownish or yellowish white (white and pale green in living larva) with several pale brown to brown tonofibrillary platelets.

Remainder of prothorax pale yellowish white, pale gray est stripes between shield and prespiracular plates and spiracle, at times only anterior part of stripes present; pale gray, usually incomplete hst stripes also usually present on prothorax (occasionally some areas of recently preserved larvae indistinctly red or pink) (living larvae with remainder of prothorax pale whitish green; anterior margin white, suffused with purple; pink and white associated with SD setae; pink and maroon est and hst stripes).

Mesothorax and metathorax pale yellowish white with incomplete, gray md stripe, gray sd, sst, and est stripes, and sometimes incomplete hst stripes (some recently preserved larvae with indistinct red or pink on dorsum) (living larva with mesothorax and metathorax whitish green; md, sd, sst, and est stripes of mesothorax and metathorax gray and maroon; red or maroon, complete or incomplete st and hst stripes sometimes present; white between mesothoracic and metathoracic stripes).

Mesothoracic SD1 rings dark brown (dark brown to black in living larva), distinct, but characteristically appearing open anteriorly and posteriorly where broadly bisected by yellowish-white (white in living larva) band that lies between sst and est stripes.

Thoracic legs brownish or yellowish white with pale brown to brown markings.

Abdomen pale yellowish white; grayish md, sd, sst, and est abdominal stripes; sd and sst of abdomen broad and more or less completely fused along their entire length; pale gray hst stripe, sometimes present on first few abdominal segments (some recently preserved larvae with red or pink on dorsum) (abdomen of living larva with maroon, md, sd, and sst stripes; est abdominal stripes maroon and pink; pink, more or less complete st abdominal stripes associated with spiracles; pink hst and sv abdominal stripes also usually present; pink mv stripe along meson of venter of abdomen; ventral stripes usually more distinct on caudal segments of abdomen).

Eighth abdominal segment SD1 rings usually dark brown and appearing open posterodorsally.

Anal shield pale brown or yellowish white (white in living larva) with incomplete pale brown to dark brown (red or black in living larva) mesal stripe (md) and distinct broad dark brown (black in living larva) lateral bands (fused sd and sst stripes); tonofibrillary platelets of anal shield brown to dark brown (dark brown to black in living larva).

Peritreme of spiracles of prothorax and abdominal segments dark brown to black.

Pinacula brown, narrow on dorsum, sometimes with a secondary ring where setae are located within stripes, usually pale and difficult to detect below spiracles; pinacula on dorsum of caudal segments larger and more clearly defined.

Tonofibrillary platelets of remainder of body yellowish white to gray near or in stripes (mostly indistinct, pale green or whitish green in living larva); postspiracular platelets pale brown to brown (brown to dark brown in living larva).

Head.—Width 1.68–1.88 mm; length 1.16–1.32 mm; surface very slightly roughened; adfrontals reach three-fourths to four-fifths distance to cervical triangle; AF2 setae slightly below to slightly above forking of epicranial suture; AF2 setae below imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum moderately to strongly emarginate; outer surface of mandibles with strong carina running distally from preartis of each mandible to tooth 2, and region between postartis of each mandible and tooth 1 distinctly expanded into a second carina; inner surface of mandibles simple; sensilla styloconica of maxillae forked (2 or 3 processes); spinneret long, about 12 times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than, or subequal to, distance between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than distance between SD1 and XD2, distance between D1 and D2 slightly greater than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae on each side arranged in approximately a vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax strongly developed (appear incomplete because of partial pigmentation); SD1 setae on mesothorax about 1.6 times as long as SD1 setae on metathorax; SD1 and SD2 pinacula on each side of metathorax separate; D1 and D2 pinacula of each side of metathorax separate.

Abdomen.—D2 setae on anterior segments about 1.1 mm long; D1 setae on anterior segments approximately three-fourths as long as D2 setae; distance between D2 setae on segments 1–7 slightly greater than, or subequal to, distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 distinctly greater than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets usually triordinal, some biordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 84–90, 86–96, 79–95, 82–91, and 65–99, respectively; spiracles on segment 8 at least 1.5 times larger than spiracles on segment 7; horizontal diameter of spiracle on each side of segment 8 slightly greater than distance between L1 and L2; SD1 rings of segment 8 strongly developed; SD1 setae of segment 8 about 1.3 times as long as SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 slightly more, to distinctly greater, than distance between D1 and SD1; D1, D2, and SD1 on each side of segment 9 on separate pinacula; 2 SV setae on each side of segment 9.

Description of Pupa (figs. 133, 153)

General.—Length 9.4–12.0 mm; width 2.6–3.0 mm.

Color.—Yellowish brown to reddish brown, with gibba, and sometimes postgibba, dark reddish brown.

Head.—Slightly wrinkled; setae short.

Thorax.—Prothorax slightly wrinkled to rugulose; spiracles distinct; mesothorax slightly wrinkled to rugulose, without punctures; metathorax rugulose, with 2 groups of about 30 punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 extending laterally to or beyond spiracles; punctures on segments 5–7 distinct and encircling segments; spiracles elliptical; short L2 usually present on segment 8; no setae on segment 9; gibba about four times as wide as median length; caudal margin of gibba very irregular with two or more distinct, posterior extensions; mesal region of gibba slightly produced dorsally and anteriorly; cremastral "spines" consisting of four centrally located, hooked, posteriorly directed "spines" and two outer, about as long, posterolaterally and ventrally directed, simple, or slightly hooked "spines."

Material Examined

ALABAMA—Pell City, 6 larvae, *Cassia nictitans*, 6-IX-73, H. H. Neunzig (USNM).

FLORIDA—Boca Raton, 2 larvae, *Cassia deeringiana*, 8-IX-75, H. H. Neunzig (USNM). St. Augustine, 4 larvae, 1 pupa, *Cassia aspera*, 3-IX-75, H. H. Neunzig.

NORTH CAROLINA—Clayton, 2 larvae, *Cassia*, 3-VIII-73, H. H. Neunzig (USNM). Elizabethtown, 2 larvae, *Cassia* sp., 20-IX-72, H. H. Neunzig. Fayetteville, 2 larvae, *Cassia*, 4-IX-70, H. H. Neunzig; 1 larva, *Cassia*, 10-IX-70, H. H. Neunzig; 3 larvae, *Schrankia microphylla*, 3-VI-71, H. H. Neunzig; 1 larva, *Cassia* sp., 2-IX-72, H. H. Neunzig; 2 larvae, *Cassia* sp., 28-IX-72, H. H. Neunzig (USNM); 2 larvae, 2 pupae, *Schrankia*, 30-V-73, H. H. Neunzig; 1 larva, *Cassia*, 26-VI-73, H. H. Neunzig (USNM). Newton Grove, 1 larva, *Lespedeza repens*, 19-VI-73, H. H. Neunzig. Raleigh, 1 larva, *Lespedeza* sp., 3-VI-71, H. H. Neunzig (USNM).

TEXAS—San Antonio, 8 larvae, *Cassia*, 15-IV-75, H. H. Neunzig.

Larval Hosts

A. petrella has been collected during the present study from *Cassia aspera* Muhlenberg ex Elliott, *C. deeringiana* (Small and Pennell) Macbride, *C. fasciculata* Michaux, *C. nictitans* L., *Lespedeza repens* (L.) Barton, and *Schrankia microphylla* (Dryander) Macbride.

Distribution

Southeastern United States (west to central Texas). Also District of Columbia, New Jersey, and Iowa (Heinrich, *1956*).

Biology

A. petrella has several generations each year in Florida. In eastern North Carolina, it has only approximately two generations each year. Overwintering takes place in the pupal stage.

The oviposition site is unknown for *A. petrella*, but it probably is the stem near the base of the host plant or other parts of a host where the plant comes in contact with the soil.

Small larvae make tiny underground tubes of soil, silk, and sometimes pieces of organic matter. These tubes are attached to the host where the stem enters the soil or where other plant parts touch the soil (fig. 168, *A* and *B*). Most of the time the larva stays in its tube. Leaflets near the mouth of the tube are eaten, or apparently during the night the insect ventures forth to sever leaflets from the host to bring back and gradually consume within its shelter. As the larva grows, the tubes are enlarged or new, larger ones are constructed. In time, entire leaves are cut from the host, carried back to the tube entrance, and used as food by large larvae (fig. 168, *C*). A small part of the petiole remains on the plant, but this stub dehisces in about a week. Although the larvae and tubes of *A. petrella* are well concealed in the soil, large larvae can usually be detected by looking for silk extending from the tube entrance to and on the host plant. Also with hosts that grow erect (*Cassia* spp.), the absence of leaves on the lower part of the plant, as well as the presence of silk, is indicative of the presence of *A. petrella*.

In sandy soils, the tube constructed by the larva is usually entirely of soil and silk. In heavier soils, such as clay, trash (dead leaves, etc.) and frass are used along with the soil and silk.

In eastern North Carolina, larvae of the first generation are present from late April through June. Pupation occurs in June and early July, and adults of the first generation fly and oviposit primarily during July. Larvae are again present from mid-July through early October. Most larvae enter the soil to pupate and overwinter in September.

Parasitoids

No parasitoids have been reported in the literature a. being associated with *A. petrella.*

During this study the following parasitoids were reared from the immatures of *A. petrella*: Braconidae—*Cardiochiles apicalis* (Cresson). Ichneumonidae—*Syzeuctus* sp.

Ufa rubedinella (Zeller)

Pempelia rubedinella Zeller, 1848: 885.

Description of Larva (figs. 35, 53, 56, 76, 95, 115)

General.—Length 12.5–21.1 mm; width 1.9–2.1 mm.

Color.—Head brownish white (white in living larva); md group, triangular part of sd group, sd cl, and lower arm of sv group of tonofibrillary platelets of head usually brown to dark brown (dark brown to black in living larva); base of sd group, l group, upper arm of sv group, and v group of platelets of head usually distinctly paler; large triangular-shaped patch of sd group of head usually most deeply pigmented and distinctive; brown (black in living larva) within arc of ocelli; mandibles brownish white basally between preartis and postartis, becoming dark brown to black distally and dark brown to black along anterior and posterior margins; hypostoma brownish white (white in living larva); spinneret pale brown to brown.

Prothoracic shield yellowish white (white in living larva); brown (dark brown to black in living larva) longitudinal streak along meson of prothorax (lateral parts of md stripe); also on each side of prothoracic shield, broad, brown (dark brown to black in living larva) patch (sst stripe) starting posteroventral to XD1 and posterior to XD2 and extending posteriorly, narrowing slightly between D2 and SD2; d and sd tonofibrillary platelets of thoracic shield pale brown (dark brown or black in living larva); pale brown lower shield margins (dorsal part of est stripes) and base of some setae on thoracic shield, pale brown; (darker in living larva).

Prespiracular plates indistinct, whitish yellow (white in living larva) with tonofibrillary platelets pale brown.

Remainder of prothorax pale yellowish white with gray continuations of md, sst, and est stripes evident anterior to, and at times lateral to, shield; gray stripes (?hst) sometimes present starting on each side of prothorax at a point posterior to base of maxillae and extending posteriorly (living larva with remainder of prothorax greenish white with greenish-gray md, sst, and est stripes; ?hst stripes, if present on prothorax, greenish gray).

Mesothorax and metathorax pale yellowish white with distinct or indistinct gray md, sd, sst, and est stripes; sd of mesothorax and metathorax slightly weaker than others; sst and est stripes broad, almost completely fused on mesothorax and metathorax; integument below fused sst and est mesothoracic and metathoracic stripes yellowish white; parts of venter of mesothorax and metathorax at times pale gray (living larva with md, sd, sst, and est stripes of mesothorax and metathorax greenish gray; green or yellow between mesothoracic and metathoracic stripes; integument of mesothorax and metathorax immediately below fused sst and est stripes white, whitish yellow, or greenish yellow, mottled with gray and sometimes pink; venter of mesothorax and metathorax usually gray).

Mesothoracic SD1 rings brown (dark brown to black in living larva), usually with pale posterior spot.

Metathorax usually with brown to dark brown, enlarged, distinctive pinacula at base of SD1 setae.

Thoracic legs brownish white (white in living larva) with brown to dark brown markings.

Abdomen similar to mesothorax and metathorax.

Eighth abdominal segment SD1 rings pale brown to brown.

Anal shield yellowish white with brown (dark brown to black in living larva) mesal streak (md stripe) and brown (dark brown to black in living larva) lateral streaks (?sst stripes); tonofibrillary platelets of anal shield brown to dark brown; brown to dark brown at base of setae.

Peritreme of prothoracic and abdominal spiracles dark brown to black.

Pinacula brown (dark brown in living larva), small, but relatively distinct.

Tonofibrillary platelets of remainder of body pale gray, relatively indistinct, usually more apparent on dorsum of abdominal segments.

Head.—Width 1.35–1.52 mm; length 1.16–1.29 mm; surface slightly uneven to rugulose; adfrontals reach approximately four-fifths to five-sixths distance to cervical triangle; AF2 setae below forking of epicranial suture; AF2 setae below imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum strongly emarginate; outer surface of mandibles with strongly developed carina extending from preartis of each mandible to tooth 2, and region between postartis of each mandible and tooth 1 strongly expanded into a second carina; inner surface of each mandible with two, low, arc-shaped, transverse retinacula (lower arc usually more elevated and irregular); sensilla styloconica of maxillae forked (2 or 3 processes); spinneret long, about 12 times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than, or subequal to, distance between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than distance between SD1 and XD2, distance between D1 and D2 usually slightly less than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae on each side arranged in approximately a vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax strongly developed; SD1 setae on mesothorax usually slightly less than twice as long as SD1 setae on metathorax; SD1 pinaculum on each side of metathorax enlarged, usually fused with SD2 pinaculum; D1 and D2 pinacula of each side of metathorax fused or separate.

Abdomen.—D2 setae on anterior segments about 0.9 mm long; D1 setae on anterior segments approximately two-thirds to three-fourths as long as D2 setae; distance between D2 setae on segments 1–7 slightly greater than, or subequal to, distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 distinctly greater than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets mostly triordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 72–84, 78–95, 75–86, 71–90, and 68–83, respectively; spiracles on segment 8 at least 1.5 times longer than spiracles on segment 7; horizontal diameter of spiracle of each side of segment 8 slightly greater than distance between L1 and L2; SD1 rings of segment 8 strongly developed; SD1 setae of segment 8 about twice as long as SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly greater than distance between D1 and SD1; 2 SV setae on each side of segment 9.

Description of Pupa (figs. 135, 152)

General.—Length 8.0–10.8 mm; width 2.1–2.5 mm.

Color.—Yellowish brown with reddish-brown gibba and postgibba.

Head.—Slightly wrinkled; setae short.

Thorax.—Prothorax slightly wrinkled; spiracles distinct; mesothorax slightly wrinkled to rugulose, without punctures; metathorax slightly wrinkled to rugulose, with 2 groups of about 35 punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 extending laterally to, or beyond, spiracles; punctures on segments 5–7 distinct and encircling segments; spiracles elliptical; short L2, and at times D1 present on segment 8; no setae on segment 9; gibba about 3.5 times as wide as median length; caudal margin of gibba very irregular with two or more distinct, posterior extensions; mesal region of gibba slightly produced dorsally and anteriorly; cremastral "spines" consisting of four centrally located, hooked, posteriorly directed "spines" and two outer, almost as long, posterolaterally and slightly ventrally directed, hooked "spines."

Material Examined

FLORIDA—Delray Gardens, 11 larvae, 3 pupae, *Vigna* foliage, 14-V-73, H. H. Neunzig

(USNM). Hypoluxo, 3 larvae, on black-eyed peas (leaves), 5 May 1944, lot 44-11518, S.S. 15071, Linduska #569 (USNM). Lake Worth, 1 larva, *Vigna* foliage, 8-IX-74, H. H. Neunzig (USNM). Riviera Beach, 15 larvae, 10 pupae, *Vigna* foliage, 14-V-73, H. H. Neunzig. Vero Beach, 3 larvae, *Vigna* foliage, 15-V-73, H. H. Neunzig (USNM). West Palm Beach, 4 larvae, lima bean (in mass of leaves at base of plant), 26 Apr. 1945, lot 45-9058, S.S. 25495, Anderson 568 (USNM).

Larval Hosts

Reared from *Vigna luteola* (Jacquin) Bentham during this study. Heinrich (*1956*) and Stone (*1968*) also reported *U. rubedinella* as feeding on *Phaseolus lunatus* L. (lima bean) and *V. unguiculata* (L.) Walpers (black-eyed pea).

Distribution

Southern Florida. Also Cuba, Dominican Republic, Puerto Rico, Virgin Islands, Jamaica, Trinidad, Mexico, Guatemala, Costa Rica, Panama, Venezuela, French Guiana, Brazil, Paraguay, and Argentina (Heinrich, *1956*).

Biology

In tropical regions, development of *U. rubedinella* is more or less continuous throughout the year, with some arrested development during the dry winter months. In south Florida, development is also more or less continuous, with a slowing of development more pronounced at the cooler times of the year.

It is not known where the eggs of *U. rubedinella* are laid. Small larvae live in silk-lined, soil tubes. These structures are attached to the host (usually the leaflet) where it lies in contact with the soil, and the tubes are gradually enlarged, or new larger ones constructed, as the larva grows (fig. 169, *A*). The epidermis and mesophyll of leaflets near the opening of the tubes are eaten (fig. 169, *B*). In time the injured parts appear whitish because of skeletonizing. With large larvae, silk becomes more apparent on infested plants where it is laid down from the soil tube openings to the foliage being consumed. Leaflets are also loosely tied together near the tube shelter to facilitate concealed feeding by the larva. Entire leaflets are consumed. Nests composed of woven-together leaflets, sand tubes, and several larvae occur with heavy infestations. The feeding site eventually becomes an amorphous mass of soil tubes and partially consumed brown and green leaflets (fig. 169, *C*).

Pupation takes place in a silken cocoon in the soil.

Parasitoids

The following parasitoid has been reported in the literature as being associated with *U. rubedinella*: Braconidae—*Apanteles etiellae* Viereck (Muesebeck and Walkley, *1951*).

During this study the following parasitoid was reared from immatures of *U. rubedinella*: Tachinidae—*Stomatomyia floridensis* (Townsend).

Elasmopalpus lignosellus (Zeller)

Pempelia lignosella Zeller, 1848: 885.

Description of Larva (figs. 34, 54, 75, 94, 113)

General.—Length 10.0–16.9 mm; width 1.4–1.9 mm.

Color.—Head brown or reddish brown (darker in living larva); tonofibrillary platelets of head dark brown, indistinct; integument surrounding alveoli rings of many of head setae characteristically pale (some of pale areas as large as, or larger than, ocelli); mandibles usually reddish brown basally between preartis and postartis, becoming dark brown to black distally and dark brown to black along anterior and posterior margins; hypostoma brown or reddish brown, dark brown, or black along lateral margins; spinneret brown to black.

Prothoracic shield brown to dark brown; some groups of darker tonofibrillary platelets usually apparent on shield (shield black in living larva with platelets indistinct).

Prespiracular plates usually brown with darker tonofibrillary platelets (plates black in living larva, with platelets indistinct).

Remainder of prothorax mostly yellowish white; sometimes brownish gray anterior to shield (living larva with remainder of prothorax green suffused with purple anterior of shield, along lateral margin of shield, near prespiracular plates, and at SV setae).

Mesothorax and metathorax mostly yellowish white; usually dorsum of mesothorax and metathorax with anterior one-third to one-half of each segment yellowish white, posterior part brownish gray; brownish-gray area of mesothorax and metathorax usually rather uniform, at times with some yellowish-white and irregular brownish-gray md, sd, sst, and est stripes; venter of mesothorax and metathorax yellowish white (occasionally recently preserved larva with these segments, particularly on dorsum, partially pink) (living larva with mesothorax and metathorax green; anterior dorsum of each mesothoracic and metathoracic segment white or white and purple, posterior dorsum dark purple, paler purple laterally; purple posterior area of mesothorax and metathorax usually rather uniform, but at times broken up into white or greenish-white spots with incomplete, indistinct, purple md and sd stripes, and more or less distinct purple sst and est stripes; occasionally purple extends ventrally on mesothorax and metathorax to below spiracles).

Mesothoracic SD1 rings pale brown to brown (brown to black in living larva).

Thoracic legs usually pale yellowish with brown markings or suffusions.

Abdomen with anterior one-third to one-half of dorsum of each segment usually yellowish white with brownish-gray md, sd, sst, and est stripes; posterior of dorsum of each abdominal segment usually with stripes broadly fused into a more or less solid brownish-gray saddlelike area; some specimens with stripes of abdomen incomplete and not fused posteriorly, others with entire dorsum brownish gray; at times brownish gray of abdomen extends ventrally to below spiracles, or fragmented st stripes are present; venter of abdomen yellowish white (occasionally recently preserved larva with pink undertones, particularly on caudal segments) (abdomen of living larva with anterior one-third to one-half of dorsum of each segment usually pale greenish white to white with purple stripes; posterior of dorsum of each abdominal segment usually with stripes broadly fused into a more or less homogeneous purple saddlelike area; larva sometimes with stripes of abdomen incomplete and not fused posteriorly, or entire dorsum purple; at times purple extends ventrally to below abdominal spiracles, or fragmented purple st stripes are present that are strongest at spiracles; venter of abdomen yellowish green, lightly suffused with purple).

Eighth abdominal segment SD1 rings brown to dark brown (dark brown to black in living larva).

Anal shield pale brown with yellowish-white markings and dark brown tonofibrillary platelets (living larva with shield black with white markings and black platelets).

Peritreme of prothoracic and abdominal spiracles dark brown to black.

Pinacula pale brown to dark brown; usually very pale to absent ventrally, more pronounced dorsally.

Tonofibrillary platelets of remainder of body pale (green in living larva), obscure, except for brown postspiracular tonofibrillary platelets of segments 3–6.

Head.—Width 1.12–1.39 mm; length 0.99–1.09 mm; surface slightly irregular; adfrontals reach, or almost reach, cervical triangle; AF2 setae slightly below forking of epicranial suture; AF2 setae slightly below, or on, imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum strongly emarginate; outer surface of mandibles with weak to moderately well-developed carina extending from preartis of each mandible to tooth 2, and region between postartis of each mandible and tooth 1 slightly enlarged; inner surface of mandibles simple; sensilla styloconica of maxillae forked; spinneret long, about 11 times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than, or subequal to, distance between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than distance between SD1 and XD2, distance between D1 and D2 slightly less than, subequal to, or slightly greater than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle (sometimes closely approximating a right angle); L setae on each side arranged in approximately a vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax well developed, elongate (extending posteromesally); SD1 setae on mesothorax about 1.3 times as long as SD1 setae on metathorax.

Abdomen.—D2 setae on anterior segments about 0.9 mm long; D1 setae on anterior segments approximately two-thirds as long as D2 setae; distance between D2 setae on segments 1–7 slightly greater than, or subequal to, distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 greater, to distinctly greater, than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets mostly triordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 52–62, 50–60, 52–62, 56–60, and 56–66, respectively; spiracles on segment 8 at least 1.5 times larger than spiracles on segment 7; horizontal diameter of spiracle of each side of segment 8 slightly greater than distance between L1 and L2; SD1 rings of segment 8 well developed; SD1 setae of segment 8 about 1.3 times longer than SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly greater than distance between D1 and SD1; D1, D2, and SD1 of each side of segment 9 on separate pinacula; 2 SV setae on each side of segment 9.

Description of Pupa (figs. 131, 150)

General.—Length 6.8–8.4 mm; width 1.9–2.3 mm.

Color.—Brownish yellow with slightly darker caudal segments and brown gibba (anterior margin of gibba usually with a darkened, ovoid spot on each side of meson).

Head.—Smooth to slightly wrinkled; setae short.

Thorax.—Prothorax smooth to slightly wrinkled; spiracles distinct; mesothorax smooth to slightly wrinkled, without punctures; metathorax smooth to slightly wrinkled, with 2 groups of about 20 punctures on each side of meson; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous, moderately distinct punctures; punctures on segment 4 usually not extending laterally to spiracles; punctures on segments 5–7 only moderately distinct, encircling segments; spiracles elliptical; short L2 usually present on segment 8; no setae on segment 9; gibba about 3.5 times as wide as median length; caudal margin of gibba irregular with two or more distinct posterior extensions; mesal region of gibba slightly produced dorsally and anteriorly; cremastral "spines" consisting of four centrally located, posteriorly directed, hooked "spines" and two outer, almost as long, posterolaterally and slightly ventrally directed, hooked "spines."

Material Examined

GEORGIA—Dublin, 3 larvae, soybean, 15-VIII-68, H. H. Neunzig. Tifton, 16 larvae, corn, 23-IX-70, H. H. Neunzig.

LOUISIANA—Baton Rouge, 5 larvae, lima beans, 5-IX-72, H. H. Neunzig.

NORTH CAROLINA—Castle Hayne, 6 larvae, 2 pupae, milo, 8/3/61, R. Aycock. Chadbourne, 2 larvae, soybeans, 18-VII-73, L. Goins. Clayton, 5 larvae, *Phaseolus* seedlings, 24-VIII-74, H. H. Neunzig and T. R. Weaver (USNM). Cofield, 3 larvae, *Glycine max*, 23-VIII-72, Neunzig and Rogister. Durham, 2 larvae, *Phaseolus vulgaris*, 26-VII-73, D. Dayton. Hyde County, 2 larvae, soybeans, 26-VII-73, G. W. O'Neal. Wade, 5 larvae, 2 pupae, southern peas, 1-VIII-74, H. Walker. Winston Salem, 1 larva, snap beans, 30-VII-74, E. C. Long.

SOUTH CAROLINA—Charleston, 14 larvae, 3 pupae, snap beans, 14-IX-68, R. L. Watson. Spartenburg, 1 larva, soybean, 13-IX-73, H. H. Neunzig.

TEXAS—Big Spring, 2 larvae, *Cenchrus* sp., 10-IX-73, H. H. Neunzig (USNM).

Larval Hosts

E. lignosellus (the lesser cornstalk borer) feeds on a wide variety of plants, including the following fabaceous plants: *Arachis hypogaea* L. (peanut), *Glycine max* (L.) Merrill (soybean), *Medicago sativa* L. (alfalfa), *Phaseolus lunatus* L. (lima bean), *P. mungo* L. (mung bean), *P. vulgaris* L. (snap bean, string bean), *Pisum sativum* L. (pea), and *Vigna unguiculata* (L.) Walpers (cowpea, black-eyed pea) (King et al., *1961*).

The catholic nature of *E. lignosellus* with regard to larval hosts is apparent, in that it has also been reported from plants belonging to the following additional families: Brassicaceae, Chenopodiaceae, Convolvulaceae, Cucurbitaceae, Cyperaceae, Iridaceae, Linaceae, Malvaceae, Pinaceae, Poaceae, Rosaceae, Rutaceae, and Solanaceae (King et al., *1961*). Luginbill and Ainslie (*1917*) considered *E. lignosellus* to be most closely associated with the Poaceae (grasses).

Distribution

Throughout the Southern United States from North Carolina to California. Also north to District of Columbia, New Jersey, and Massachusetts. Outside of the United States, this species is widely distributed in the Western Hemisphere (Bermuda, Cuba, Puerto Rico, Virgin Islands, Tobago, Jamaica, Mexico, Guatemala, Panama, Venezuela, French Guiana, Brazil, Paraguay, Uruguay, Argentina, and Chile).

Biology

The literature on the biology of *E. lignosellus* is relatively extensive. The more noteworthy publications are Luginbill and Ainslie (*1917*), King et al. (*1961*), and Leuck (*1966*).

E. lignosellus is multivoltine, with continuous development throughout the year in southern Florida. In other parts of the Southern United States, the insect has three to four generations (with considerable overlap) each year, with a period of inactivity during the cooler months.

According to Leuck (*1966*), eggs are laid singly on the upper and lower parts of host leaves, on the host stem, and on the soil adjacent to host plants. Larvae, upon hatching, feed on the stem of the host plant just below the surface of the soil. Snyder (*1936*) and King et al. (*1961*) reported that the larvae initially feed on the leaves of the host. If so, this is unusual and occurs only when leaves are very near, or in contact with, the soil.

Usually small tubes are constructed in the soil attached to the host near the feeding site. They extend horizontally in the soil, are made of soil, silk, and frass, and are used as retreats by the insects. Most larvae tunnel into the host and bore upward within the plant. As they feed, frass is formed that partially fills the gallery (fig. 170, *A*). Some larvae feed on older or less succulent plants. Under these circumstances, they do not penetrate too deeply into the stem but instead girdle or partially girdle the host. Snyder (*1936*) reported that with some woody plants (*Robinia pseudoacacia* L.) feeding stimulates the formation of galls. The internal tunneling severely affects herbaceous seedlings; usually all the above-soil parts of the plant quickly die (fig. 170, *B*). With these plants that are too small to sustain the larva, the insect will readily move to one or more additional hosts to complete its development. Older, more substantial plants are also sometimes killed but more slowly; frequently older, infested plants will appear normal, but break off readily at the soil line with strong winds. With peanuts, the larvae attack several parts of the host; for example, in addition to stems, young pods are tunneled into by some larvae and the developing seeds destroyed (French and Morgan, *1972*).

As the larva feeds and grows, it makes larger and larger tubes, up to about 8 cm. long. Sometimes all shelters are attached at about the same point on the host (fig. 170, *C*). The larva spends much of its time in the tube in the soil, moving to, or into, the host only to feed. With some large larvae, a small amount of silk can be detected at the base of the host at the soil surface. With completion of larval development, the distal part of the tube inhabited by the larva is usually modified into a pupal chamber.

Parasitoids

The following parasitoids have been reported in the literature as being associated with *E. lignosellus*: Braconidae—*Agathis rubricincta* Ashmead (Beg and Bennett, *1974*); *Bracon mellitor* Say (Leuck and Dupree, *1965*); *Bracon* sp. (Guagliumi, *1973*); *Chelonus* sp. (Leuck and Dupree, *1965*); *Macrocentrus ancylivorus* Rohwer (Thompson, *1945*); *M. muesebecki* Costa Lima (Guagliumi, *1973*); *Orgilus mellipes* (*laeviventris*) (Say) (Chittenden, *1900*; Luginbill and Ainslie, *1917*; Thompson, *1945*); *Orgilus* sp. (Leuck and Dupree, *1965*). Eulophidae—*Horismenus apantelivorus* Crawford (Guagliumi, *1973*). Ichneumonidae—*Pristomerus spinator* (F.) as *P. pacificus appalachianum* Viereck and *P. pacificus melleus* Cushman (Thompson, *1945*; Townes and Townes, *1951*; Leuck and Dupree, *1965*); *Pristomerus* sp. (Luginbill and Ainslie, *1917*; Guagliumi, *1973*). Scelionidae—*Telenomus* sp. (Leuck and Dupree, *1965*). Tachinidae—*Plagiprospherysa trinitatis* Thompson (Beg and Bennett, *1974*); *Plagiprospherysa* sp. (Guagliumi, *1973*); *Stomatomyia* (*Plagiprospherysa*) *floridensis* (Townsend) (Leuck and Dupree, *1965*); *S.* (*Plagiprospherysa*) *parvipalpus* (Wulp) (Leuck and Dupree, *1965*).

During this study the following parasitoid was reared from immatures of *E. lignosellus*: Braconidae—*Orgilus elasmopalpi* Muesebeck.

Metephestia simplicula (Zeller)

Ephestia simplicula Zeller, 1881: 246.

Description of Larva (figs. 37, 52, 77, 92, 116)

General.—Length 8.1–11.9 mm; width 1.3–1.8 mm.

Color.—Head yellowish white, only slightly darker than integument of most of body (in living larva, white to pale brown with green or pink undertones (undertones particularly strong on anterior part of head)); all groups of tonofibrillary platelets of head relatively indistinct, pale brown; distinct white patch within arc of ocelli; mandibles pale brown at base between preartis and postartis, becoming reddish brown distally and reddish brown along anterior and posterior margins; hypostoma yellowish white usually with very narrow brown to black streak laterally; spinneret brown to dark brown.

Prothoracic shield very pale brown with indistinct tonofibrillary platelets.

Prespiracular plates very pale brown without distinct maculation.

Remainder of prothorax pale yellowish white (greenish yellow, green, pink, or red in living larva).

Mesothorax and metathorax pale yellowish white, usually with very faint incomplete md, sd, sst, and est stripes (living larva with mesothorax and metathorax greenish white, greenish yellow, pink, or red, with pale gray, green, or reddish stripes; venter of mesothorax and metathorax greenish yellow, green, or pink).

Mesothoracic SD1 rings narrow, pale brown to brown (dark brown to black in living larva); only ventral part of mesothoracic rings strongly pigmented.

Thoracic legs yellowish white (pale brown in living larva), only slightly darker than integument of most of body.

Abdomen similar to mesothorax and metathorax.

Eighth abdominal segment SD1 rings pale brown (brown in living larva).

Anal shield pale, about same color as surrounding integument.

Peritreme of prothoracic and abdominal spiracles usually pale brown.

Pinacula barely visible in dorsal region, very narrow brown or gray, usually missing below spiracles (living larva characteristically with dorsal and lateral rings of alveoli black and distinct on prothorax (including shield), mesothorax, metathorax, and abdomen; also most larvae with pinacula surrounded by white patch at base of most setae or groups of setae).

Tonofibrillary platelets of remainder of body about same color as surrounding integument and difficult to detect.

Head.—Width 0.76–0.83 mm; length 0.66–0.69 mm; surface slightly uneven; adfrontals almost reach cervical triangle; AF2 setae below forking of epicranial suture; AF2 setae below imaginary line between P1 setae; P1 setae farther apart than P2 setae; labrum moderately emarginate; outer surface of mandibles with weakly to moderately well-developed carina extending from preartis of each mandible to tooth 2, and region between postartis of each mandible and tooth 1 distinctly expanded; inner surface of mandibles simple; sensilla styloconica of maxillae forked; spinneret long, about nine times as long as median breadth.

Prothorax.—On shield, distance between D1 setae less than distance between XD1 setae; on each side of shield, distance between SD1 and SD2 greater than distance between SD1 and XD2, distance between D1 and D2 greater than distance between D1 and XD1, and XD2, SD1, and SD2 form an acute angle; L setae on each side arranged in approximately a vertical configuration.

Mesothorax and Metathorax.—SD1 rings of mesothorax moderately well developed; SD1 setae on mesothorax about twice as long as SD1 setae on metathorax.

Abdomen.—D2 setae on anterior segments about 0.4 mm long; D1 setae on anterior segments approximately three-fourths as long as D2 setae; distance between D2 setae on segments 1–7 slightly greater than distance between D1 setae; distance between D1 and D2 on each side of segments 3–6 slightly greater than, subequal to, or slightly less than distance between D1 and SD1; no rings at base of SD1 setae on segments 1–7; crochets mostly triordinal, number on prolegs of segments 3, 4, 5, 6, and anal segment 46–50, 46–49, 46–50, 47–50, and 39–46, respectively; spiracles on segment 8 at least 1.5 times larger than spiracles on segment 7; horizontal diameter of spiracle of each side of segment 8 slightly greater than distance between L1 and L2; SD1 rings of segment 8 moderately well developed; SD1 setae of segment 8 about twice as long as SD1 setae of segment 7; 2 SV setae on each side of segment 8; distance between D1 and D2 on each side of segment 9 distinctly less than distance between D1 and SD1; 2 SV setae on each side of segment 9.

Description of Pupa (figs. 132, 154)

General.—Length 4.9–6.9 mm; width 1.5–1.8 mm.

Color.—Brownish yellow, with reddish-brown gibba and caudal margin of segment 10.

Head.—Smooth to slightly wrinkled; setae short.

Thorax.—Prothorax smooth to slightly wrinkled; spiracles relatively distinct; mesothorax smooth to slightly wrinkled, without punctures; metathorax smooth to slightly wrinkled, with 2 groups of about 25 loosely aggregated punctures on each side of mesothorax; setae short.

Abdomen.—Cephalic one-half to three-fourths of dorsum of segments 1–4 with numerous punctures; punctures on segment 4 not reaching spiracles; punctures on segments 5–7 moderately distinct and encircling segments; spiracles elliptical; short D1 and L2 usually present on segment 8; no setae on segment 9; gibba distinct, about two to three times as wide as median length; caudal margin of gibba not clearly delineated, without punctures; cremastral "spines" consisting of four centrally located, posteriorly directed, hooked "spines" and two outer, posteriorly directed, hooked "spines;" all "spines" very similar in appearance, outer "spines" slightly shorter.

Material Examined

FLORIDA—Cutler Ridge, 18 larvae, 7 pupae, *Indigofera*, 7-IX-75, H. H. Neunzig (USNM). Fort Pierce, 5 larvae, 2 pupae, *Indigofera* foliage, 11-IX-74, H. H. Neunzig (USNM). Homestead, 5 larvae, *Indigofera*, 7-IX-75, H. H. Neunzig (USNM). Perrine, 14 larvae, 6 pupae, *Indigofera* foliage, 7-IX-74, H. H. Neunzig; 5 larvae, 1 pupa, *Indigofera*, 6-IX-75, H. H. Neunzig. Port Salerno, 20 larvae, 3 pupae, *Indigofera*, 8-IX-75, H. H. Neunzig (USNM).

Larval Hosts

Indigofera spp. Reared during this study from *Indigofera hirsuta* L. and *I. suffructicosa* Miller. Heinrich (*1956*) also listed *I. tinctoria* L. (the source of commercial indigo) as a host.

Distribution

Southern Florida. Also Puerto Rico, Colombia, and West Indies (Heinrich, *1956*).

Biology

M. simplicula is multivoltine. Based on the brief data available, this species appears to have at least three generations each year in southern Florida.

Eggs are laid on the terminal foliage of the host. The small larvae feed on unexpanded leaflets. As the larva grows, it loosely silks together several leaflets, and eventually all or most of the terminal leaflets become a part of the larva's shelter (fig. 171, *A* and *C*). Within this enclosure the larva feeds on the leaflets and bores into, or completely severs, the petiolules of the leaflets. Silk is laid down within the shelter to form a rough tubelike structure. The silk restraints on the host terminal cause the terminal to become distorted, and it usually curves more or less downward. The silk tube is loosely extended by large larvae downward from the terminal to include additional fresh leaflets at a slightly lower level on the host. In the advanced stages of infestation, the terminal becomes a mass of twisted, partially dead, brown and green leaflets, silk, and frass (fig. 171, *B* and *D*). Some large larvae move to a fresh terminal to feed in the last instar. Many, however, complete their development within a single terminal.

When infested terminals are present and relatively abundant and adults are also in flight, the females are attracted to these terminals and place their eggs on the dead or dying leaflets of the shelters. Larvae hatching from these eggs enter the already formed shelters to feed. It is not unusual to find several larvae of various sizes in a heavily infested terminal.

Parasitoids

No parasitoids have been reported in the literature as being associated with *M. simplicula*.

During this study the following parasitoid was reared from immatures of *M. simplicula*: Ichneumonidae—*Pristomerus* sp.

DISCUSSION

In comparing the classification of Heinrich (*1956*), based on adult morphology, with the affinities apparent in this study of larval and pupal morphology and biology of leguminous feeding phycitines of the Southern United States, there generally appears to be congruence. However, a few taxa seem to be misplaced in Heinrich's arrangement.

Approximately one-half of the species form four rather closely knit groups, as shown in the following data arranged according to similarities in morphology and biology of immature stages:

Group 1—*S. ceratoniae* and *A. transitella*:

Larvae (last instar).—Body without stripes; usually pinkish white. Head with adfrontals reaching, or almost reaching, cervical triangle. Mandibles simple. SD1 rings present (not only on mesothorax and abdominal segment 8, but rings or partial rings also associated with metathorax and abdominal segments 1–7). Distance between SD1 and SD2 on each side of prothorax almost always greater than distance between SD1 and XD2; L setae on each side of prothorax arranged in vertical or approximately vertical position. Distance between D1 and D2 on each side of abdominal segments 3–6 distinctly less than distance between D1 and SD1; two SV setae on each side of abdominal segments 8 and 9.

Pupae.—Thoracic spiracles present. Cremastral "spines" distinctly modified. Many caudal setae.

Biology.—Feed in legumes and other fruits of many plants. Only mature and injured fruit attacked. Pupate in host fruit.

Group 2—*E. zinckenella* and *U. groteii*:

Larvae (last instar).—Body without stripes, or with very weak stripes. Head with adfrontals reaching, or almost reaching, cervical triangle. Mandibles simple. SD1 rings absent. Distance between SD1 and SD2 on each side of prothorax almost always less than distance between SD1 and XD2; L setae on each side of prothorax arranged horizontally. Distance between D1 and D2 on each side of abdominal segments 3–6 less (usually considerably less) than distance between D1 and SD1; one to two SV setae on each side of segment 8, and one SV seta on each side of segment 9.

Pupae.—Thoracic spiracles present. Cremastral "spines" typical. Few caudal setae.

Biology.—Occur on *Tephrosia* spp. (*E. zinckenella* also has many other hosts and does not appear to be associated with *Tephrosia* in the United States but occurs on *Tephrosia* spp. in Puerto Rico, Africa, and Sri Lanka.) Feed usually within legume. Pupate in soil.

Group 3—*N. dammersi floridensis, N. subcaesiella, N. virgatella*, and *T. reductella*:

Larvae (last instar).—Body with stripes (stripes fragmented in *N. dammersi floridensis* and weak or sometimes weak in other species). Head with adfrontals and cervical triangle widely separated. Mandible with strong inner transverse retinaculum. SD1 rings present and strong or relatively strong. Distance between SD1 and SD2 on each side of prothorax almost always greater than distance between SD1 and XD2; L setae on each side of prothorax arranged in vertical or approximately vertical position. Distance between D1 and D2 on each side of abdominal segments 3–6 less than distance between D1 and SD1; two SV setae on each side of abdominal segments 8 and 9.

Pupae.—Thoracic spiracles absent. Cremastral "spines" typical. Few caudal setae.

Biology.—*Robinia* a common host to two of the species. All form similar leaf shelters on host. Pupate in soil.

Group 4—*C. minimus, C. decoloralis, A. petrella, U. rubedinella*, and *E. lignosellus*:

Larvae (last instar).—Body with distinct stripes. Head with adfrontals and cervical triangle widely separated. Mandibles with outer surface modified (inner surface simple, with exception of *U. rubedinella*, which has low retinacula). SD1 rings distinct. Distance between SD1 and SD2 on each side of prothorax almost always less than distance between SD1 and XD2; L setae on each side of prothorax arranged in vertical or approximately vertical position. Distance between D1 and D2 on each side of abdominal segments 3–6 greater (usually distinctly greater) than distance between D1 and SD1; two SV setae on each side of abdominal segments 8 and 9.

Pupae.—Thoracic spiracles present. Cremastral "spines" typical. Few caudal setae.

Biology.—*Cassia* common host to three of the species. Most form larval soil tubes for shelter. Pupate in soil.

S. ceratoniae and *A. transitella* of group 1 are obviously near relatives, with many shared characters as immatures. The presence of SD1 rings, ring fragments, or incipient rings, not only on the mesothorax and abdominal segment 8 but also on other segments as well, is a character not known in other phycitines. The biology of the two species is also very similar. Both feed on ripe, sometimes partially decayed fruit. Heinrich (*1956*) also found many similarities between the adults of *S.* (*E.*) *ceratoniae* and *A.* (*P.*) *transitella*, even though he considered them separate genera.

The second group allies *E. zinckenella* with *U. groteii.* Heinrich (*1956*) did not indicate a close relationship between these two species, principally because of differences in the genitalia. The general appearance of the larvae, particularly the head, and the arrangement of some of the setae, especially on the prothorax the position of the L setae and the relative distances between SD1 and SD2 and SD1 and XD2, dictate that these species be grouped together. Similar larval behavior and a relationship with the host plant *Tephrosia* also suggest a close affinity.

In the literature (Heinrich, *1956*) the genus *Pima* has been considered tentatively to be closely related to *Etiella.* Although there is a superficial resemblance between the larvae of the two species (preserved larvae of *Pima* are frequently misidentified as *E. zinckenella*) and they have similar feeding habits as larvae, many dissimilarities became evident during this study.

For example, the adfrontals of *E. zinckenella* reach, or almost reach, the cervical triangle, whereas the adfrontals and cervical triangle of *Pima* are widely separated; the SD1 rings of *E. zinckenella* are completely absent in all larval stages, whereas, although extremely weak in late-stage *Pima* larvae, rings are clearly evident in early-stage larvae; on each side of the prothorax of larvae of *E. zinckenella*, the distance between SD1 and SD2 is less than the distance between SD1 and XD2, in contrast to the situation in *Pima*, where the distance between SD1 and SD2 is subequal to slightly greater than the distance between SD1 and XD2; on the prothorax of *E. zinckenella*, the L setae of each side are horizontal or closely approximate a horizontal configuration, whereas in *Pima* these setae are in a vertical configuration or form approximately a 45° angle. Also, although *E. zinckenella* and *Pima* larvae feed in a similar manner, their biology subsequent to feeding is very dissimilar.

T. reductella immediately follows the genus *Nephopterix* in Heinrich's treatment of the adults, and this placement is, in general, supported by information obtained on the immatures. In comparing legume-feeding *Nephopterix* species with *T. reductella* (group 3), several similarities exist, particularly the habitus of the larvae, appearance of the larval mandibles, lack of thoracic spiracles in the pupal stage, and biology of the immatures.

The fourth group consists of five species in four genera. Heinrich closely grouped *E. lignosellus*, *A. petrella*, and *U. rubedinella.* However, on the basis of genitalia differences, the genus *Caristanius*, although known (Heinrich, *1956*) to share larval characters with *U. rubedinella*, was considered to be only distantly related to the other three genera. This study of the immatures would suggest a closer tie between *Caristanius* and the other species; the similarities between *Caristanius* and *A. petrella* are particularly numerous and apparent.

Aside from the obvious relationship of the species within *Fundella* and within *Pima*, the remaining phycitines included in this study appear, almost without exception, to be species with no close relatives. This is true within the restricted context of phycitines that are associated with leguminous plants and also applies in considering the adults and known immatures of the entire subfamily. One exception to this is *A. ochrodesma*, a species that shares many features as an adult with the genus *Acrobasis*.

In comparing the immatures of *A. ochrodesma* with immature *Acrobasis* species (Neunzig, *1972*), Heinrich's erection of a separate genus for *A. ochrodesma* appears justified. Setal arrangement and appearance of the SD1 rings of the two species are similar and suggest a close relationship; however, the distinct longitudinal body stripes of *A. ochrodesma* immediately separates this species from all known species of

Acrobasis in North America. Biologically *A. ochrodesma* also apparently differs from *Acrobasis* species in that it has several generations throughout the year, whereas all known species of *Acrobasis* have one to only a few generations with development interrupted by diapause.

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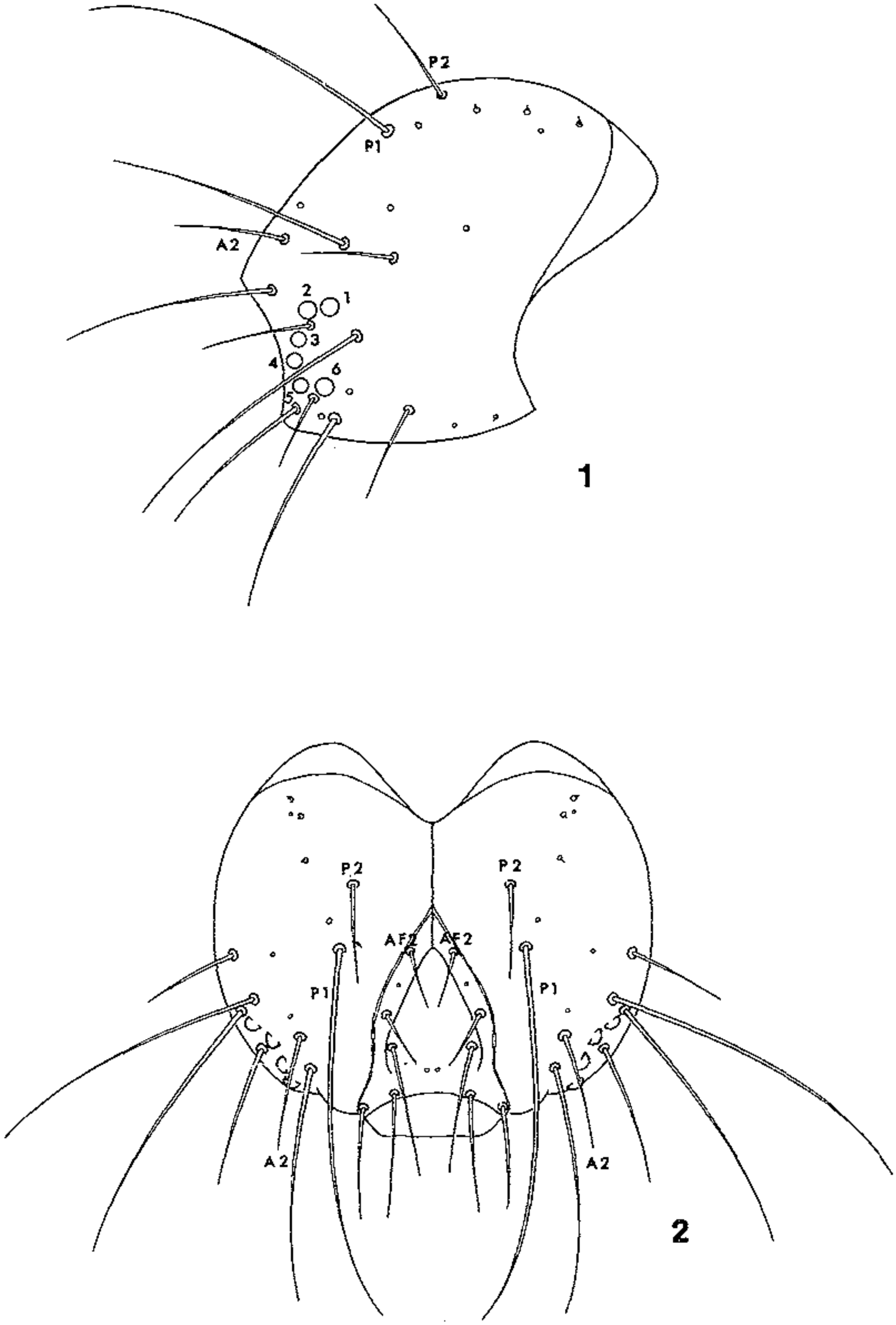
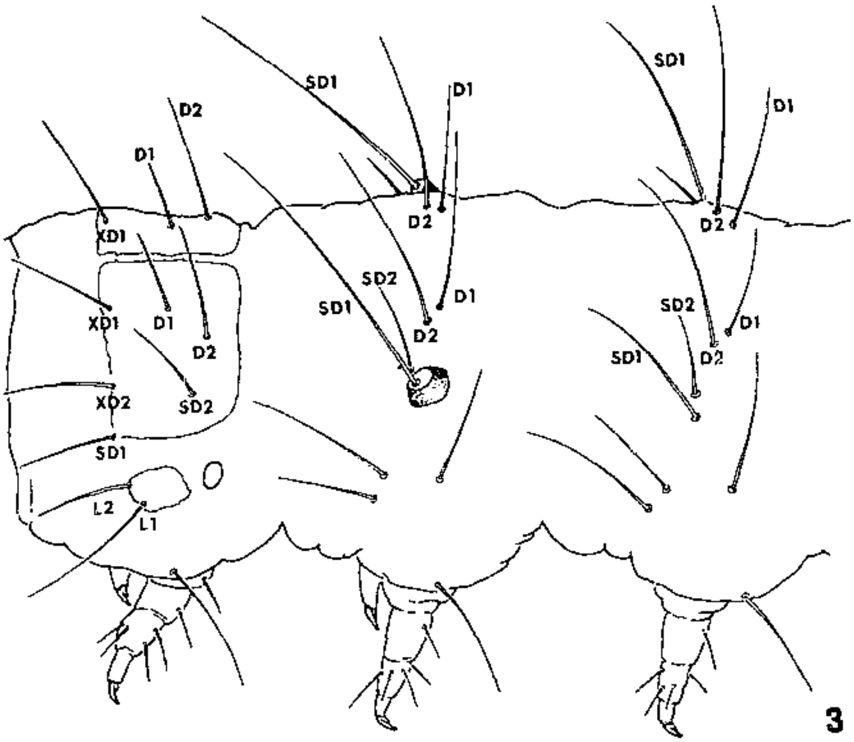


FIGURES 1-2.—Generalized head of last-instar phycitine, showing *A2*, *AF2*, and *P* setae and ocelli: Lateral (1) and frontal (2) views. [*A*, anterior; *AF*, adfrontal; *P*, posterior]



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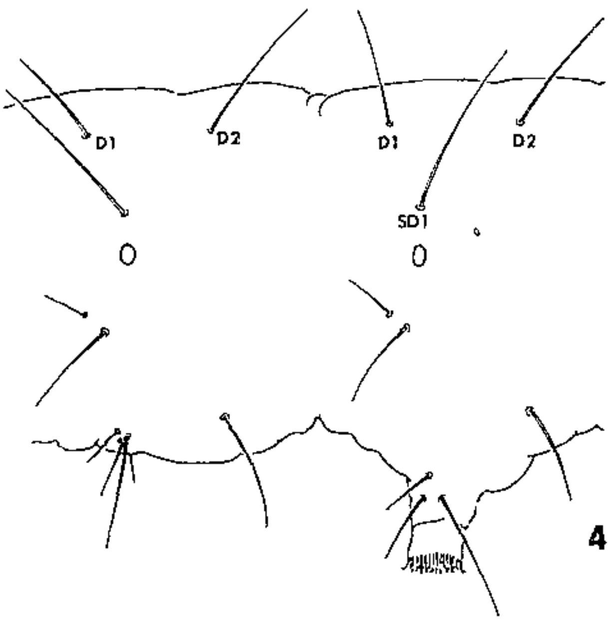

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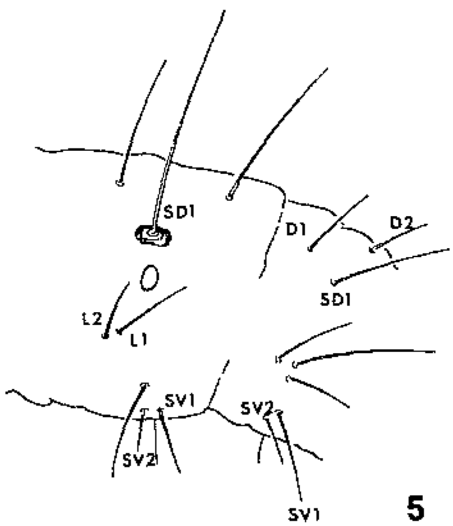

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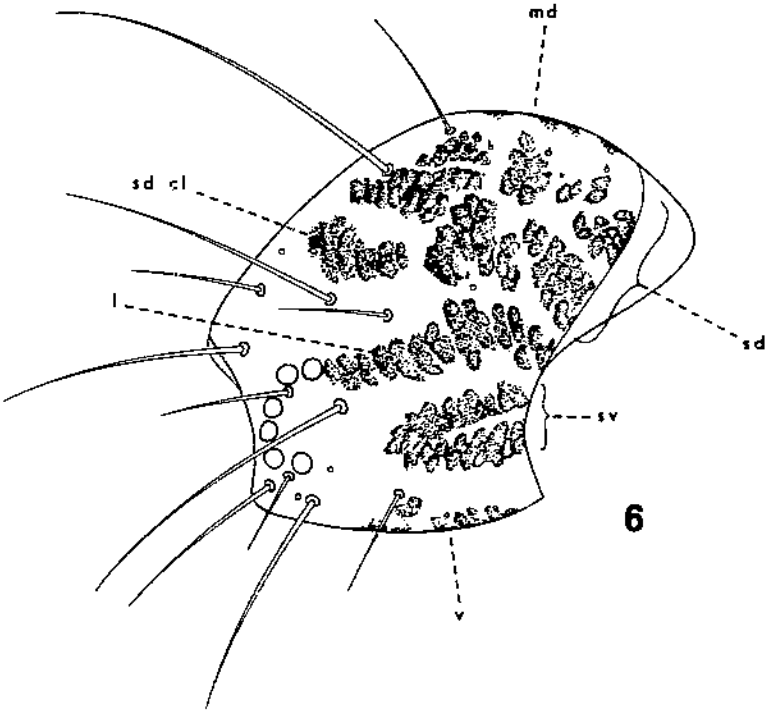
FIGURES 3-5.—Generalized last-instar phycitine, showing *XD, D, SD, L,* and *SV* setae: 3, Prothorax, mesothorax, and metathorax (laterodorsal view); 4, abdominal segments 2 and 3 (lateral view); 5, abdominal segments 8 and 9 (lateral view). [*XD,* anterodorsal; *D*, dorsal; *SD*, subdorsal; *L*, lateral; *SV*, subventral]



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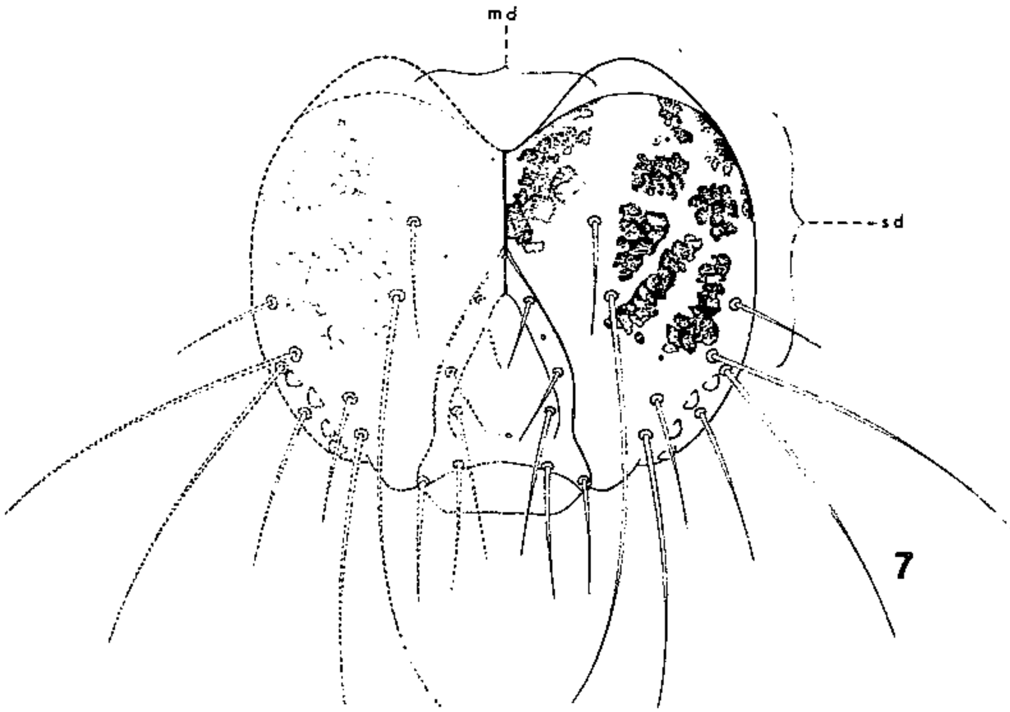

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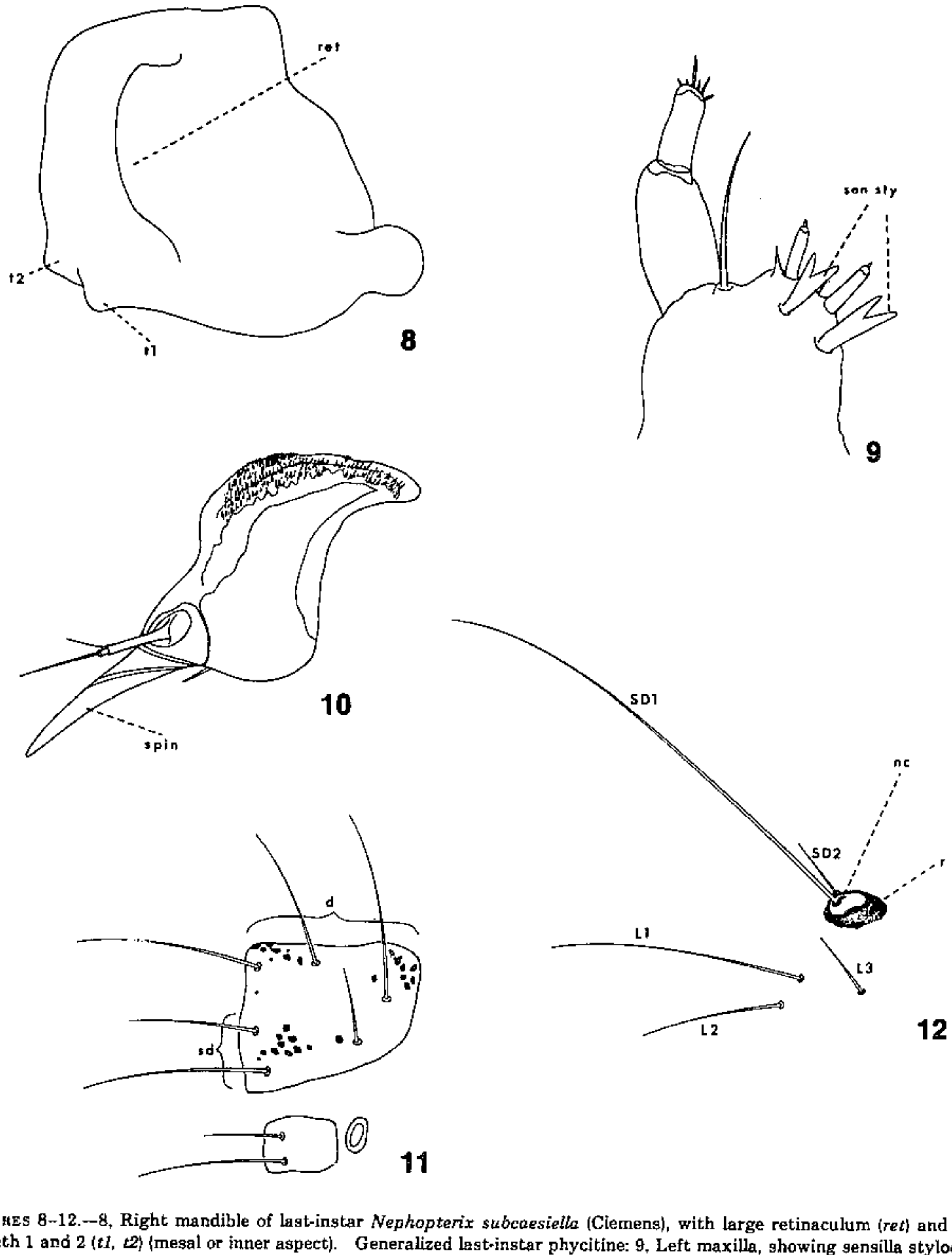
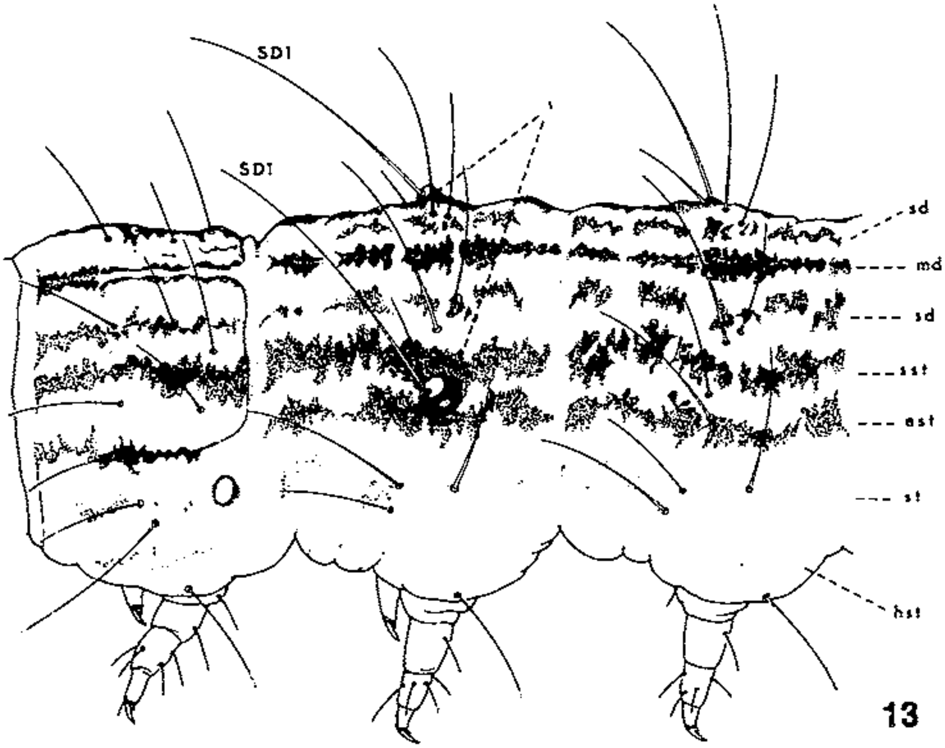
FIGURES 6–7.—Generalized head of last-instar phycitine, showing *md*, *sd*, *sd cl*, *l*, *sv*, and *v* tonofibrillary platelet groups: Lateral (6) and frontal (7) views. [*md*, middorsal; *sd*, subdorsal; *sd cl*, subdorsal club; *l*, lateral; *sv*, subventral; *v*, ventral]



FIGURES 8–12.—8, Right mandible of last-instar *Nephopterix subcaesiella* (Clemens), with large retinaculum (*ret*) and distal teeth 1 and 2 (*t1*, *t2*) (mesal or inner aspect). Generalized last-instar phycitine: 9, Left maxilla, showing sensilla styloconica (*sen sty*) (mesal or inner aspect); 10, hypopharyngeal complex, including spinneret (*spin*) (lateral view); 11, shield, prespiracular plate, and spiracle of prothorax, showing dorsal (*d*) and subdorsal (*sd*) tonofibrillary platelet groups of shield (lateral view); 12, subdorsal (*SD*) and lateral (*L*) setae of mesothorax, with SD1 ring (*r*) and rodlike neural connection (*nc*) at ring of alveolus (lateral view).



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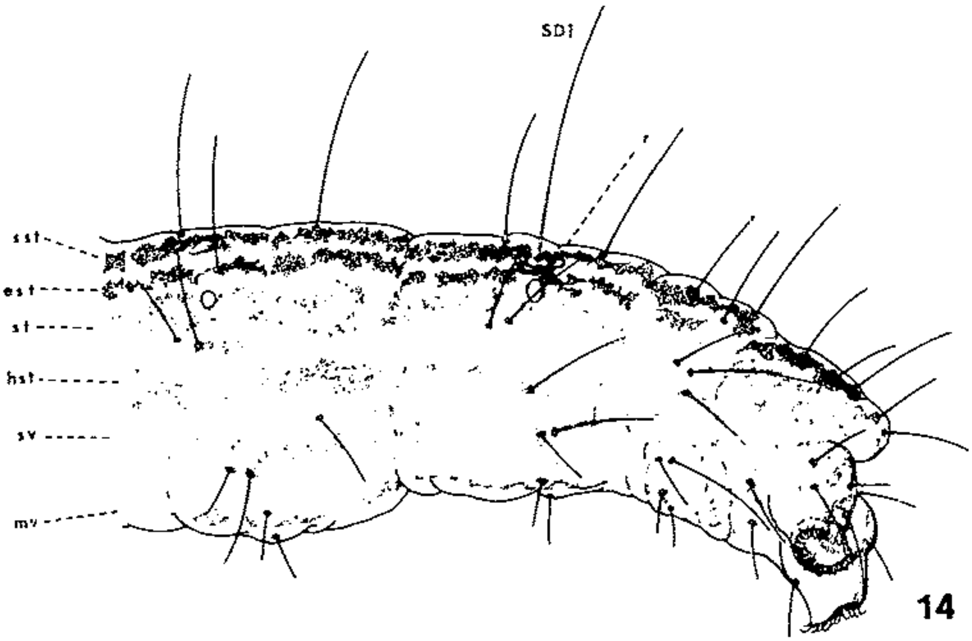

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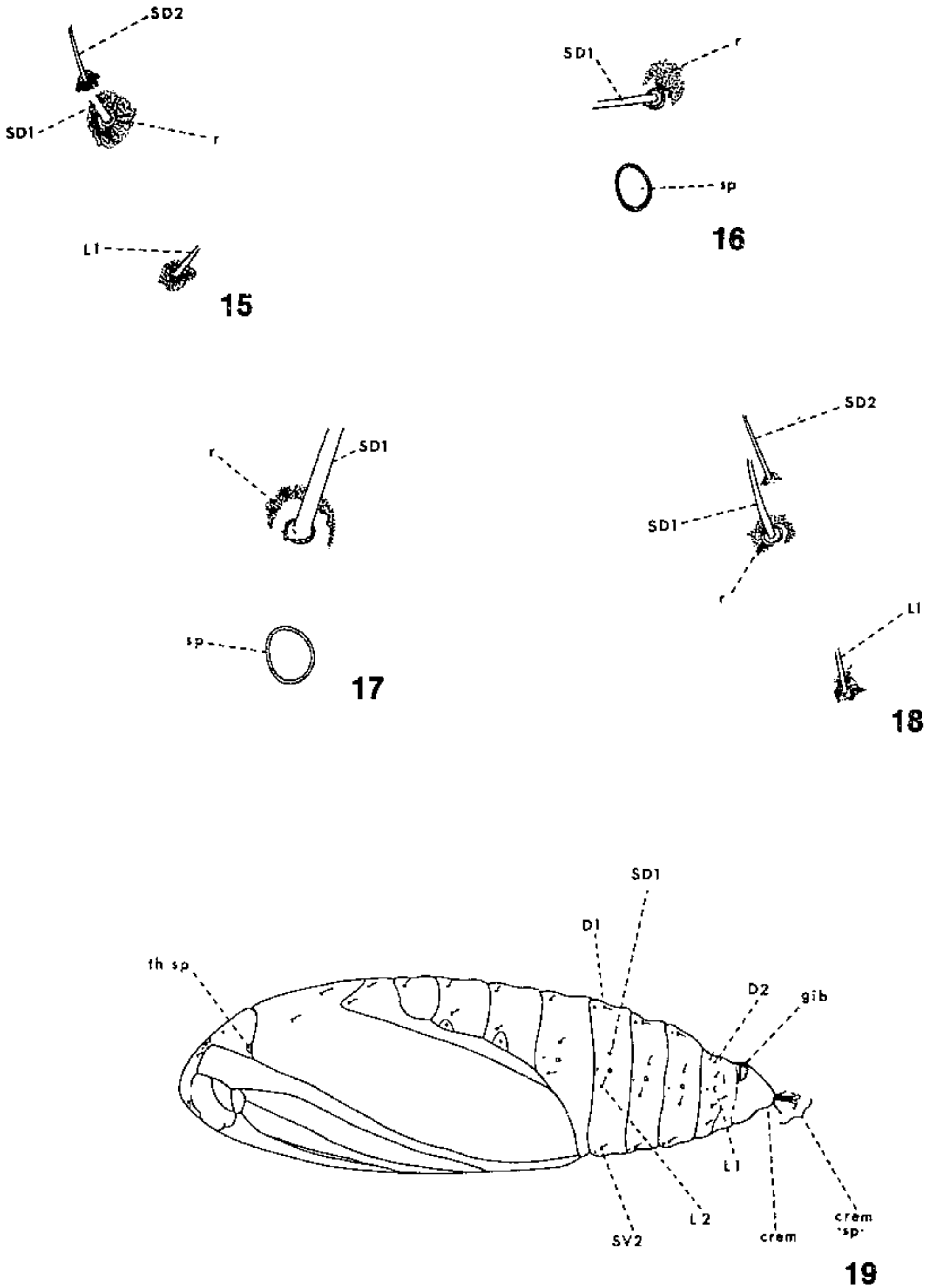
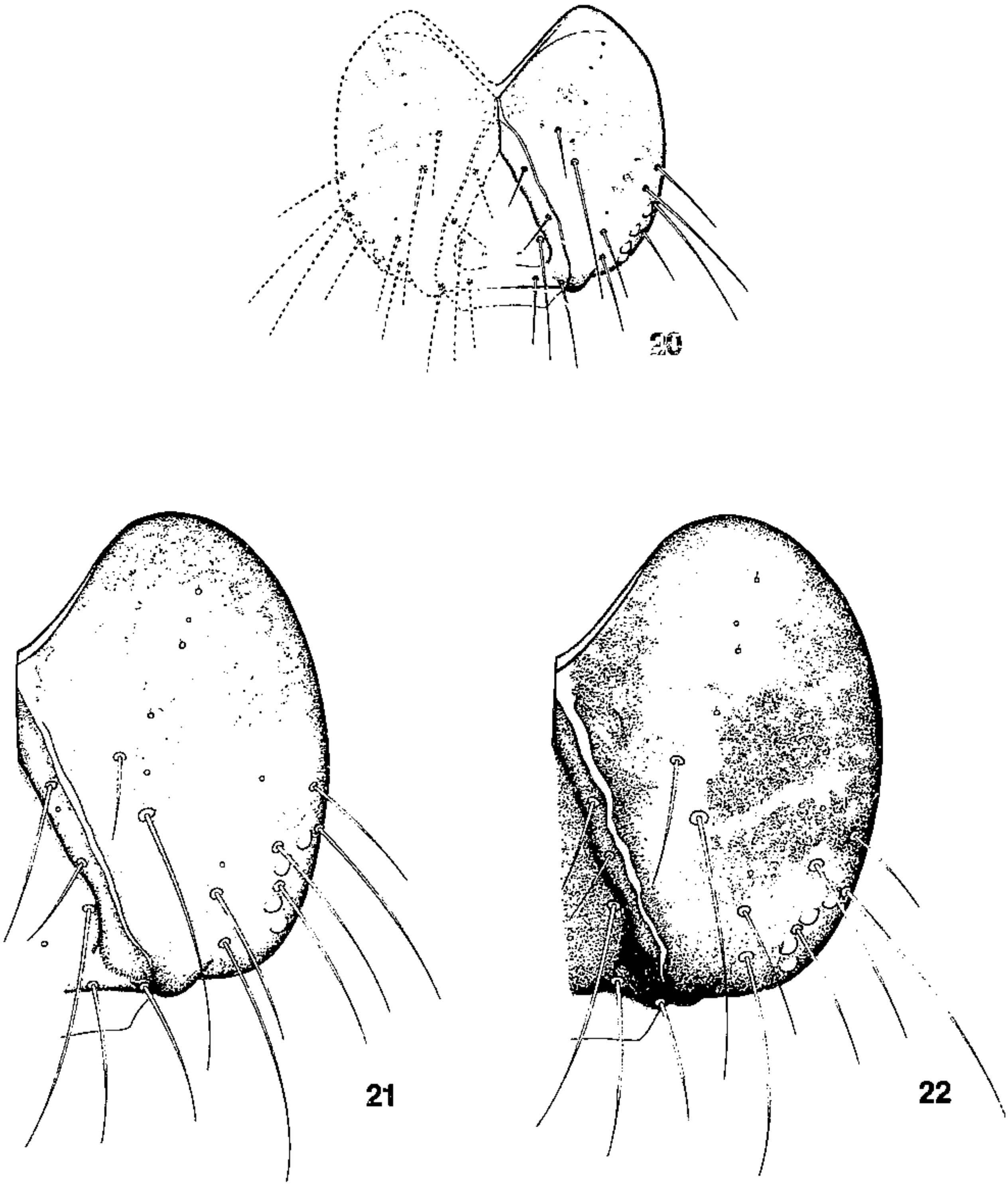
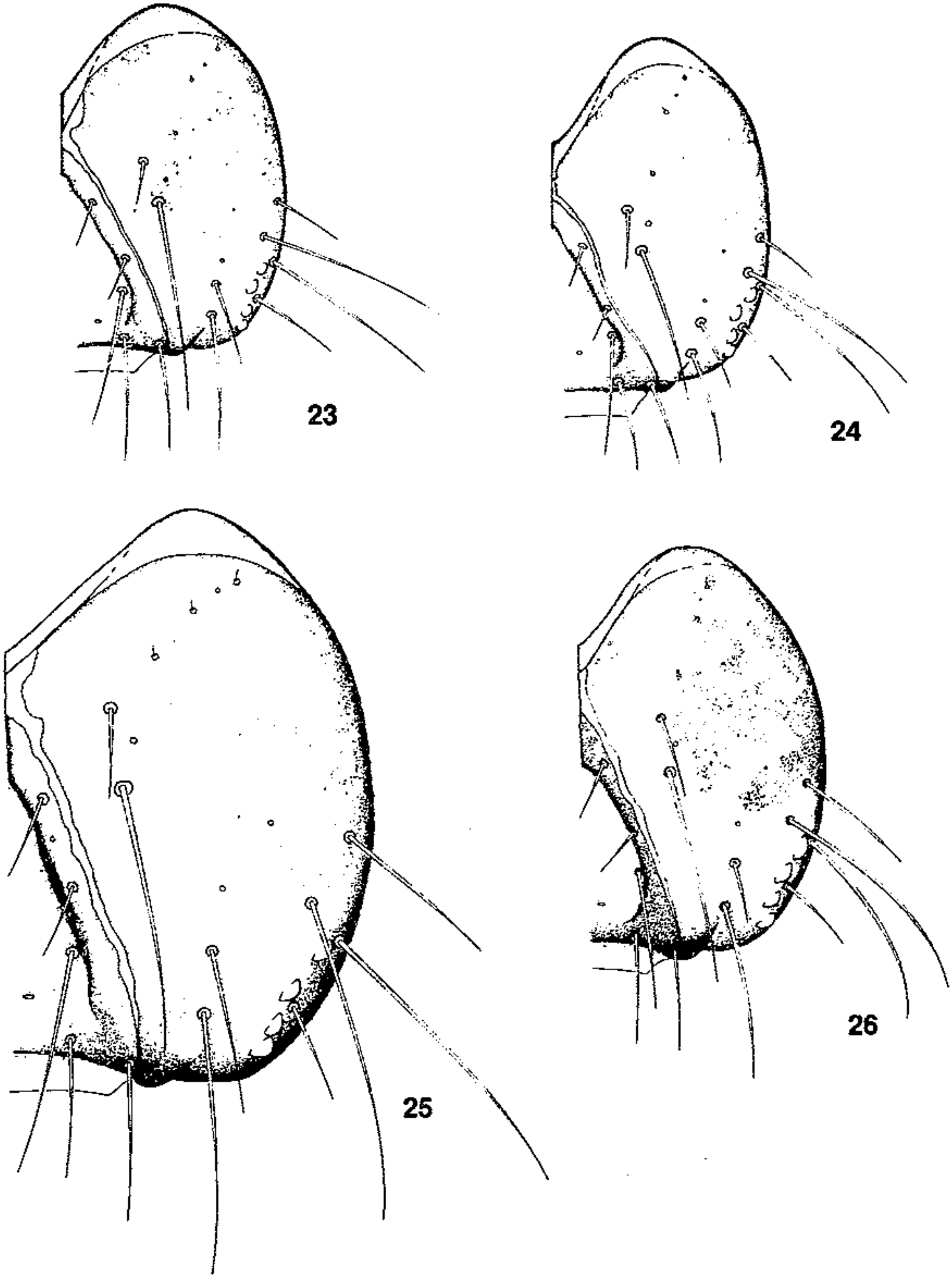
FIGURES 13-14.—Generalized last-instar phycitine: 13, Prothorax, mesothorax, and metathorax, showing mesothoracic *SD1* rings (*r*) and body stripes (laterodorsal view); 14, caudal abdominal segments, showing eighth abdominal *SD1* rings (*r*) and body stripes (lateroventral view). [*md*, middorsal; *sd*, subdorsal; *sst*, suprastigmatal; *est*, epistigmatal; *st*, stigmatal; *hst*, hypostigmatal; *sv*, supraventral; *mv*, midventral]



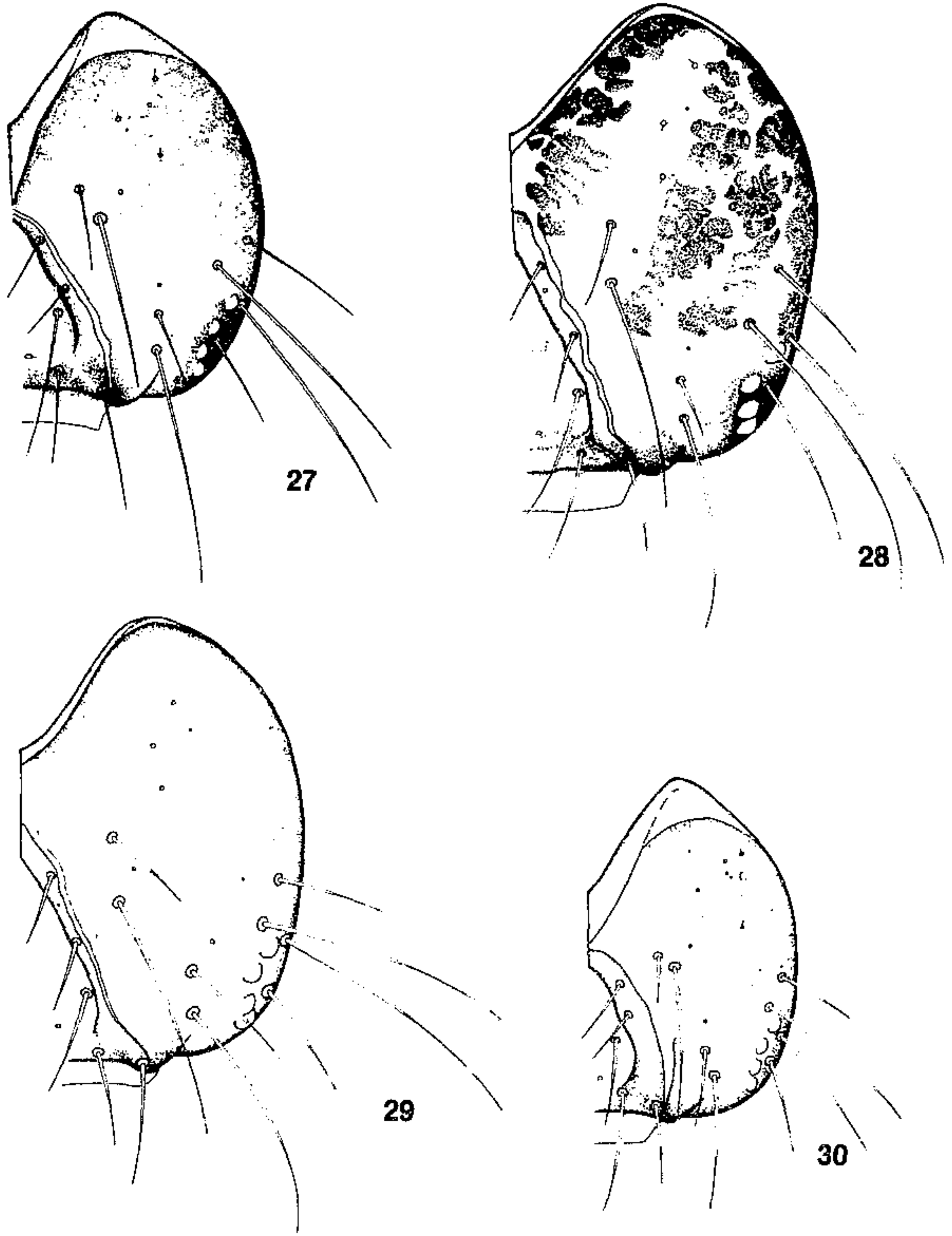
FIGURES 15–19.—15, *SD1, SD2,* and *L1* setae of metathorax of last-instar *Spectrobates ceratoniae* (Zeller), with ring (*r*) closely embracing *SD1*; 16, *SD1* seta and spiracle (*sp*) of abdominal segment 1 of last-instar *Amyelois transitella* (Walker), with typical ring fragment (*r*) adjacent to *SD1*; 17, *SD1* seta and spiracle (*sp*) of abdominal segment 1 of last-instar *S. ceratoniae*, with partial crescent-shaped ring (*r*) usually found associated with *SD1*; 18, *SD1, SD2,* and *L1* setae of metathorax of last-instar *A. transitella*, with partial ring (*r*) closely embracing *SD1*; 19, generalized phycitine pupa, including thoracic spiracle (*th sp*), *D, SD1, L,* and *SV2* setae, gibba (*gib*), cremaster (*crem*), and cremastral "spines" (*crem "sp"*) (lateral view).



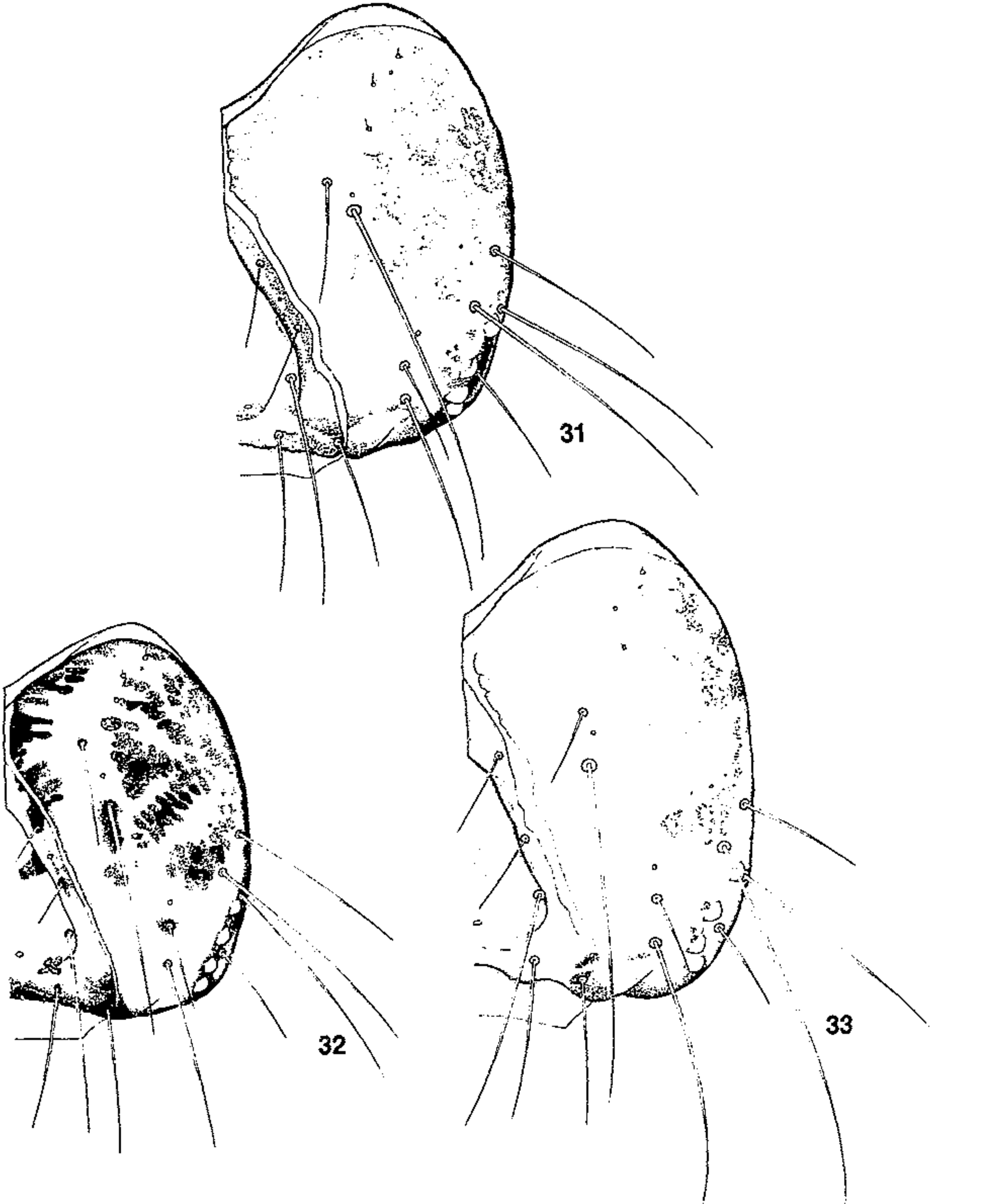
FIGURES 20–22.—20, Head of last-instar *Anabasis ochrodesma* (Zeller) (frontal view). Left half of head of last instar (frontal view): 21, *Spectrobates ceratoniae* (Zeller); 22, *Amyelois transitella* (Walker).



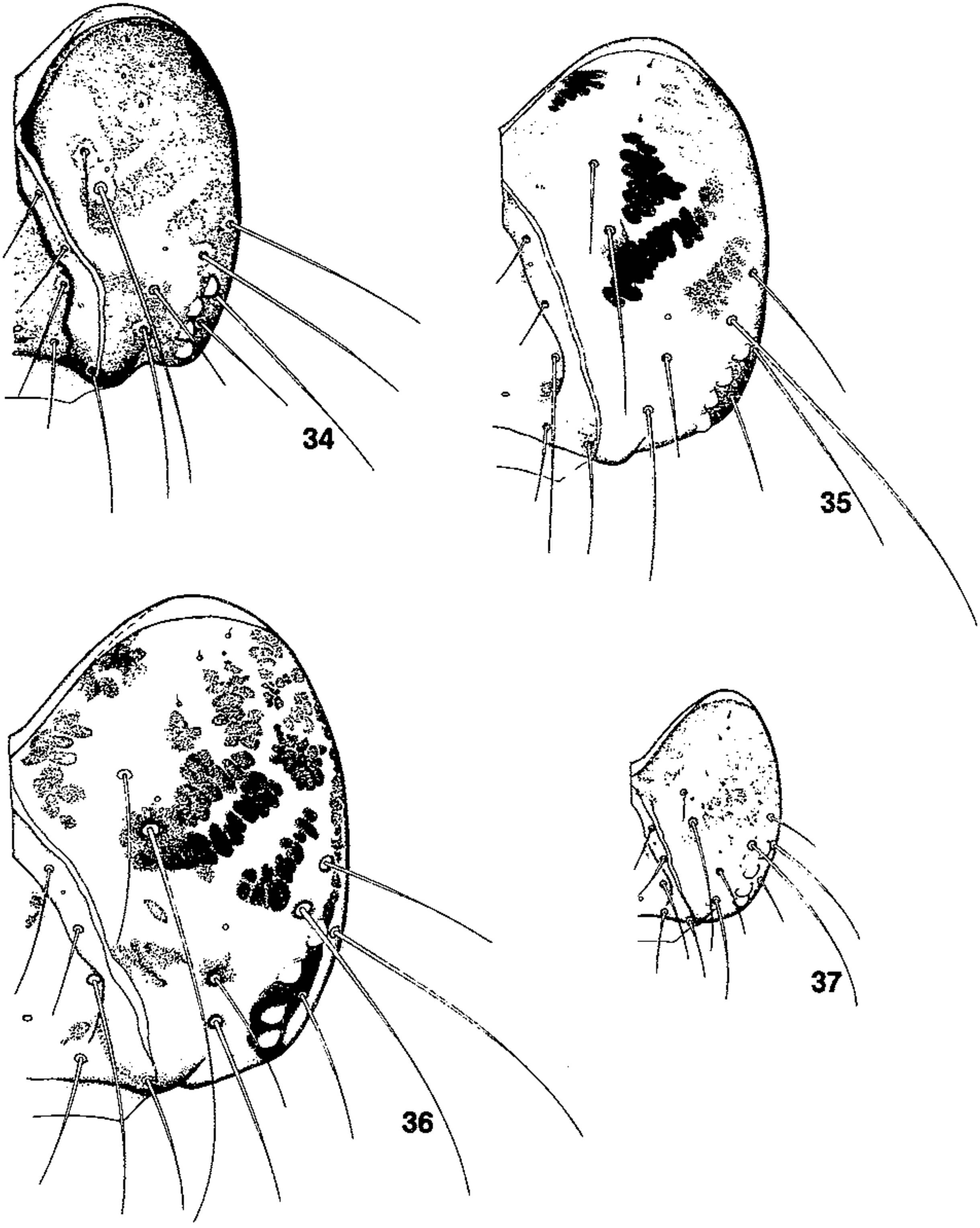
FIGURES 23–26.—Left half of head of last instar (frontal view): 23, *Fundella argentina* Dyar; 24, *F. pellucens* Zeller; 25, *Monoptilota pergratialis* (Hulst); 26, *Ancylostomia stercorea* (Zeller).



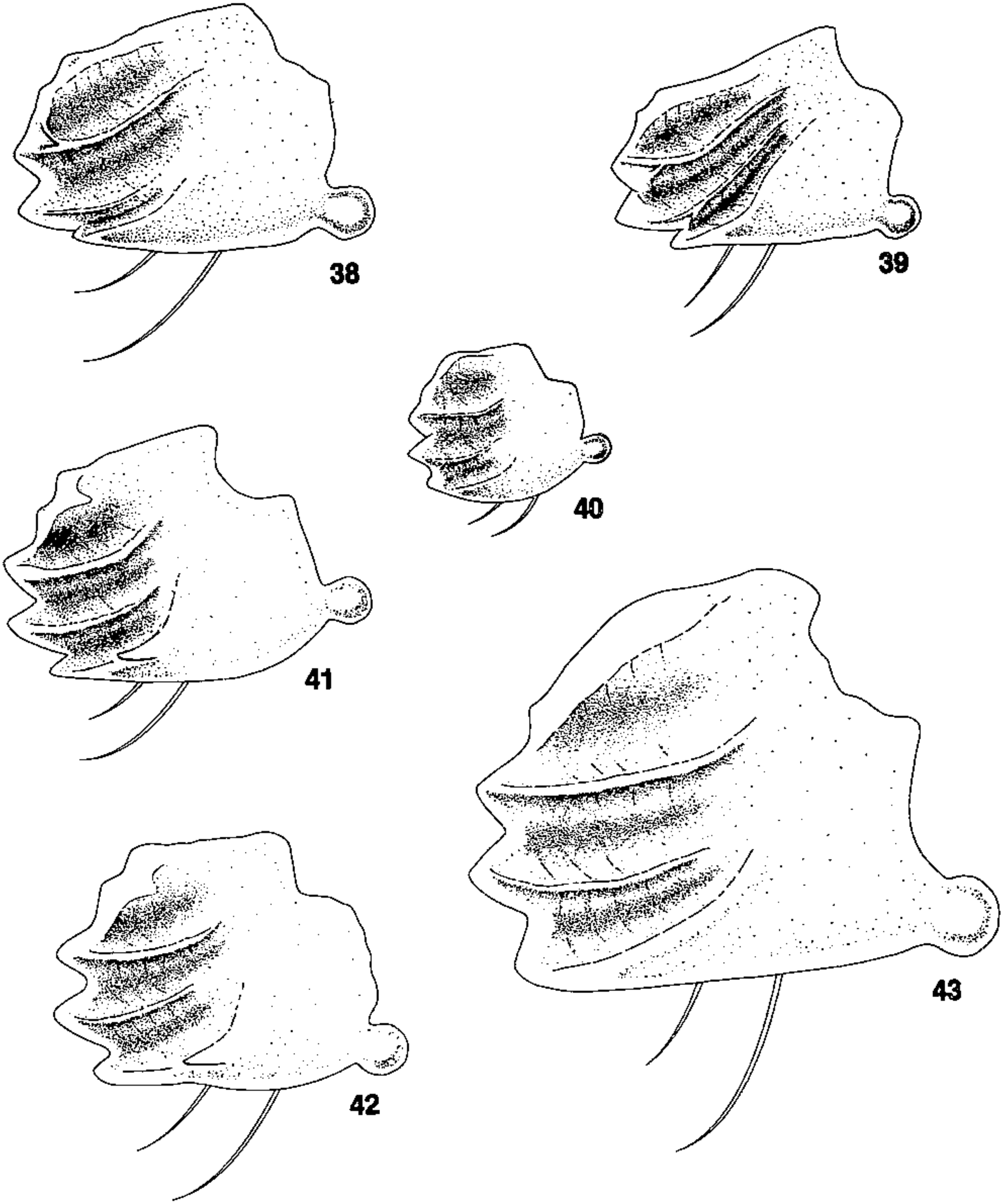
FIGURES 27–30.—Left half of head of last instar (frontal view): 27, *Etiella zinckenella* (Treitschke); 28, *Pima granitella* (Ragonot); 29, *P. albiplagiatella occidentalis* Heinrich; 30, *Ulophora groteii* Ragonot.



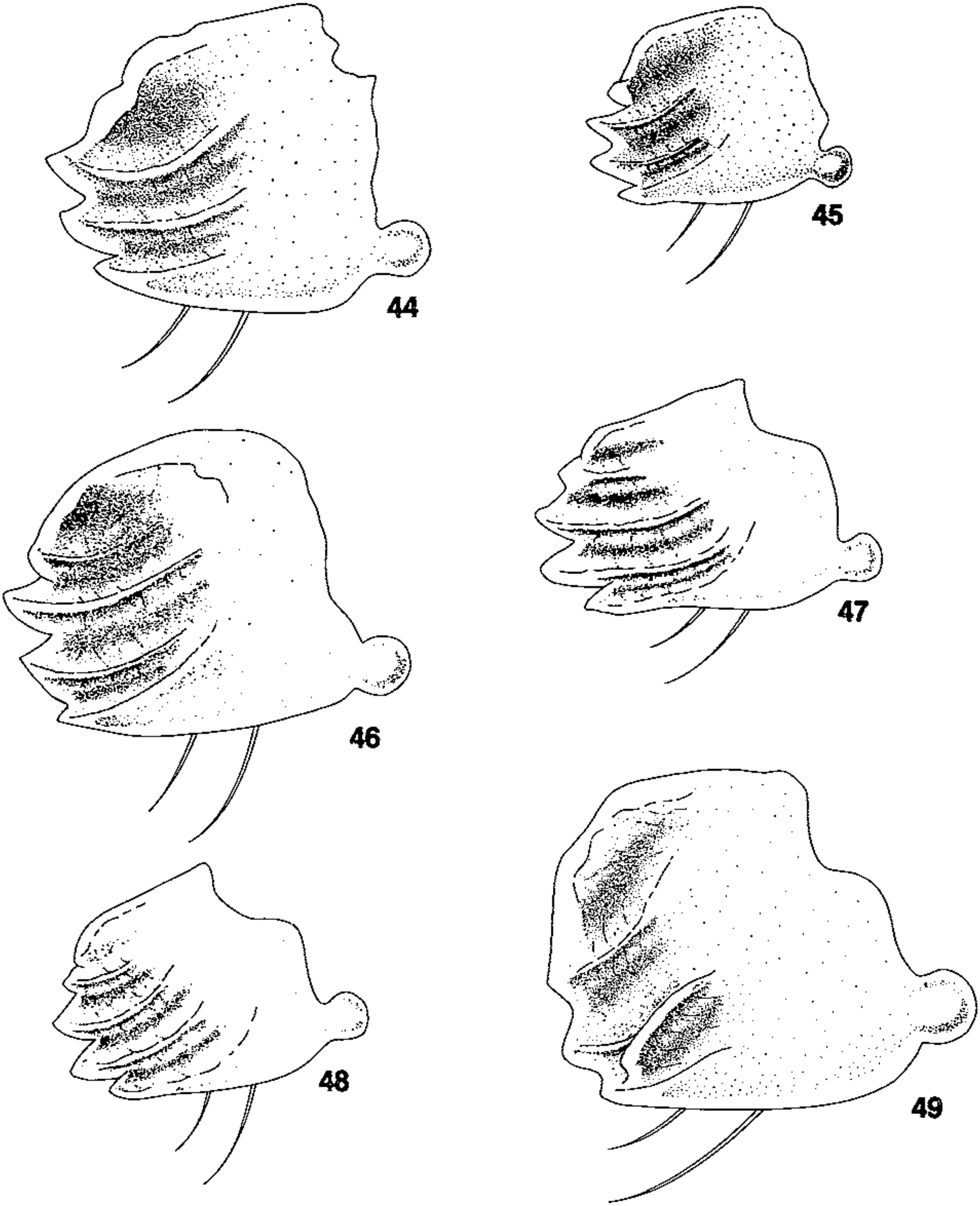
FIGURES 31–33.—Left half of head of last instar (frontal view): 31, *Caristanius decoloralis* (Walker); 32, *C. minimus* Neunzig; 33, *Tlascala reductella* (Walker).



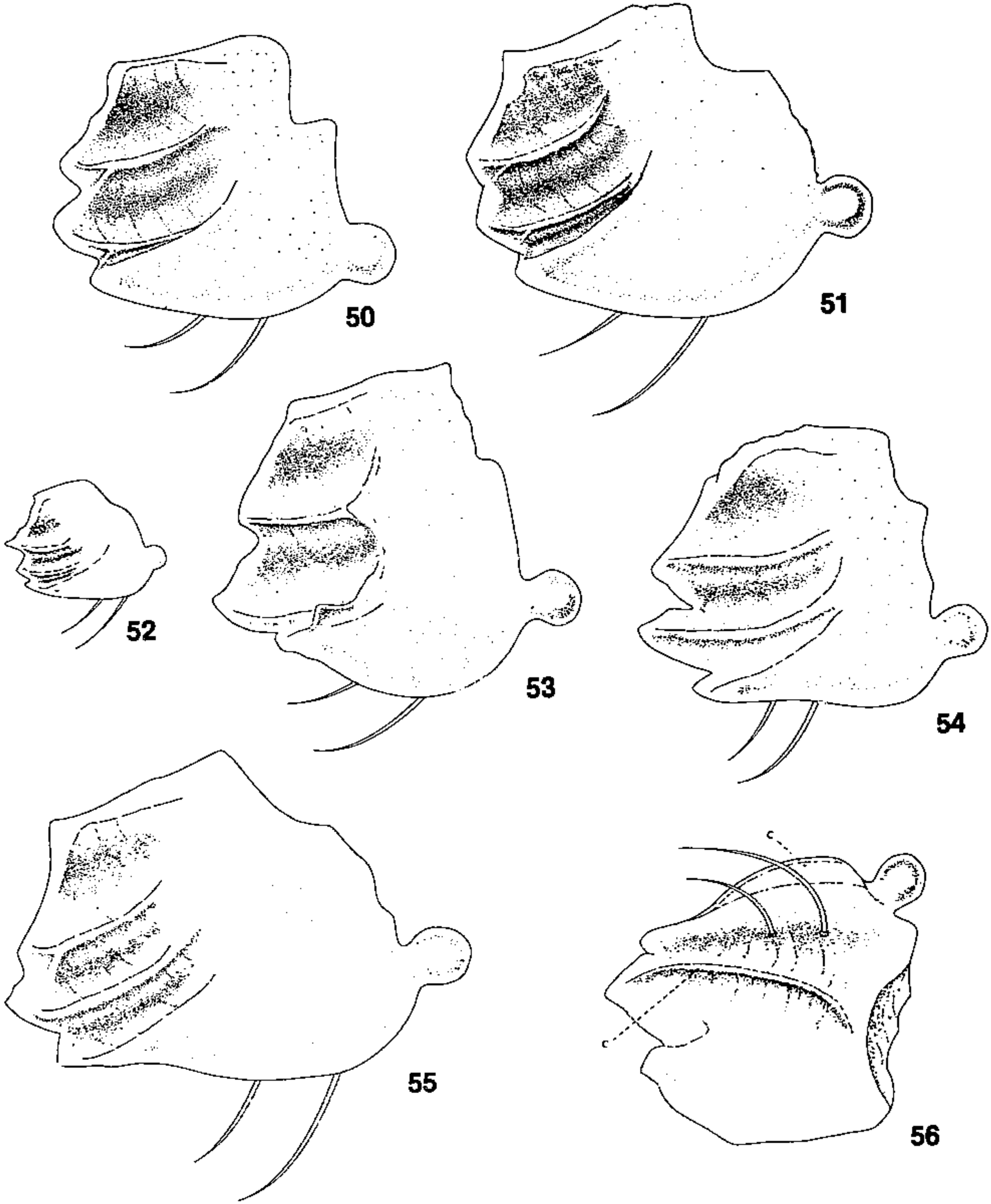
FIGURES 34–37.—Left half of head of last instar (frontal view): 34, *Elasmopalpus lignosellus* (Zeller); 35, *Ufa rubedinella* (Zeller); 36, *Adelphia petrella* (Zeller); 37, *Metephestia simplicula* (Zeller).



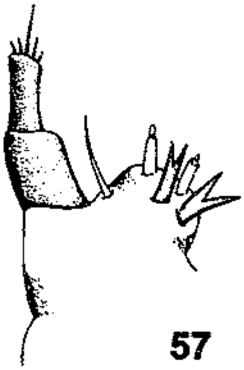
FIGURES 38-43.—Right mandible of last instar (mesal or inner aspect): 38, *Spectrobates ceratoniae* (Zeller); 39, *Amyelois transitella* (Walker); 40, *Anabasis ochrodesma* (Zeller); 41, *Fundella pellucens* Zeller; 42, *F. argentina* Dyar; 43, *Monoptilota pergratialis* (Hulst).



FIGURES 44–49.—Right mandible of last instar (mesal or inner aspect): 44, *Ancylostomia stercorea* (Zeller); 45, *Ulophora groteii* Ragonot; 46, *Etiella zinckenella* (Treitschke); 47, *Pima albiplagiatella occidentalis* Heinrich; 48, *P. granitella* (Ragonot); 49, *Tlascala reductella* (Walker).



FIGURES 50–56.—Right mandible of last instar (mesal or inner aspect): 50, *Caristanius minimus* Neunzig; 51, *C. decoloralis* (Walker); 52, *Metephestia simplicula* (Zeller); 53, *Ufa rubedinella* (Zeller); 54, *Elasmopalpus lignosellus* (Zeller); 55, *Adelphia petrella* (Zeller). 56, Right mandible of last-instar *U. rubedinella*, showing two well-developed carinae (*c*) (outer aspect).



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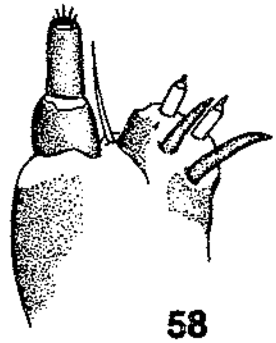

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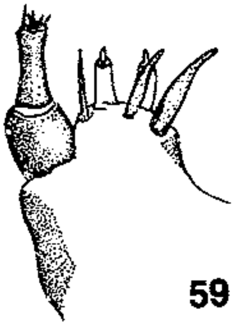

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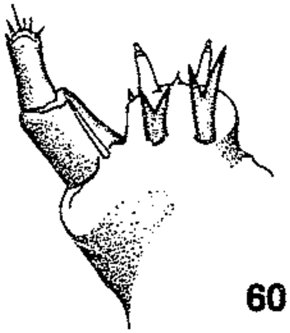

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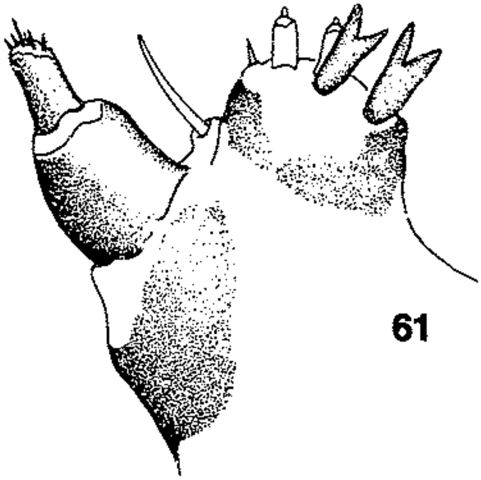

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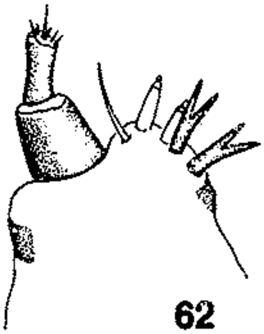

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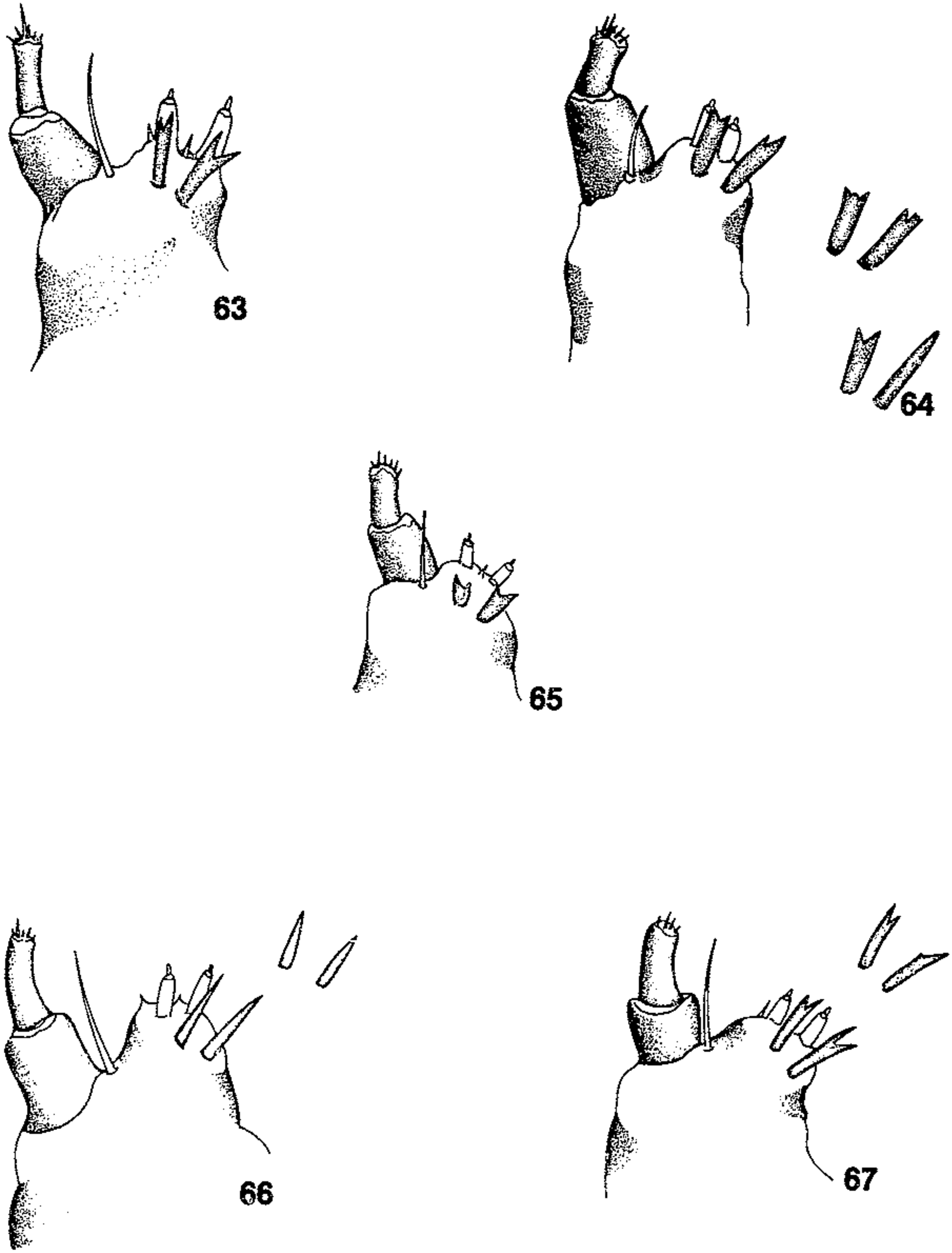
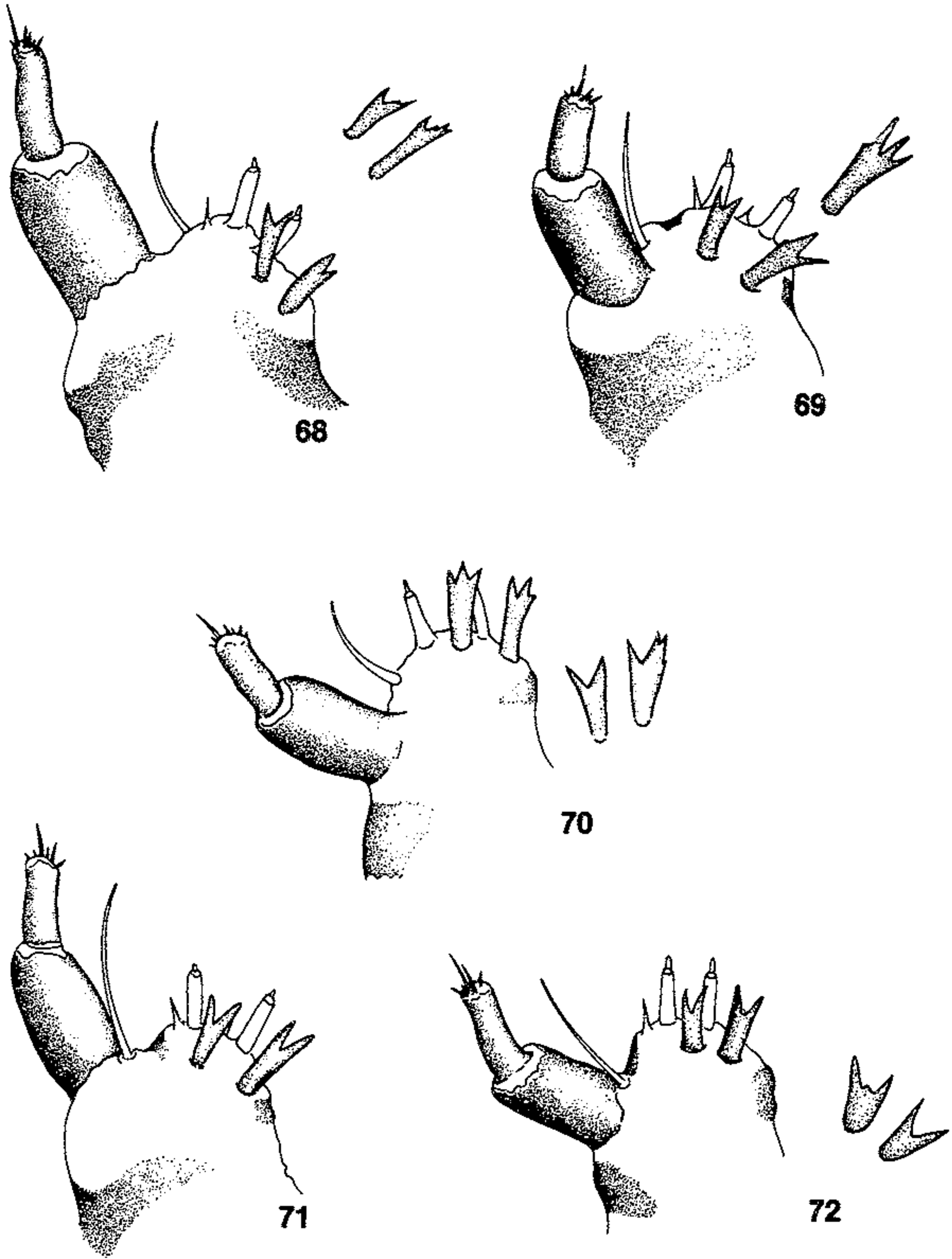
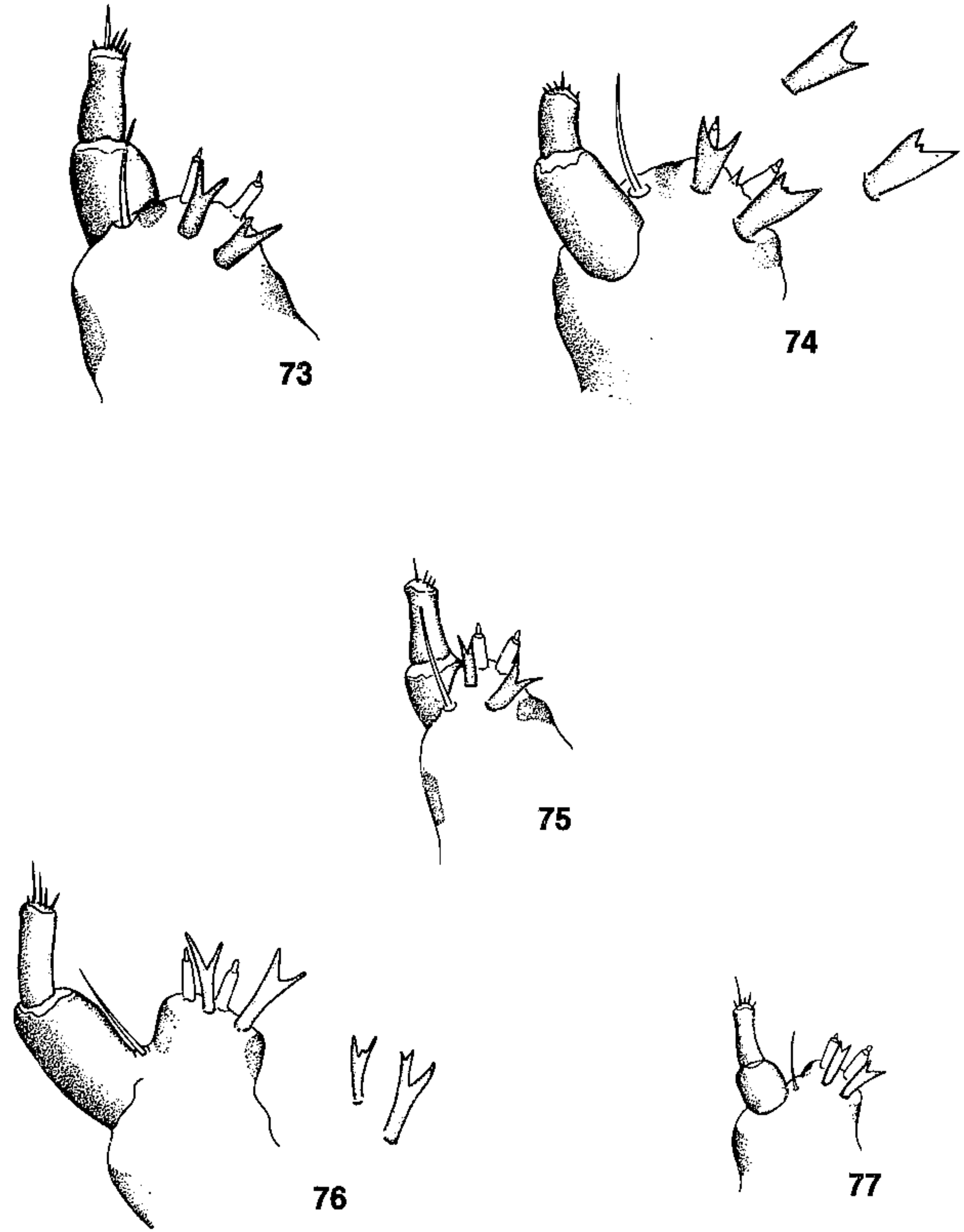
FIGURES 57–62.—Left maxilla of last instar (mesal or inner aspect): 57, *Anabasis ochrodesma* (Zeller); 58, *Amyelois transitella* (Walker); 59, *Spectrobates ceratoniae* (Zeller); 60, *Fundella pellucens* Zeller; 61, *Monoptilota pergratialis* (Hulst); 62, *F. argentina* Dyar.



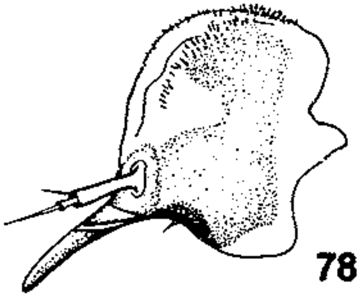
FIGURES 63–67.—Left maxilla of last instar (mesal or inner aspect): 63, *Ancylostomia stercorea* (Zeller); 64, *Etiella zinckenella* (Treitschke); 65, *Ulophora groteii* Ragonot; 66, *Pima granitella* (Ragonot); 67, *P. albiplagiatella occidentalis* Heinrich.



FIGURES 68-72.—Left maxilla of last instar (mesal or inner aspect): 68, *Nephopterix dammersi floridensis* Heinrich; 69, *N. subcaesiella* (Clemens); 70, *N. virgatella* (Clemens); 71, *Tlascala reductella* (Walker); 72, *Caristanius minimus* Neunzig.



FIGURES 73–77.—Left maxilla of last instar (mesal or inner aspect): 73, *Caristanius decoloralis* (Walker); 74, *Adelphia petrella* (Zeller); 75, *Elasmopalpus lignosellus* (Zeller); 76, *Ufa rubedinella* (Zeller); 77, *Metephestia simplicula* (Zeller).



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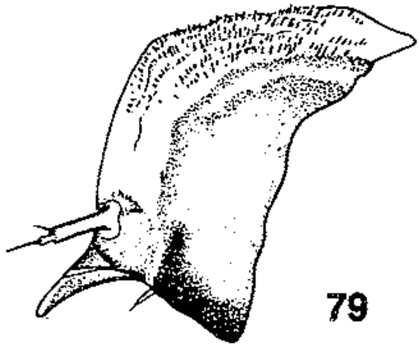

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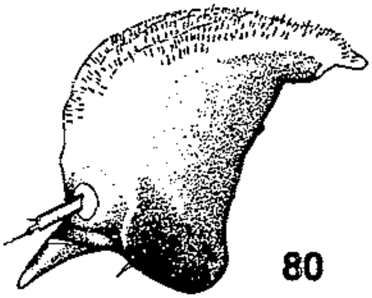

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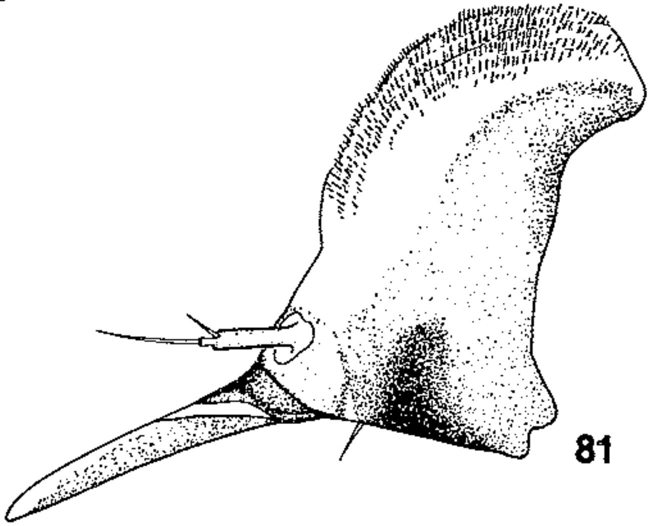

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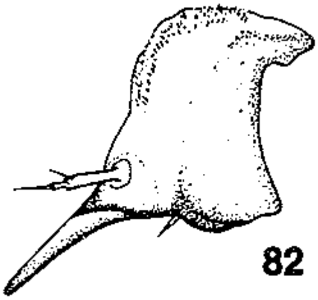

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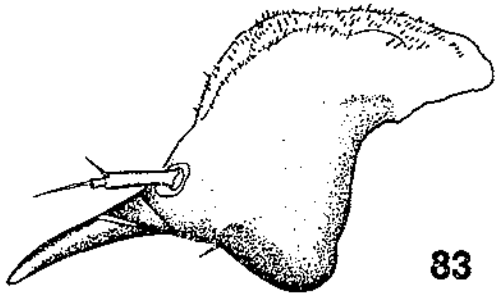

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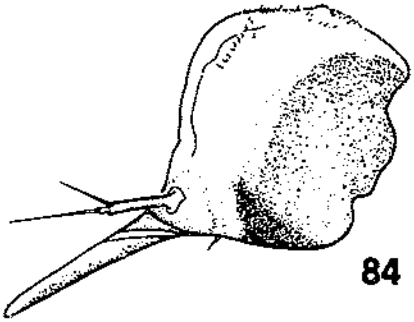
FIGURES 78–83.—Hypopharyngeal complex of last instar (lateral view): 78, *Anabasis ochrodesma* (Zeller); 79, *Spectrobates ceratoniae* (Zeller); 80, *Amyelois transitella* (Walker); 81, *Monoptilota pergratialis* (Hulst); 82, *Fundella argentina* Dyar; 83, *F. pellucens* Zeller.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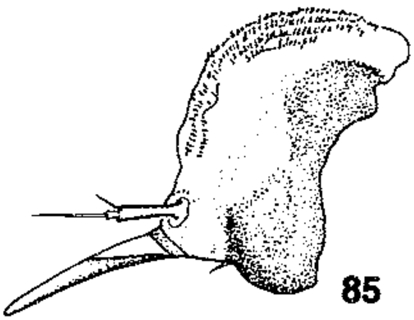
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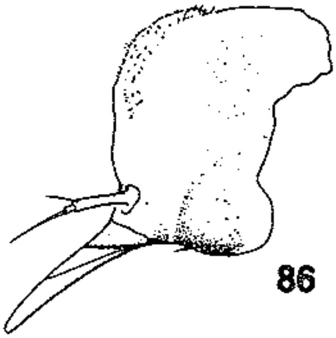
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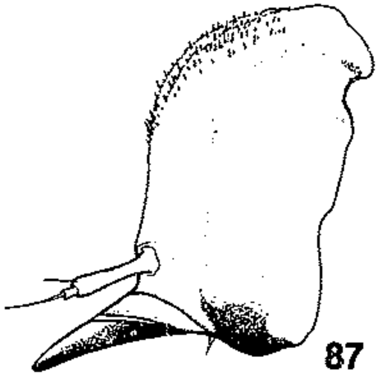
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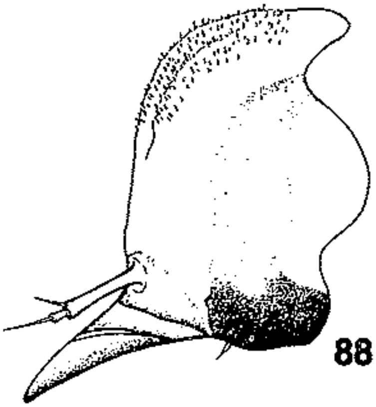
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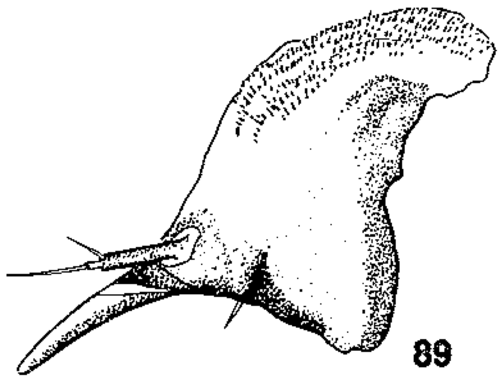
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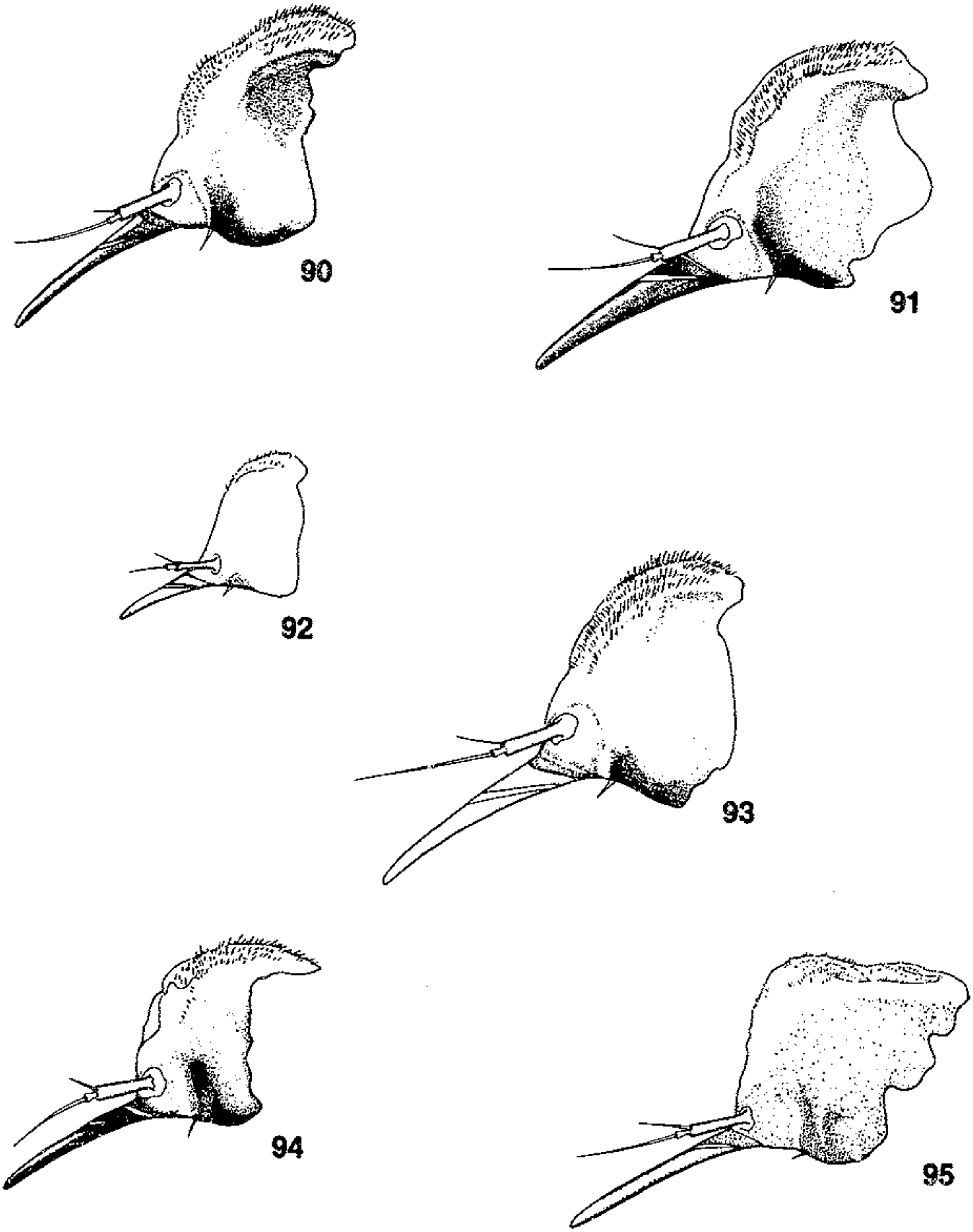
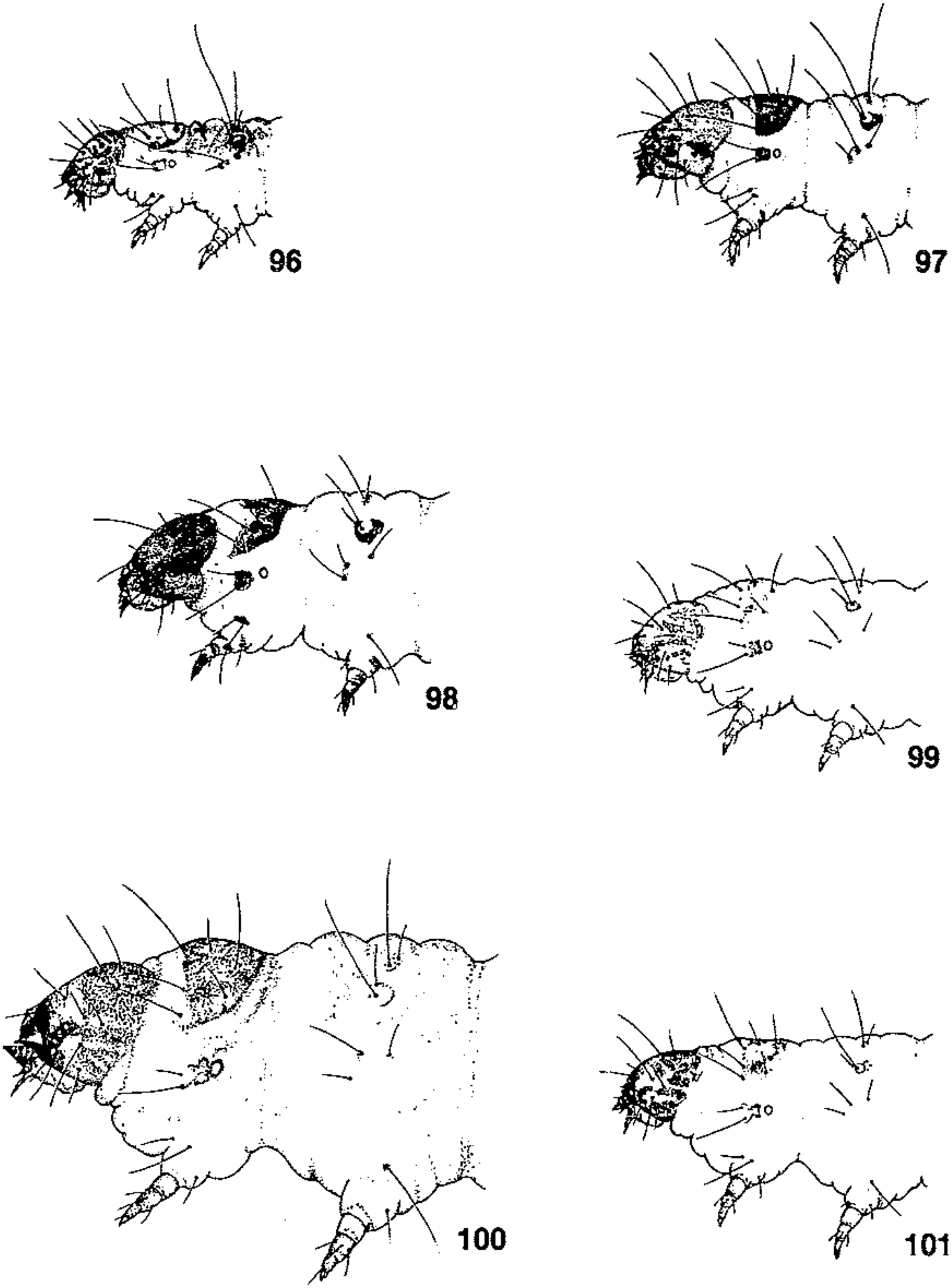
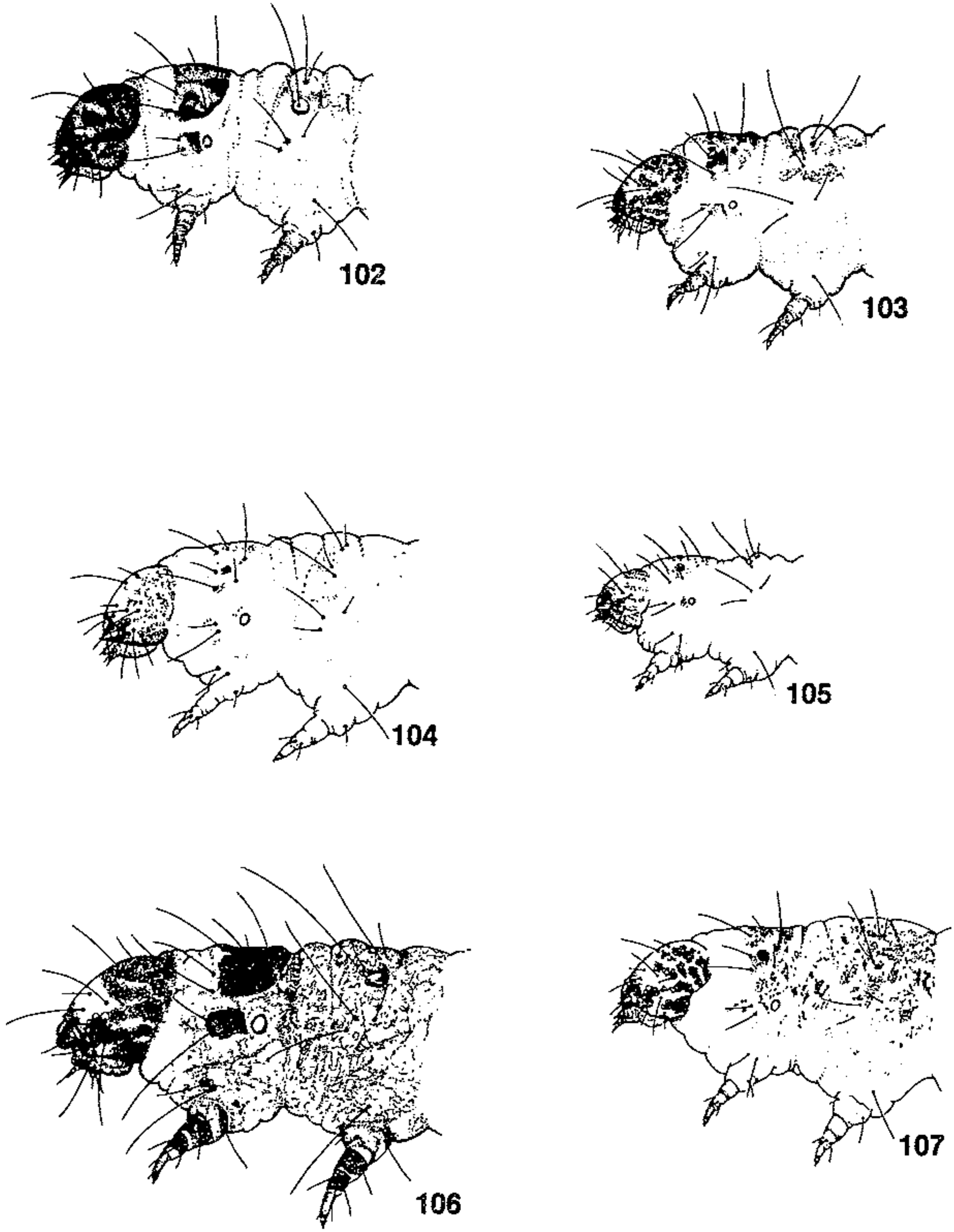
FIGURES 84-89.—Hypopharyngeal complex of last instar (lateral view): 84, *Ancylostomia stercorea* (Zeller); 85, *Etiella zinckenella* (Treitschke); 86, *Ulophora groteii* Ragonot; 87, *Pima albiplagiatella occidentalis* Heinrich; 88, *P. granitella* (Ragonot); 89, *Tlascala reductella* (Walker).



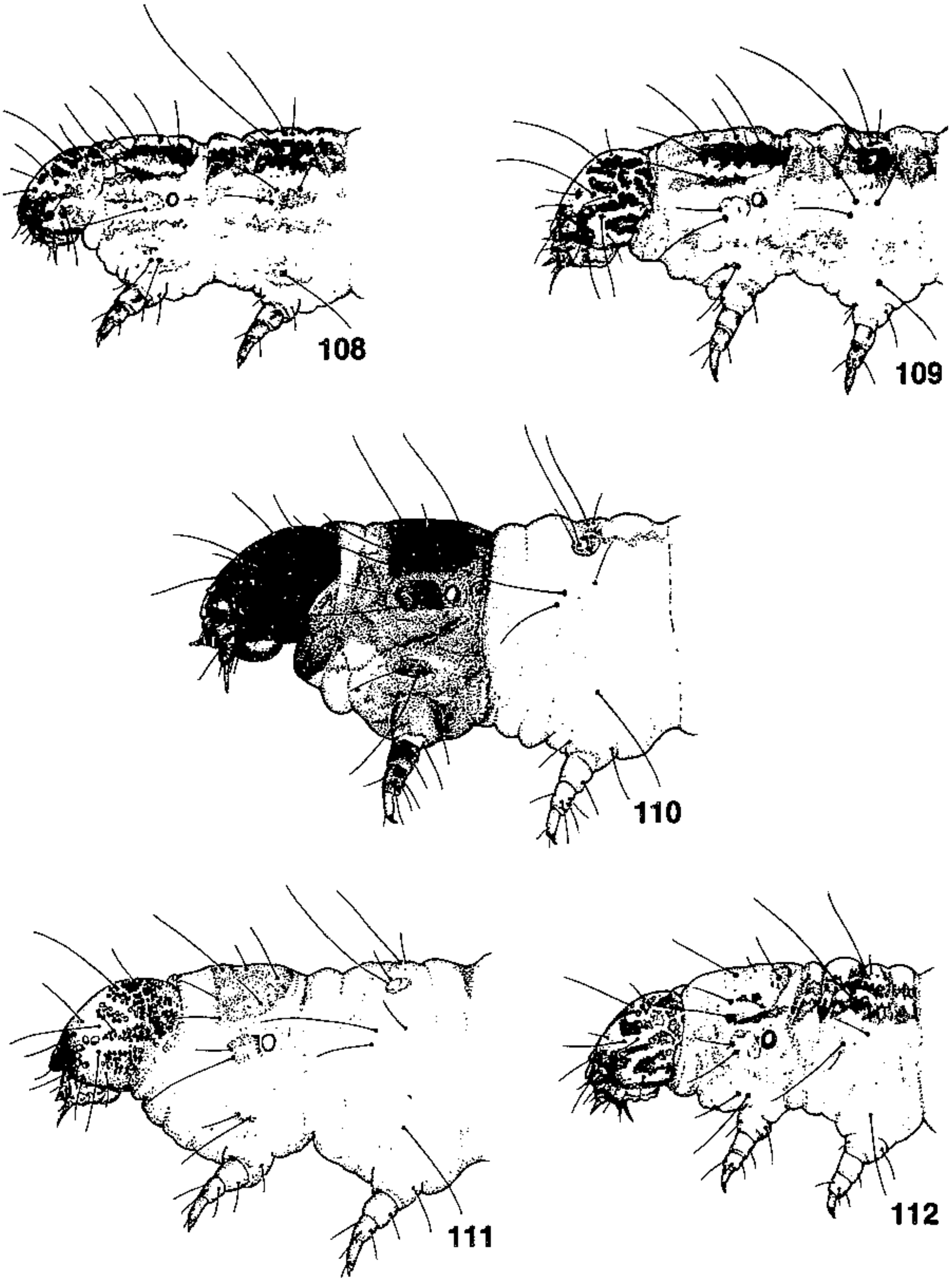
FIGURES 90–95.—Hypopharyngeal complex of last instar (lateral view): 90, *Caristanius minimus* Neunzig; 91, *C. decoloralis* (Walker); 92, *Metephestia simplicula* (Zeller); 93, *Adelphia petrella* (Zeller); 94, *Elasmopalpus lignosellus* (Zeller); 95, *Ufa rubedinella* (Zeller).



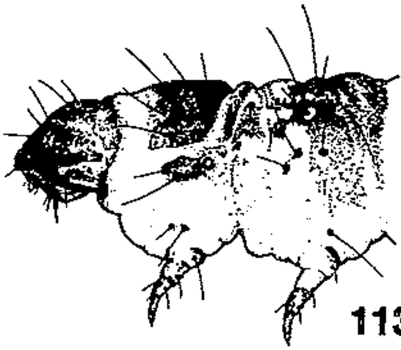
FIGURES 96–101.—Head, prothorax, and mesothorax of last instar (lateral view): 96, *Anabasis ochrodesma* (Zeller); 97, *Spectrobates ceratoniae* (Zeller); 98, *Amyelois transitella* (Walker); 99, *Fundella argentina* Dyar; 100, *Monoptilota pergratialis* (Hulst); 101, *F. pellucens* Zeller.



FIGURES 102–107.—Head, prothorax, and mesothorax of last instar (lateral view): 102, *Ancylostomia stercorea* (Zeller); 103, *Etiella zinckenella* (Treitschke); 104, *Pima albiplagiatella occidentalis* Heinrich; 105, *Ulophora groteii* Ragonot; 106, *Nephopterix dammersi floridensis* Heinrich; 107, *P. granitella* (Ragonot).



FIGURES 108-112.—Head, prothorax, and mesothorax of last instar (lateral view): 108, *Caristanius minimus* Neunzig; 109, *C. decoloralis* (Walker); 110, *Nephopterix subcaesiella* (Clemens); 111, *N. virgatella* (Clemens); 112, *Tlascala reductella* (Walker).



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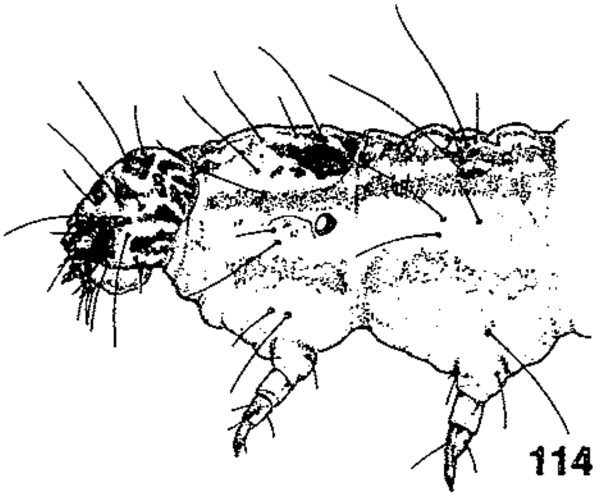

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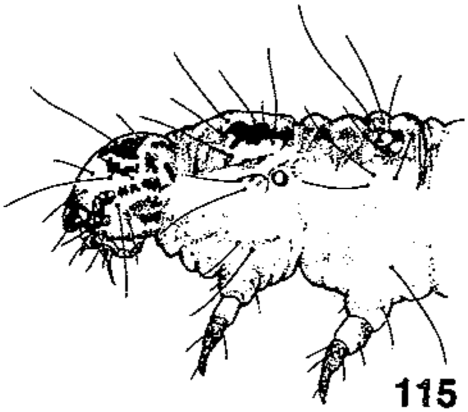

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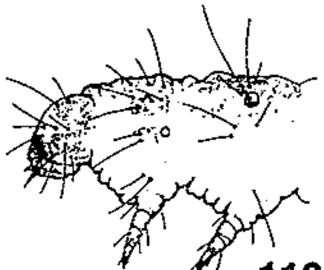
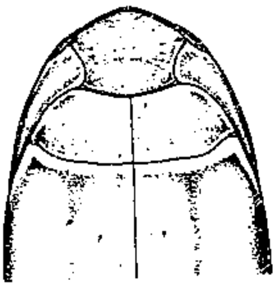


116

FIGURES 113–116.—Head, prothorax, and mesothorax of last instar (lateral view): 113, *Elasmopalpus lignosellus* (Zeller); 114, *Adelphia petrella* (Zeller); 115, *Ufa rubedinella* (Zeller); 116, *Metephestia simplicula* (Zeller).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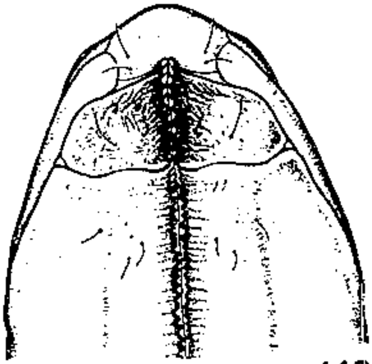
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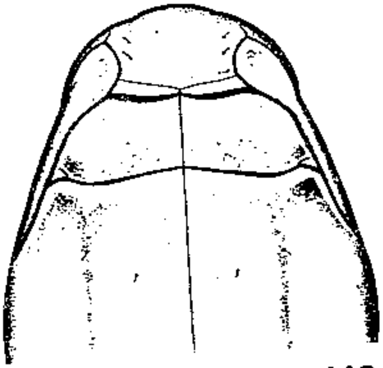
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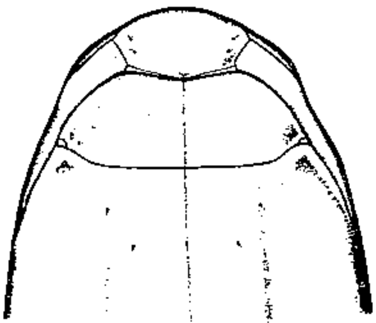
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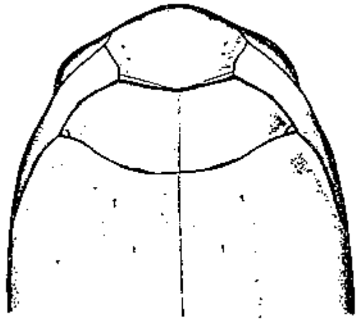
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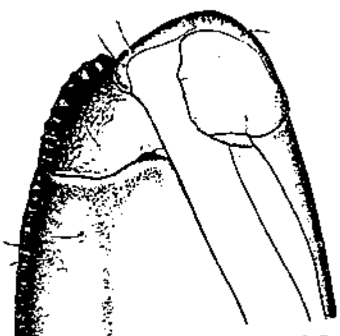
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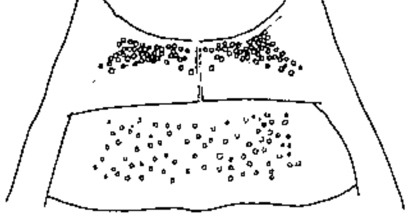
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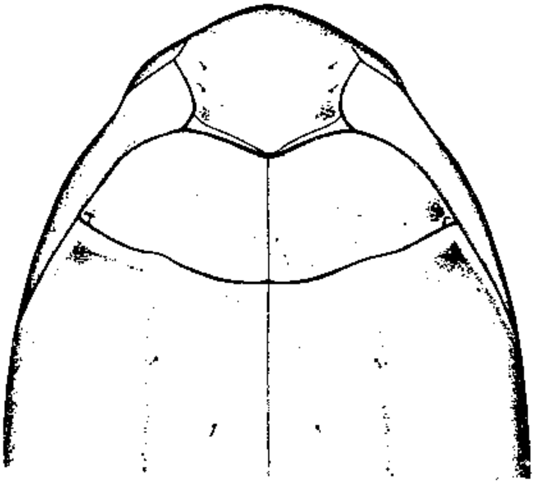
FIGURES 117-123.—Cephalic segments of pupa (dorsal aspect): 117, *Anabasis ochrodesma* (Zeller); 118, *Spectrobates ceratoniae* (Zeller); 119, *Amyelois transitella* (Walker); 120, *Fundella pellucens* Zeller; 121, *F. argentina* Dyar. 122, Cephalic segments of *S. ceratoniae* pupa (lateral view). 123, Metathorax and abdominal segment 1 of *A. ochrodesma* pupa (dorsal aspect).



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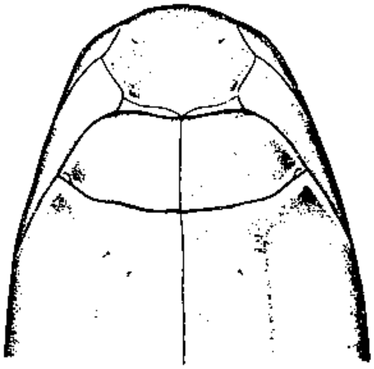

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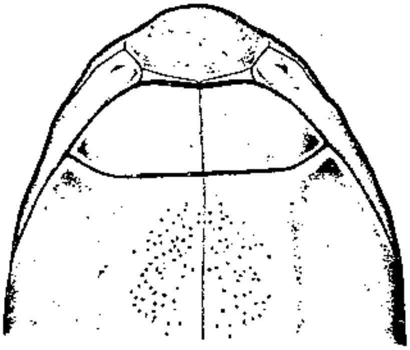

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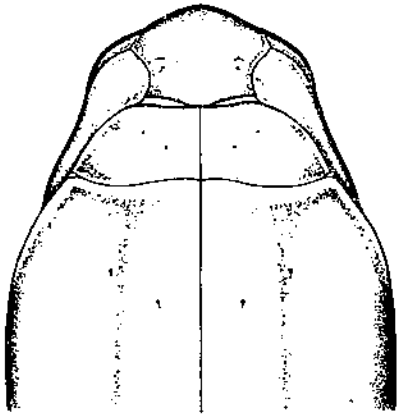

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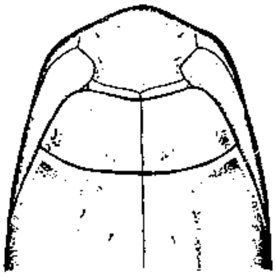

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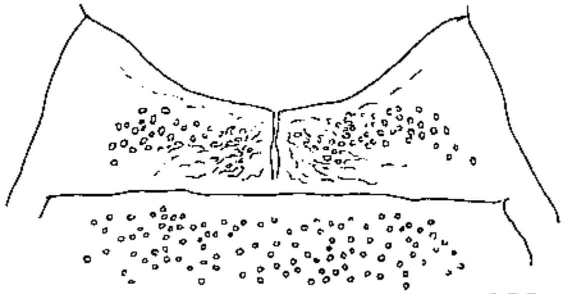
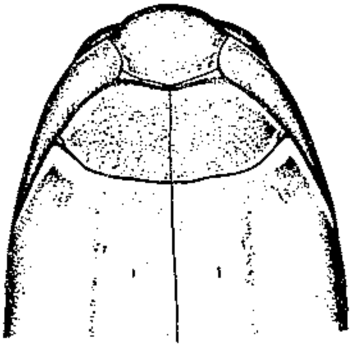


129

FIGURES 124–129.—Cephalic segments of pupa (dorsal aspect): 124, *Monoptilota pergratialis* (Hulst); 125, *Etiella zinckenella* (Treitschke); 126, *Tlascala reductella* (Walker); 127, *Pima granitella* (Ragonot); 128, *Ulophora groteii* Ragonot. 129, Metathorax and anterior part of abdominal segment 1 of *M. pergratialis* pupa (dorsal aspect).



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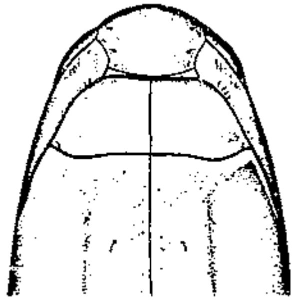
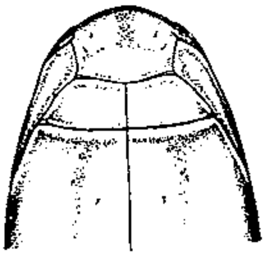
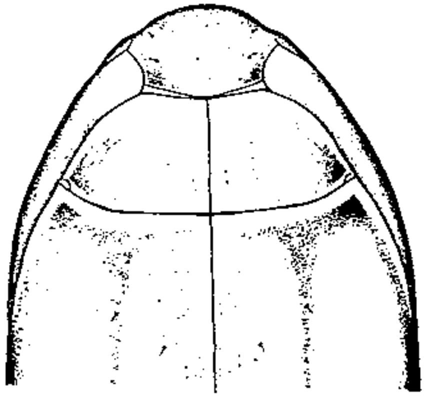


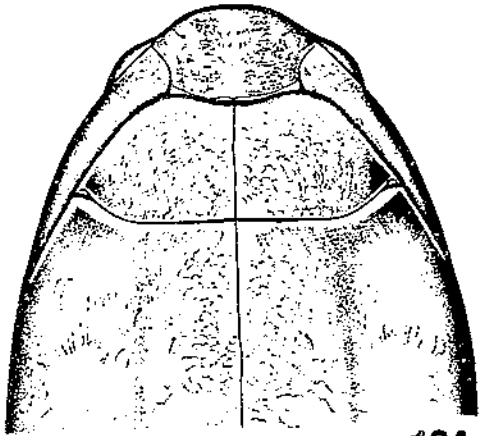
131



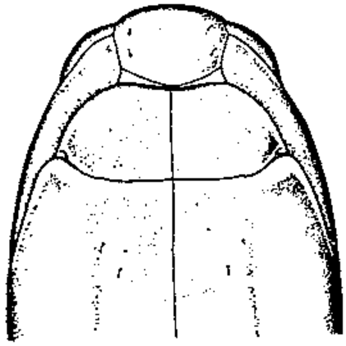
132



133



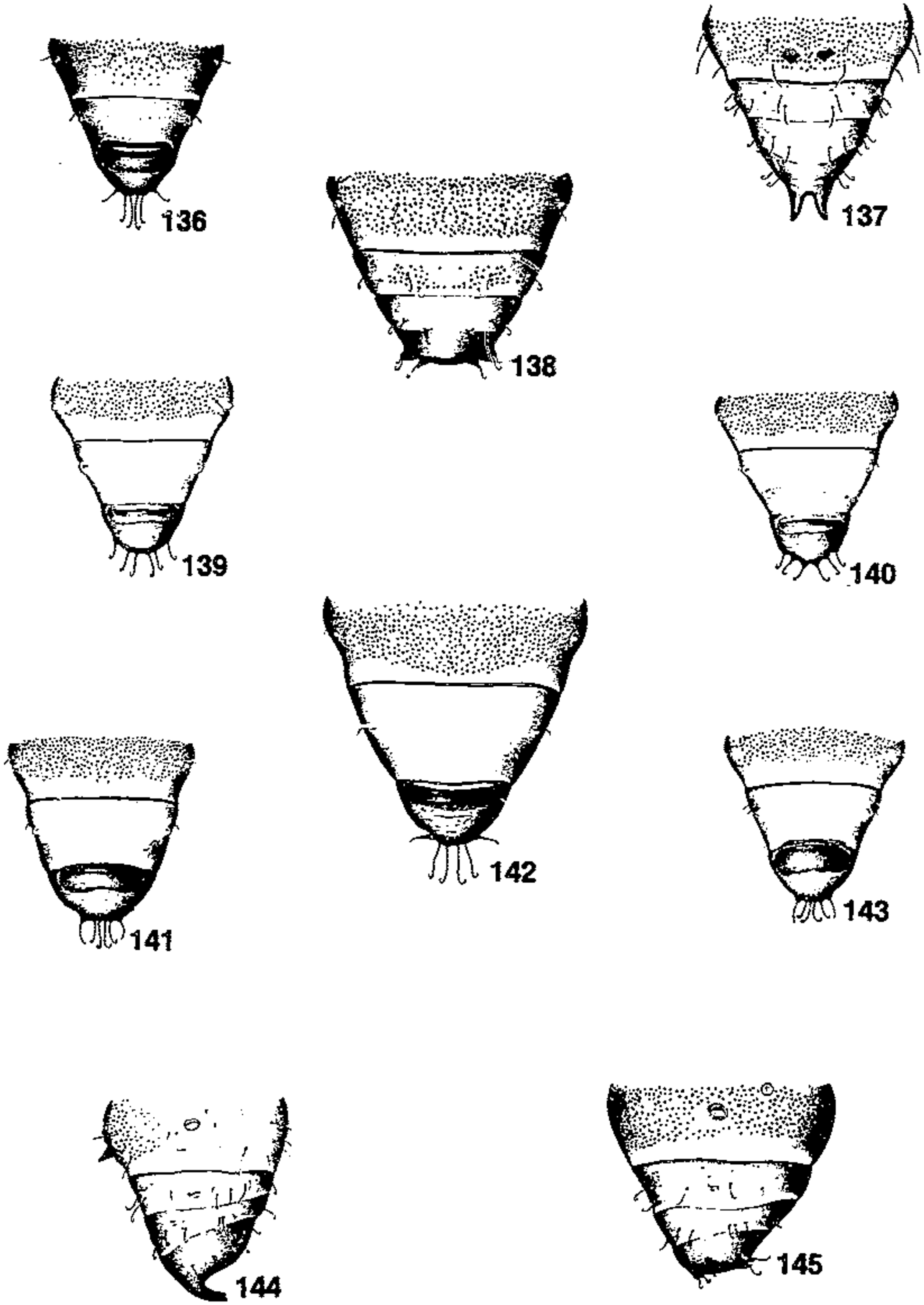
134



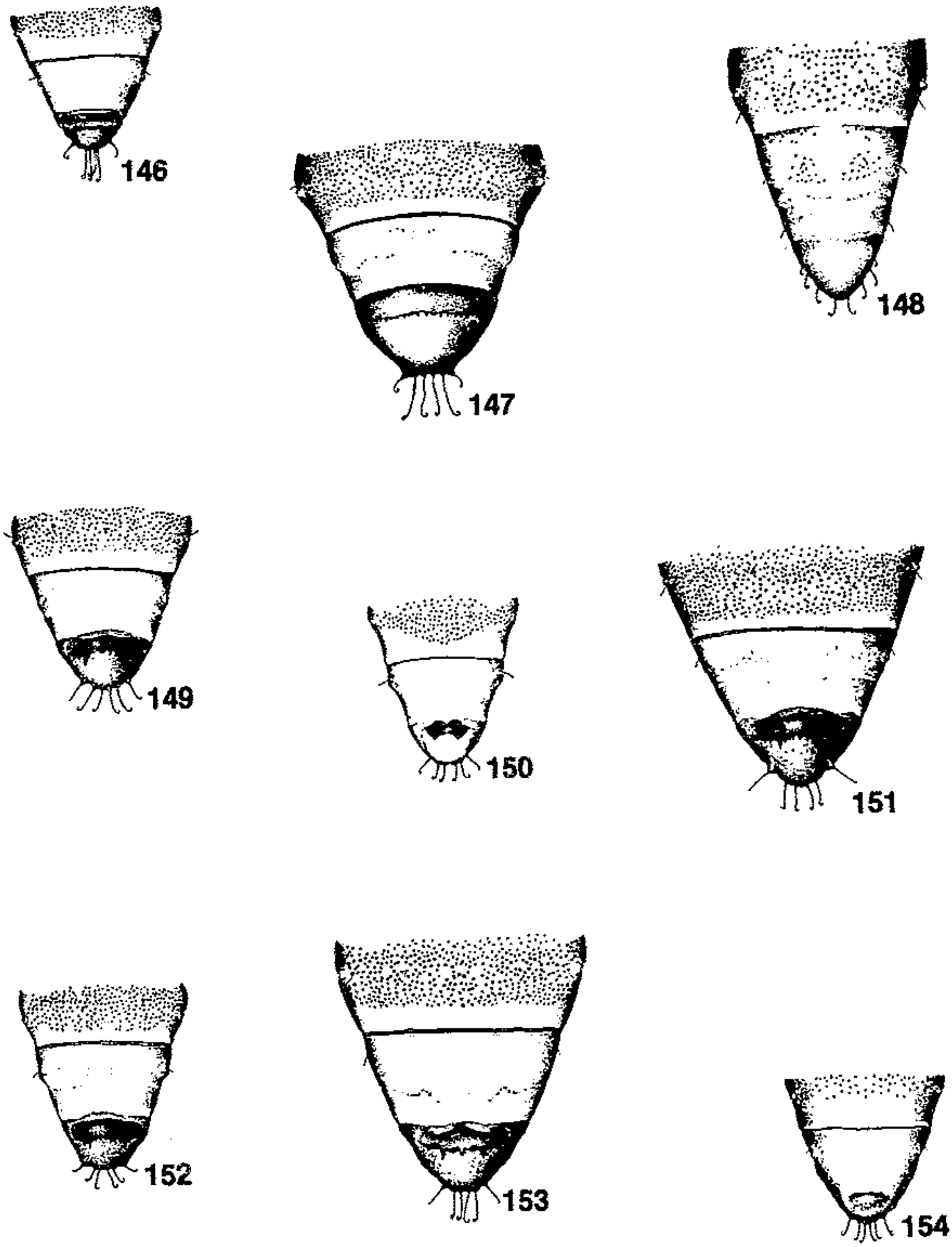
135

FIGURES 130–135.—Cephalic segments of pupa (dorsal aspect): 130, *Caristanius minimus* Neunzig; 131, *Elasmopalpus lignosellus* (Zeller); 132, *Metephestia simplicula* (Zeller); 133, *Adelphia petrella* (Zeller); 134, *C. decoloralis* (Walker); 135, *Ufa rubedinella* (Zeller).

TB 1589 (1979) USDA TECHNICAL BULLETINS UPDATA
SYSTEMATICS OF IMMATURE PHYCITINES (LEPIDOPTERA: PYRALIDAE) ASSOCIATED
NEUNZIG, H.H. 2 OF 2



FIGURES 136–145.—Caudal segments of pupa (dorsal aspect): 136, *Anabasis ochrodesma* (Zeller); 137, *Spectrobates ceratoniae* (Zeller); 138, *Amyelois transitella* (Walker); 139, *Ftiella zinckenella* (Treitschke); 140, *E. zinckenella*, showing variation in appearance of segment 10 at base of cremastral "spines;" 141, *Fundella pellucens* Zeller; 142, *Monoptilota pergratialis* (Hulst); 143, *F. argentina* Dyar. Caudal segments of pupa (lateral view): 144, *S. ceratoniae*; 145, *A. transitella*.



FIGURES 146–154.—Caudal segments of pupa (dorsal aspect): 146, *Ulophora groteii* Ragonot; 147, *Tlascala reductella* (Walker); 148, *Pima granitella* (Ragonot); 149, *Caristanius minimus* Neunzig; 150, *Elasmopalpus lignosellus* (Zeller); 151, *C. decoloralis* (Walker); 152, *Ufa rubedinella* (Zeller); 153, *Adelphia petrella* (Zeller); 154, *Metephestia simplicula* (Zeller).

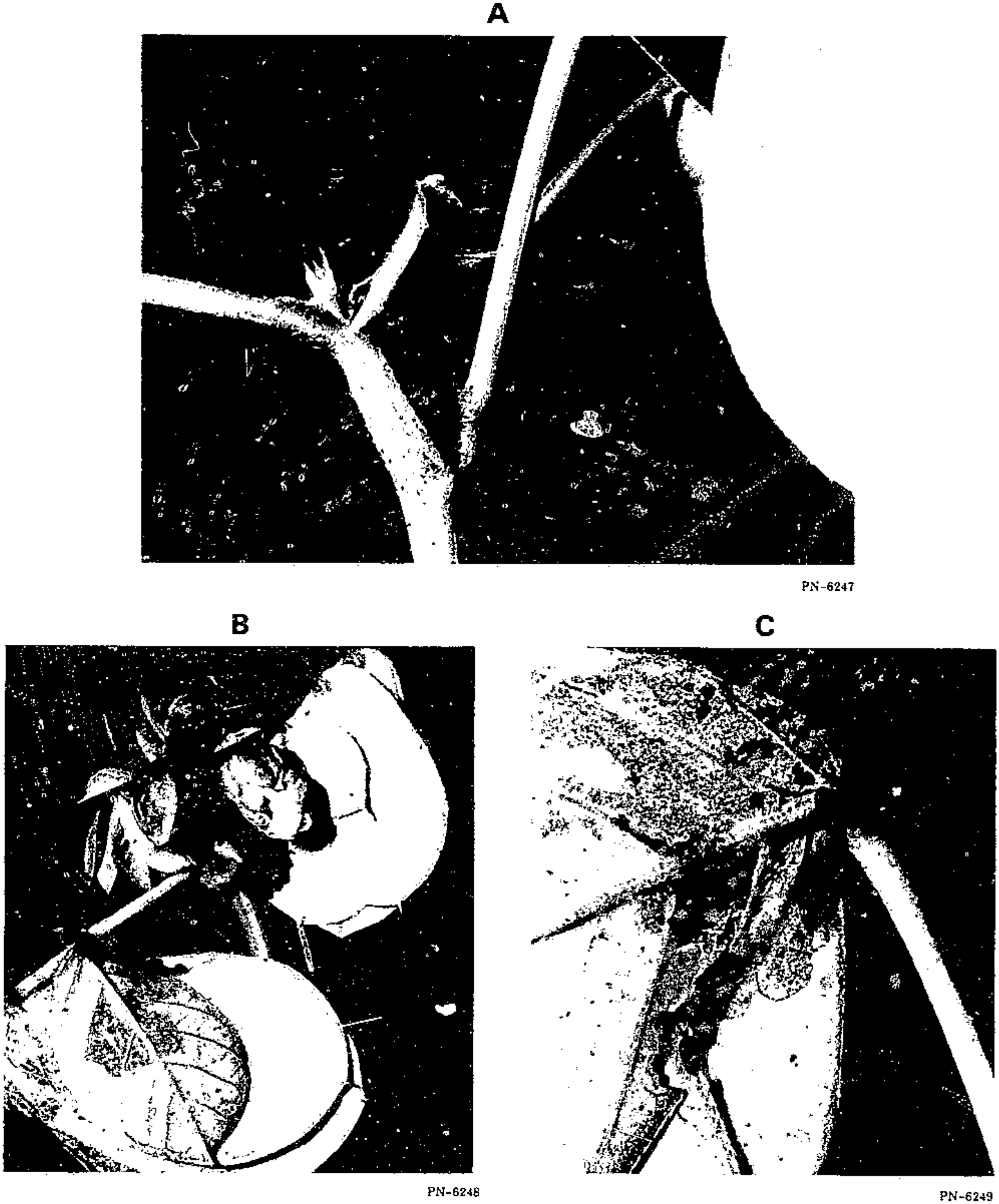


FIGURE 155.—*Anabasis ochrodesma* (Zeller) and sicklepod (*Cassia obtusifolia* L.): *A*, Plant terminal infested with small larva (Homestead, Fla., 4-IX-75); *B*, shelter (arrow) of last instar formed of tied-together leaflets (Perrine, Fla., 8-IX-74); *C*, base of leaflets injured by larvae (Perrine, Fla., 8-IX-74).

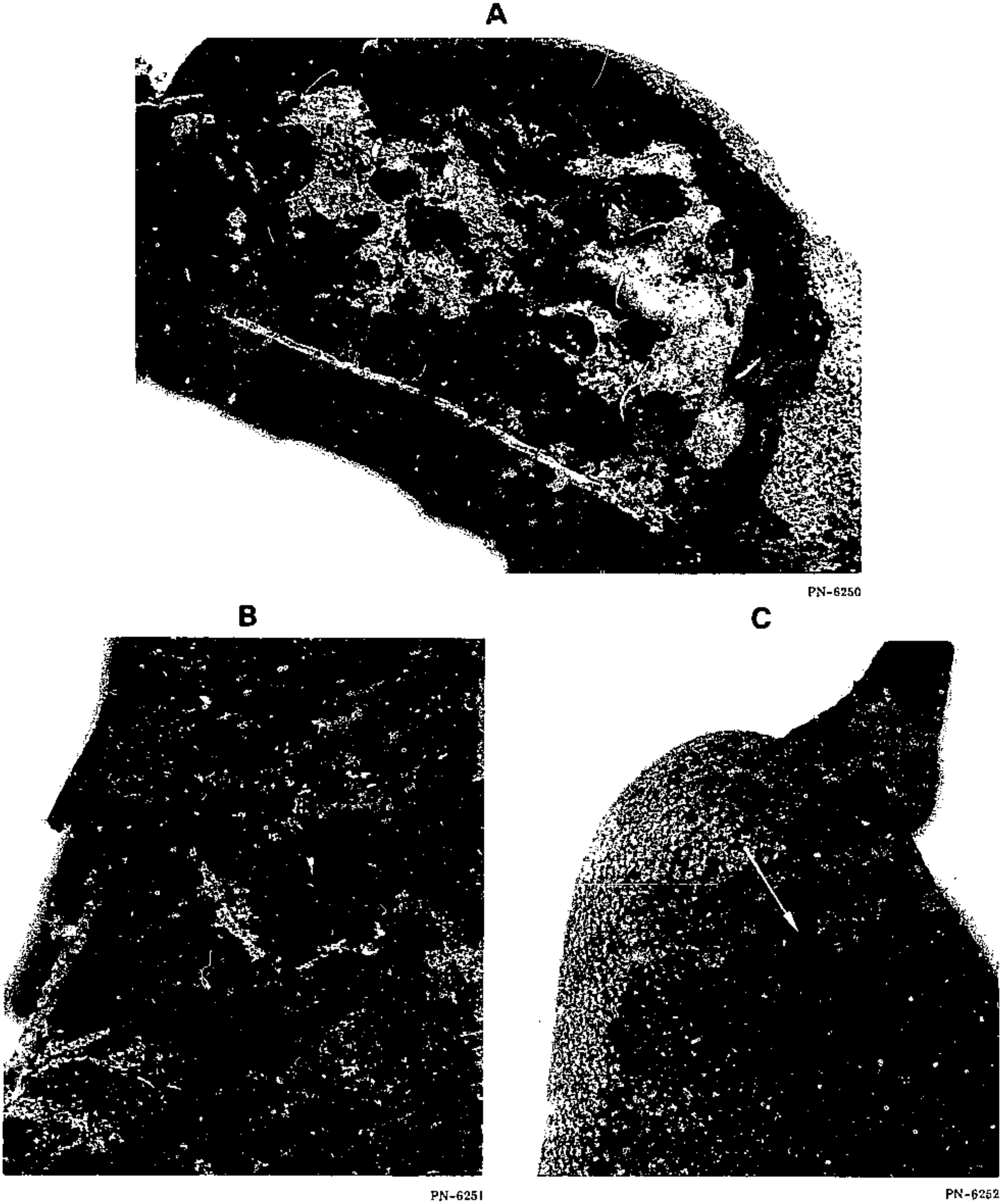


FIGURE 156.—Carob moth (*Spectrobotes ceratoniae* (Zeller)) and tamarind (*Tamarindus indica* L.): *A*, Opened legume with last instar; note injury to pulp and seeds by larval feeding (Big Pine Key, Fla., 10-V-73); *B*, opened legume with pupa in pupal chamber (Big Pine Key, Fla., 10-V-73); *C*, legume with silked-over exit hole (arrow) made by larva for subsequent adult emergence; silk is distal extension of pupal chamber (Islamorada, Fla., 5-IX-74).

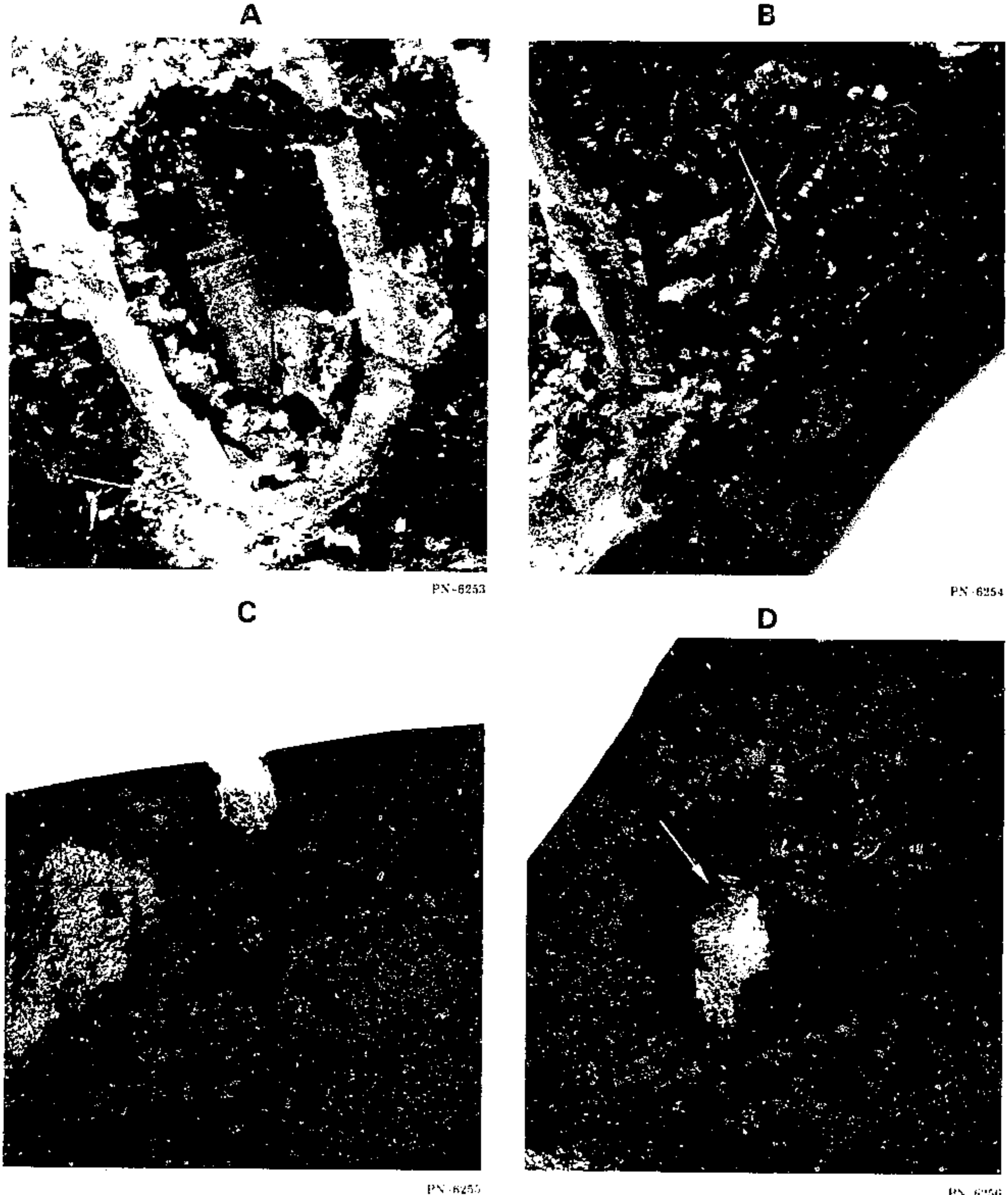


FIGURE 157.—Navel-orange worm (*Amyelois transitella* (Walker)) and honeylocust (*Gleditsia triacanthos* L.): *A*, Opened legume with seed and pulp eaten by larva (Raleigh, N.C., 1-III-74); *B*, opened legume with pupa (arrow) (Raleigh, N.C., 15-IX-75); *C*, legume with silked-over exit hole made by larva for subsequent adult emergence (Raleigh, N.C., 15-IX-75); *D*, legume with partially silked-over fissure or crack caused by drying; silk is distal extension of pupal chamber (Troy, N.C., 14-IV-70).

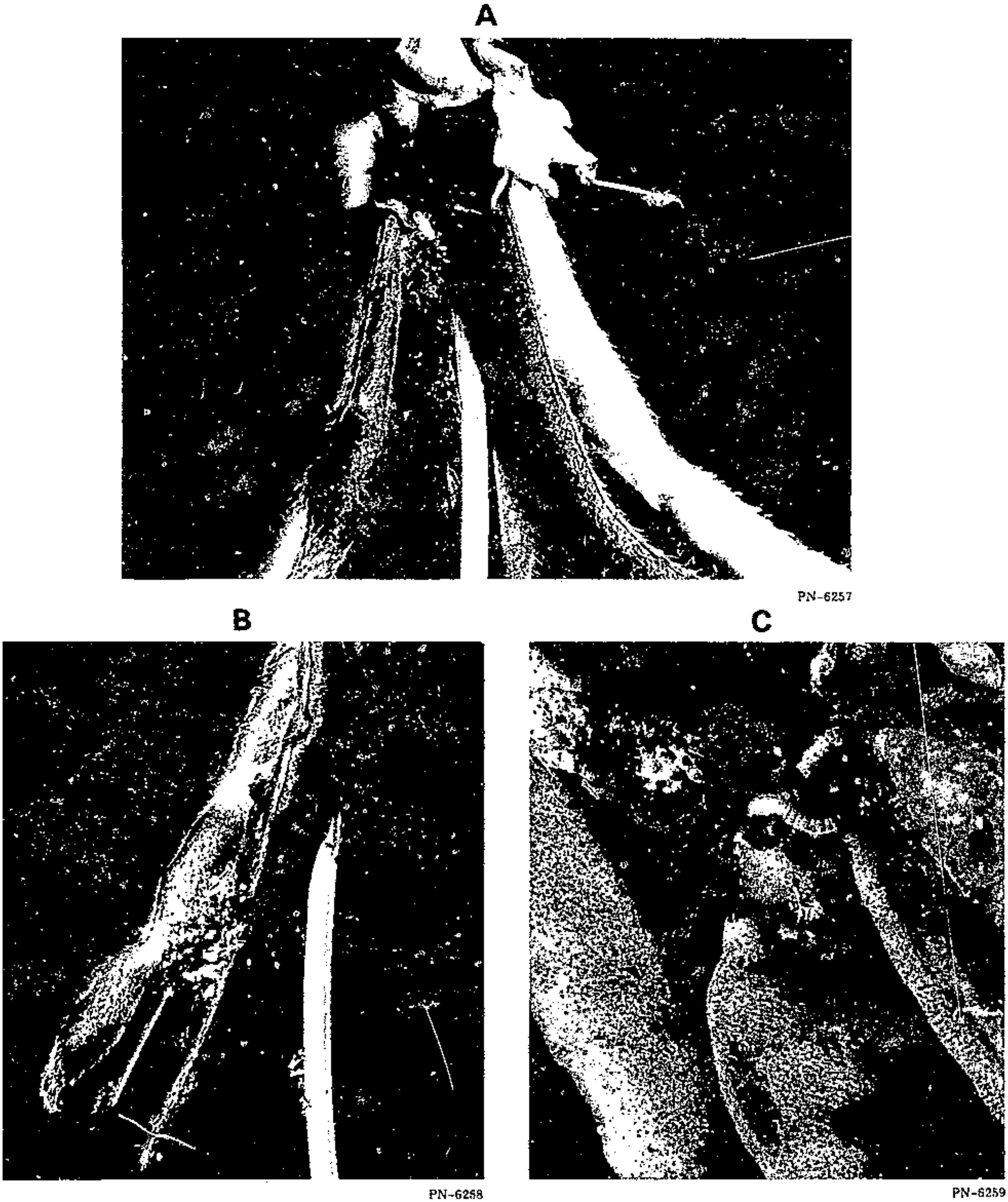


FIGURE 158.—Caribbean pod borer (*Fundella pellucens* Zeller) and cowpea (*Vigna luteola* (Jacquin) Bentham): *A*, Legumes infested with late instar (Riviera Beach, Fla., 12-V-73); *B*, same, except infested with last instar (Delray Gardens, Fla., 9-IX-74). Caribbean pod borer and crab's eye (*Abrus precatorius* L.): *C*, Legumes infested with late instar; some frass has been removed to expose one of the larvae (Lake Worth, Fla., 9-IX-74).

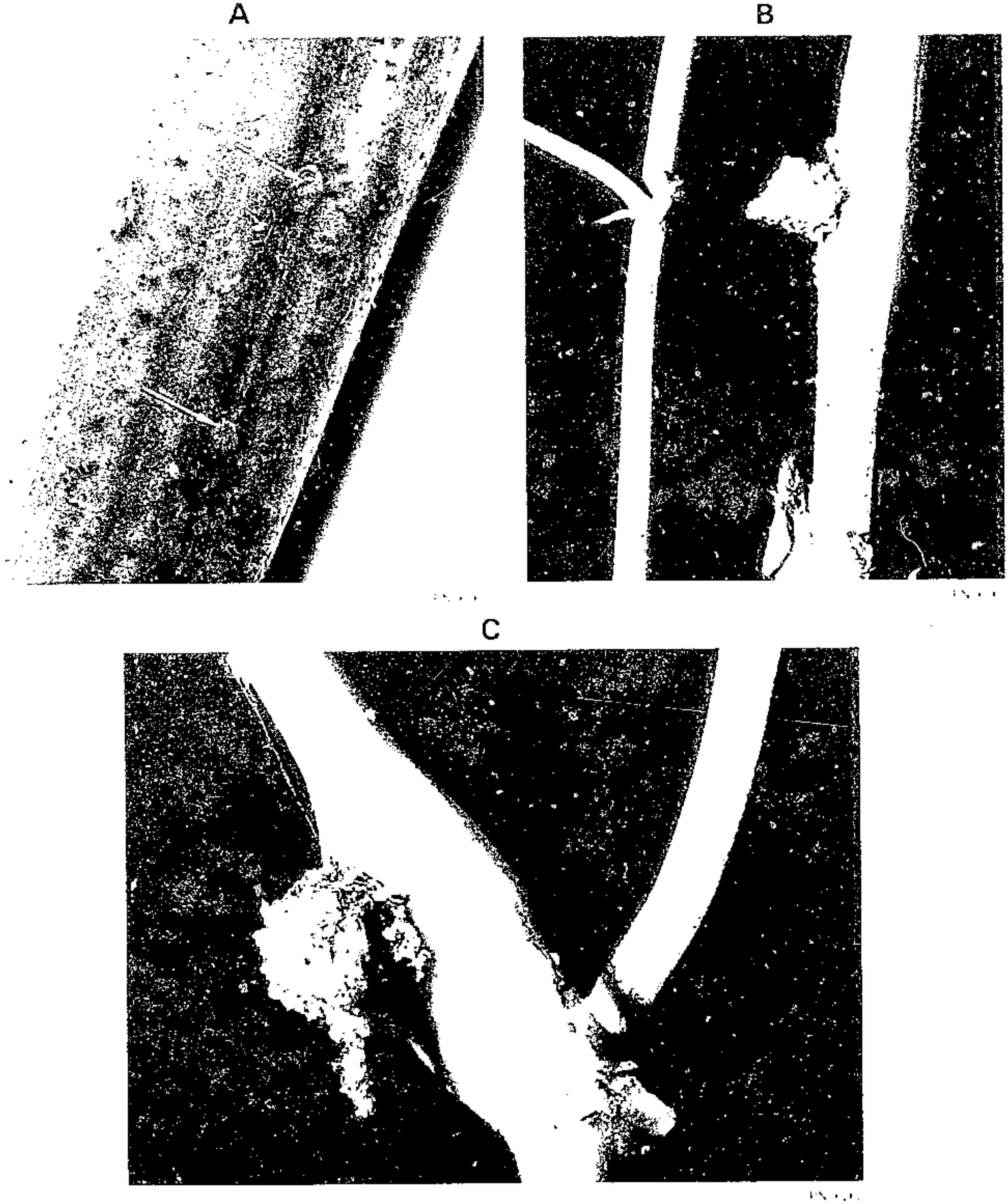


FIG. [illegible].—Limabean vine borer (*Monoptilota pergratialis* (Hulst)) and lima bean (*Phaseolus lunatus* L.): *A*, Stem with developing egg (lower arrow) and hatched egg (upper arrow); note their placement in stem groove (Pink Hill, N.C., 29-IV-73). *B*, stem infested with small larva (Pink Hill, N.C., 17-V-7[illegible]). *C*, hypertrophied stem (gall) infested with large larva (Wilson, N.C., 18-VI-72).

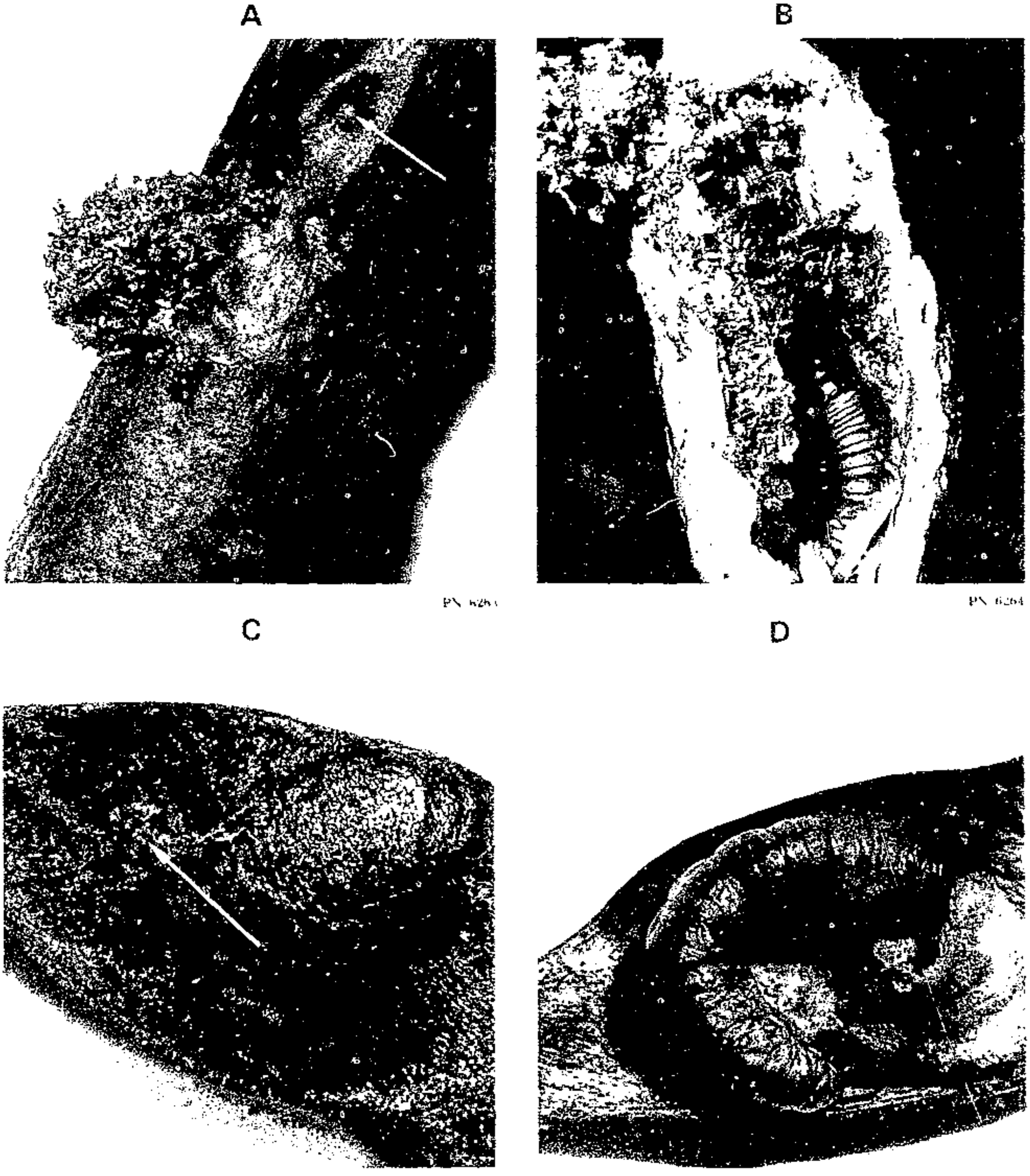


FIGURE 166.—Limabean vine borer (*Monoptilota pergratialis* (Hulst)) and lima bean (*Phaseolus lunatus* L.): *A*, Hypertrophied stem (gall) infested with large larva; note egg (arrow) in small depression on gall (Wilson, N.C., 20-VIII-73); *B*, opened hypertrophied stem (gall), showing internal appearance and position of large larva (Wilson, N.C., 20-VIII-73). *Ancylostomia stercorea* (Zeller) and pigeon pea (*Cajanus cajan* (L.) Huth): *C*, Legume with small mound of frass and silk (arrow) covering entrance hole of first instar (Homestead, Fla., 5-II-75); *D*, opened legume infested with last instar (Homestead, Fla., 24-II-75).

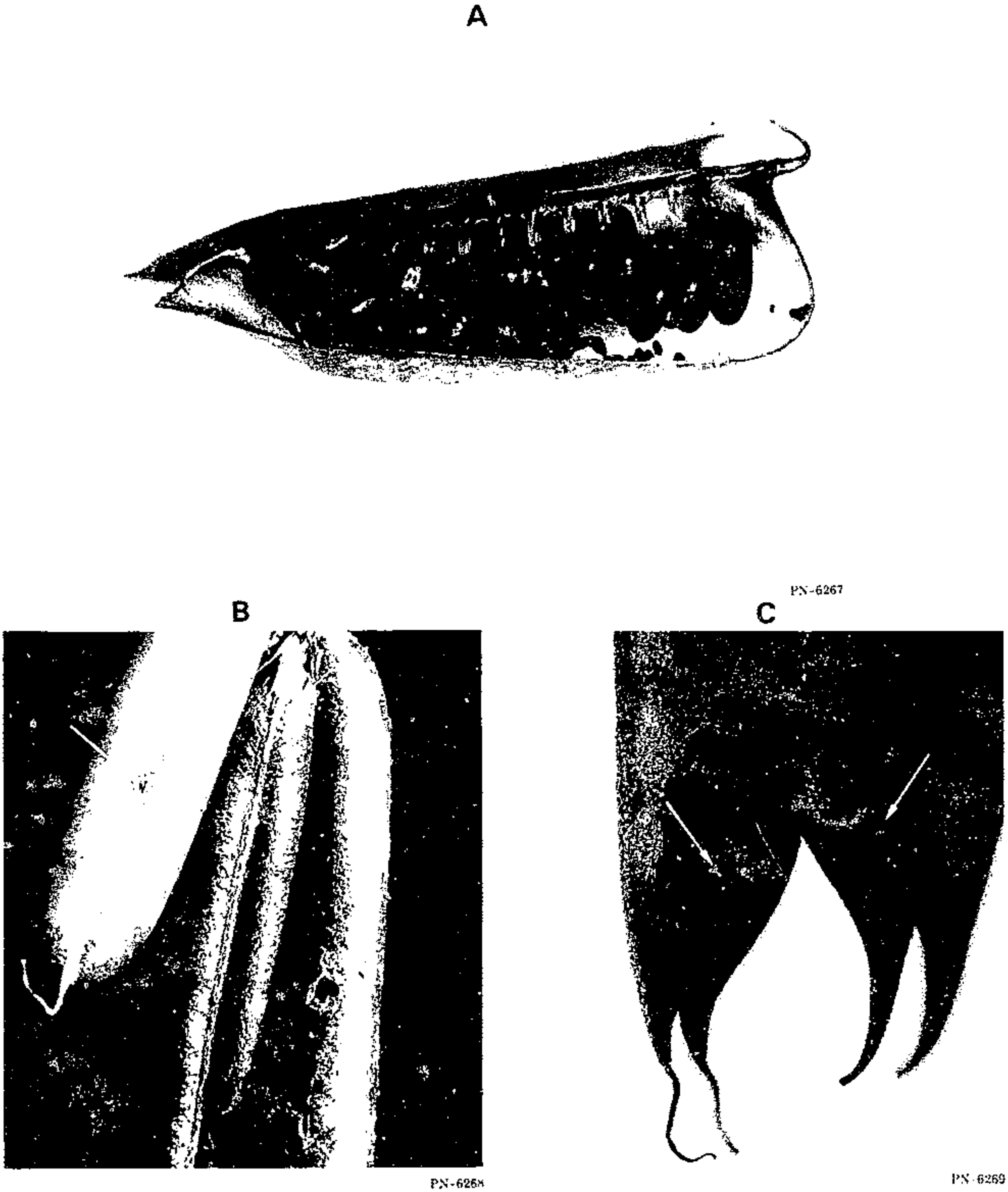


FIGURE 161.—Limabean pod borer (*Etiella zinckenella* (Treitschke)) and rattlebox (*Crotalaria* spp.): *A*, Half of opened legume infested with late instar (Perrine, Fla., 12-V-73); *B*, legumes with entrance hole (arrow) of first instar and exit holes (center and right) of late and last instars (Riviera Beach, Fla., 13-V-73). *Ulophora groteii* Ragonot and *Tephrosia florida* (Dietrich) C. E. Wood: *C*, Legumes with small mounds of frass and silk (arrows) covering entrance holes of first instar (Fayetteville, N.C., 5-VI-75).

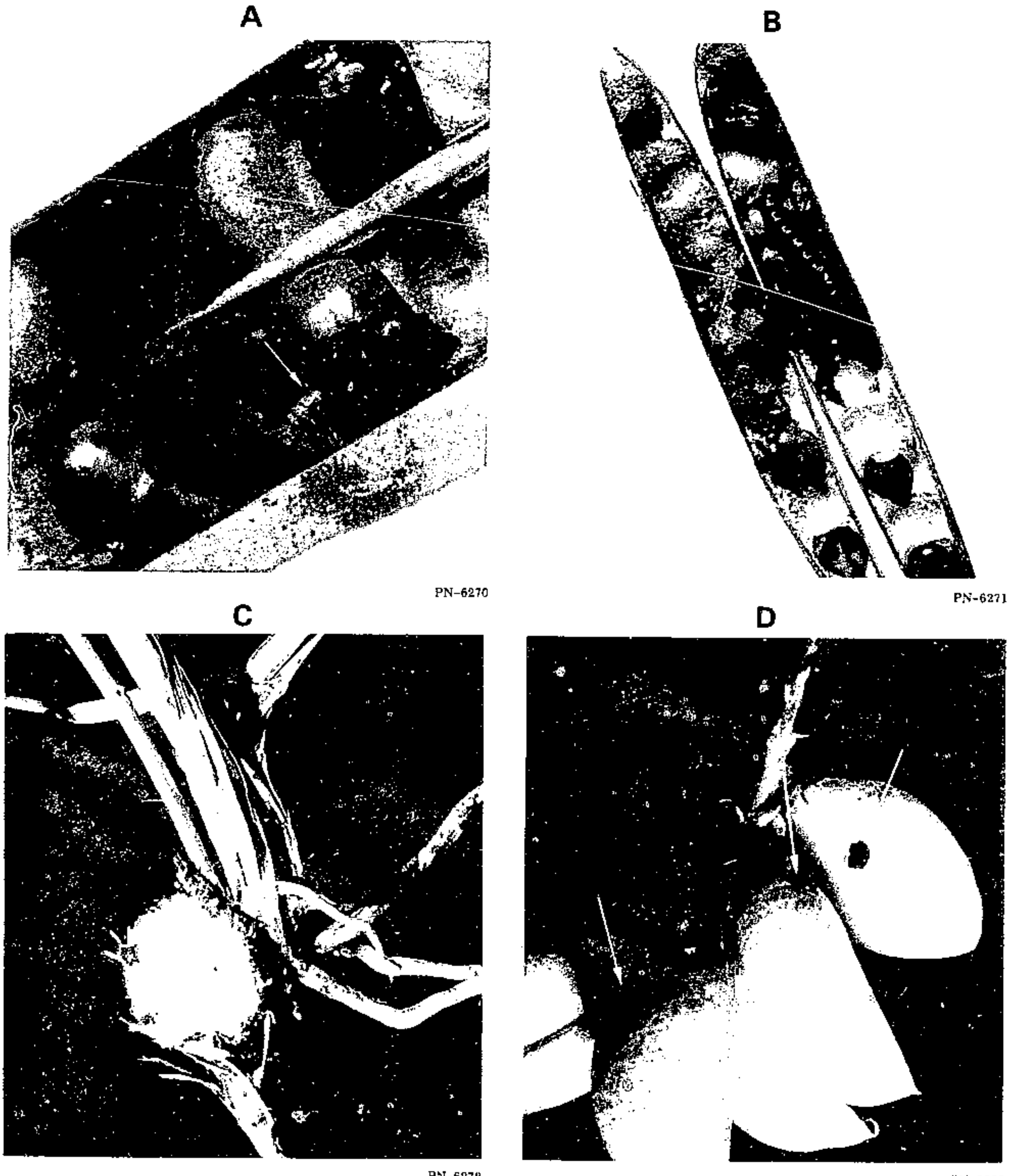


FIGURE 162.—*Ulophora groteii* Ragonot and *Tephrosia* sp.: *A*, Opened legume with half-grown larva (arrow) (Tyler, Tex., 8-IX-73); *B*, opened legume with last instar; note dark color of this larva compared with smaller paler larva in *A* (Tyler, Tex., 8-IX-73). *Pima albiplagiatella occidentalis* Heinrich: *C*, Hemispherically shaped silk hibernaculum of last instar fastened to base of grass (Alamogordo, N. Mex., 26-IV-74); *D*, two legumes of locoweed (*Astragalus wootonii* Sheldon) with typical exit holes (upper arrows) and one legume (lower arrow) with silked-over entrance hole all made by late instar (Alamogordo, N. Mex., 26-IV-75).

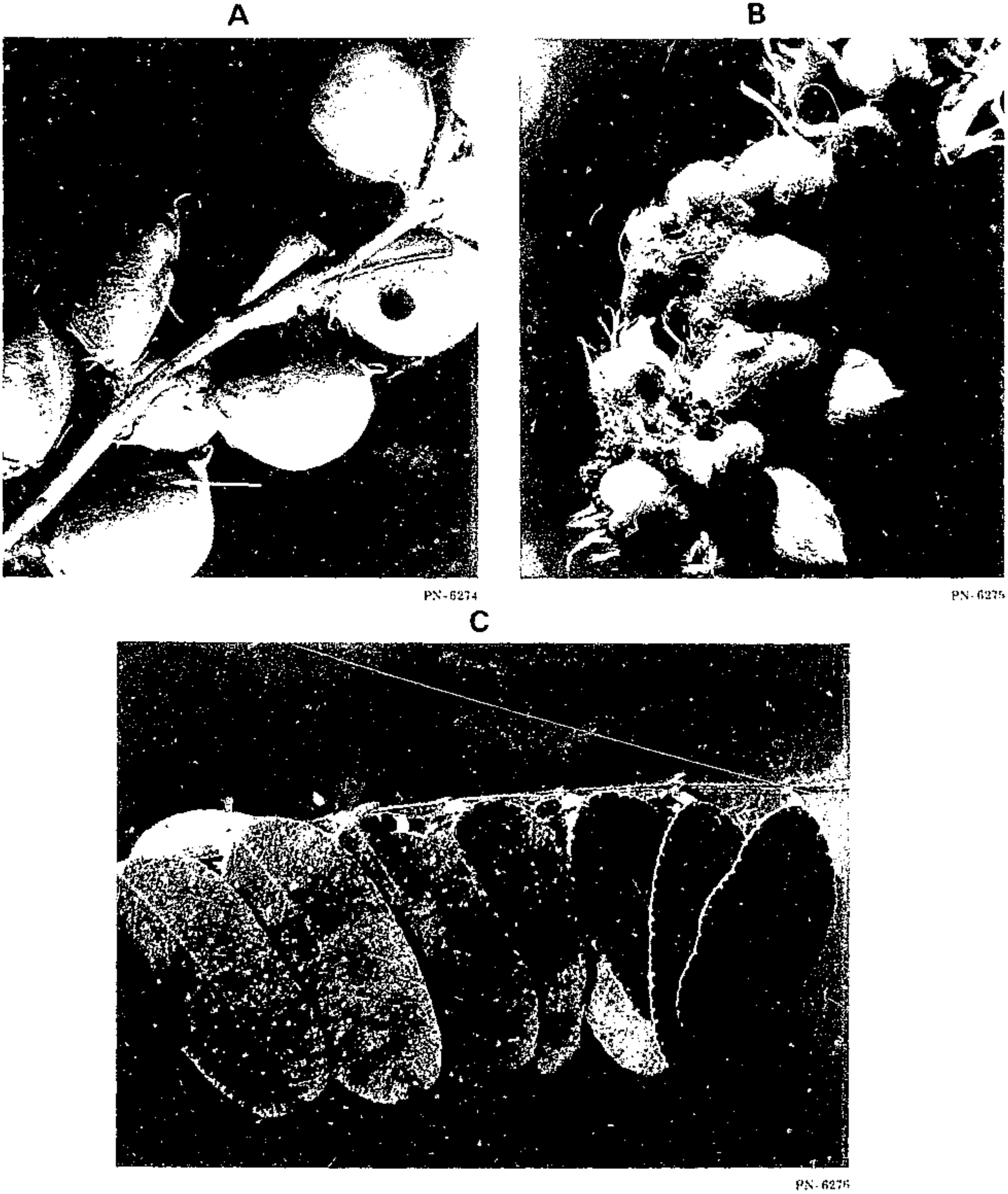


FIGURE 163.—*Pima albiplagiatella occidentalis* Heinrich and locoweed (*Astragalus thurberi* Gray): *A*, Injured legumes; lower legume (arrow) has silked-over entrance hole of partially grown larva of this insect (Douglas, Ariz., 25-IV-74). *P. granitella* (Ragonot) and locoweed (*A. mollissimus* var. *earlei* (Rydberg) Tidestrom): *B*, Legumes infested with late instar (Fort Davis, Tex., 28-IV-74). *Nephopterix dammersi floridensis* Heinrich and false indigo (*Amorpha herbacea* Walter): *C*, Shelter of late instar made of silked-together leaflets (Elizabethtown, N.C., 20-VII-73).

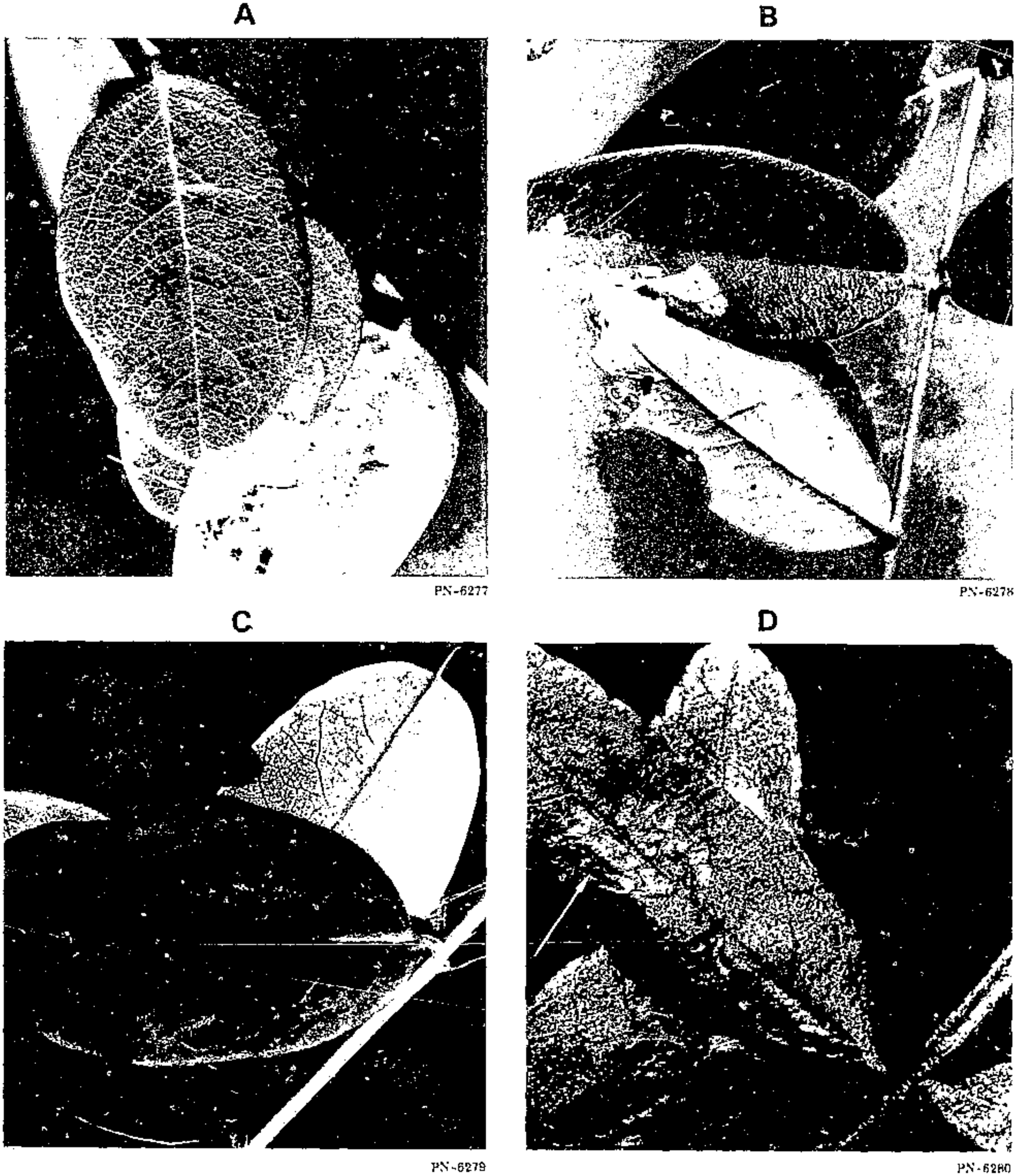


FIGURE 164.—Locust leafroller (*Nephopterix subcaesiella* (Clemens)): *A*, Shelter of small larva made of silked-together leaflets of *Robinia nana* Elliott; note external necrotic areas (arrow) and frass (Garland, N.C., 16-VIII-72); *B*, shelter of third instar made of leaflets of wisteria (*Wisteria frutescens* (L.) Poiret) (Elizabethtown, N.C., 25-V-72); *C*, typical three-leaflet shelter of last instar on *Robinia*; notched leaflet has been severed and is being eaten by larva concealed between two other silked-together leaflets (Garland, N.C., 30-VIII-72). *Tlascala reductella* (Walker) and honeylocust (*Gleditsia triacanthos* L.): *D*, Shelter of first instar; note pale necrotic areas (arrow) (Fayetteville, N.C., 5-V-72).

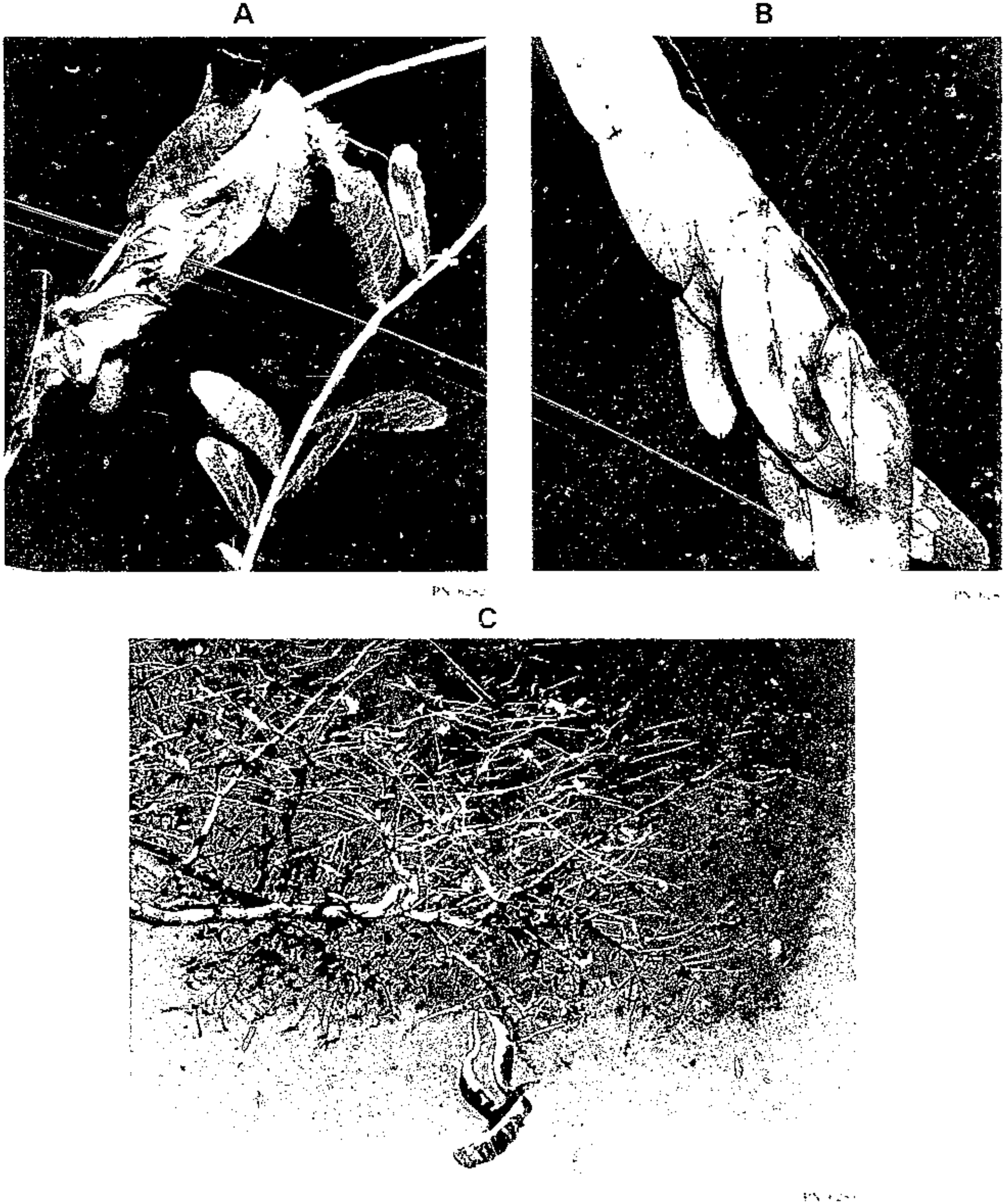


FIGURE 165.—*Tascala robustella* (Walker) and honeylocust (*Gleditsia triacanthos* L.): *A*, Shelter of late instar (Fayetteville, N.C., 26-VI-73); *B*, shelter of last instar (Taccoa, Ga., 13-IX-73); *C*, heavily infested branch of tree with most leaflets eaten; almost all leaflets remaining are being used as larval shelters (Taccoa, Ga., 13-IX-73).

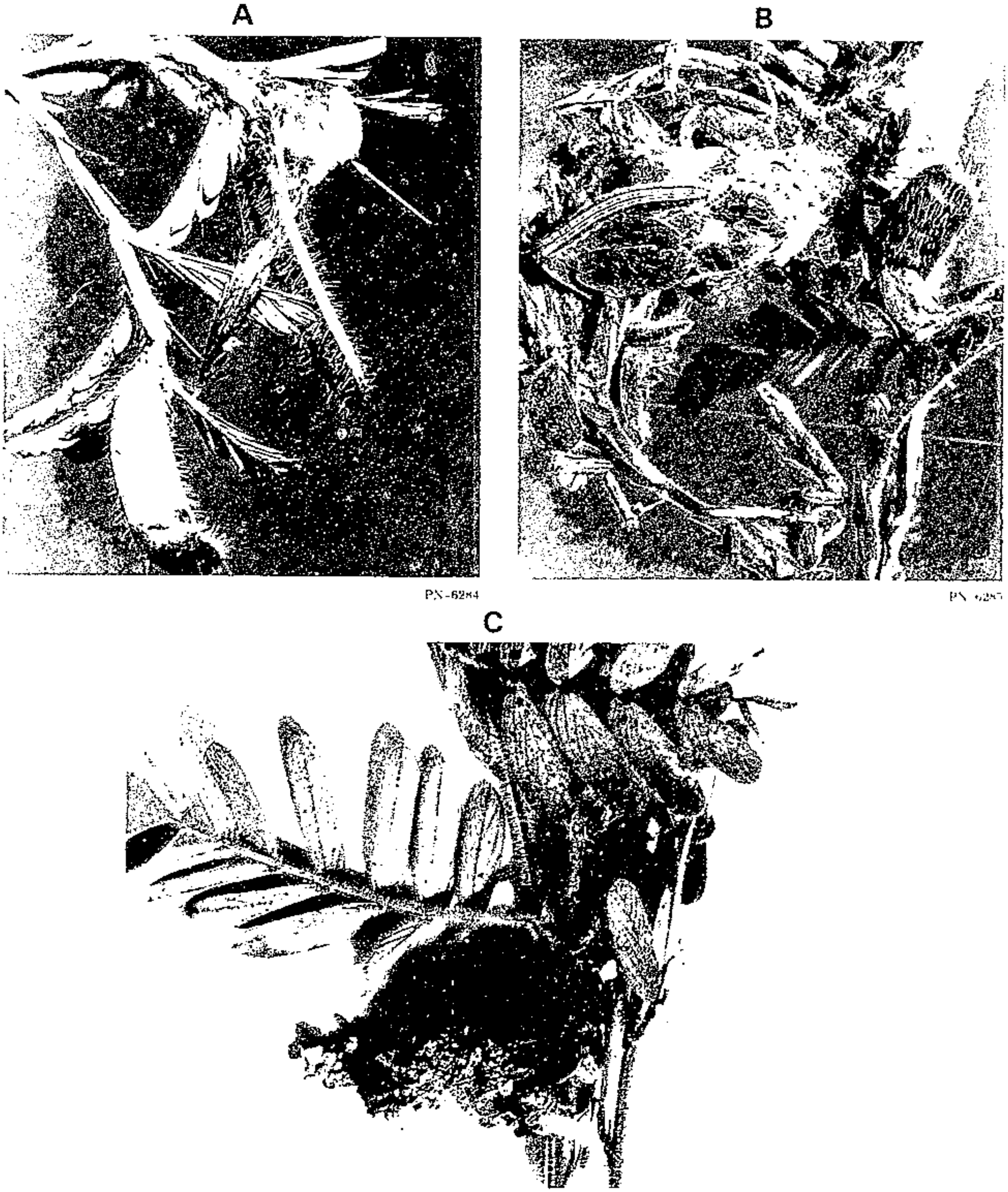


FIGURE 166.—*Caristanius minimus* Neunzig and *Cassia keyensis* (Pennell) Macbride: *A*, Shelter (arrow) of partially developed larva on upper foliage (Big Pine Key, Fla., 10-V-73); *B*, shelter and exposed late instar on upper foliage (Big Pine Key, Fla., 4-IX-75); *C*, shelter of last instar constructed of soil, debris, frass, and silk attached to base of plant (Big Pine Key, Fla., 10-V-73).

FIGURE 167.—*Caristanius decoloralis* (Walker) and *Cassia fasciculata* Michaux: *A*, Feeding injury (arrow) of first instar on leaflets (Fayetteville, N.C., 26-VI-71); *B*, shelter of last instar made of silk and leaflets (Fayetteville, N.C., 26-V-71); *C*, eggs deposited on silk and leaflets, which are part of last instar's shelter (Fayetteville, N.C., 10-VIII-73).

FIGURE 168.—*Adelphia petrella* (Zeller) and sensitive brier (*Schrankia microphylla* (Dryander) Macbride): *A*, Soil and debris tube of early instar attached to leaflets (Fayetteville, N.C., 2-V-71); *B*, same, except tubes of larger larva. *A. petrella* and *Cassia fasciculata* Michaux; *C*, Upper part of soil tube of last instar attached to base of plant; note leaflets cut from host and carried to tube entrance for food (Clayton, N.C., 3-VIII-73).

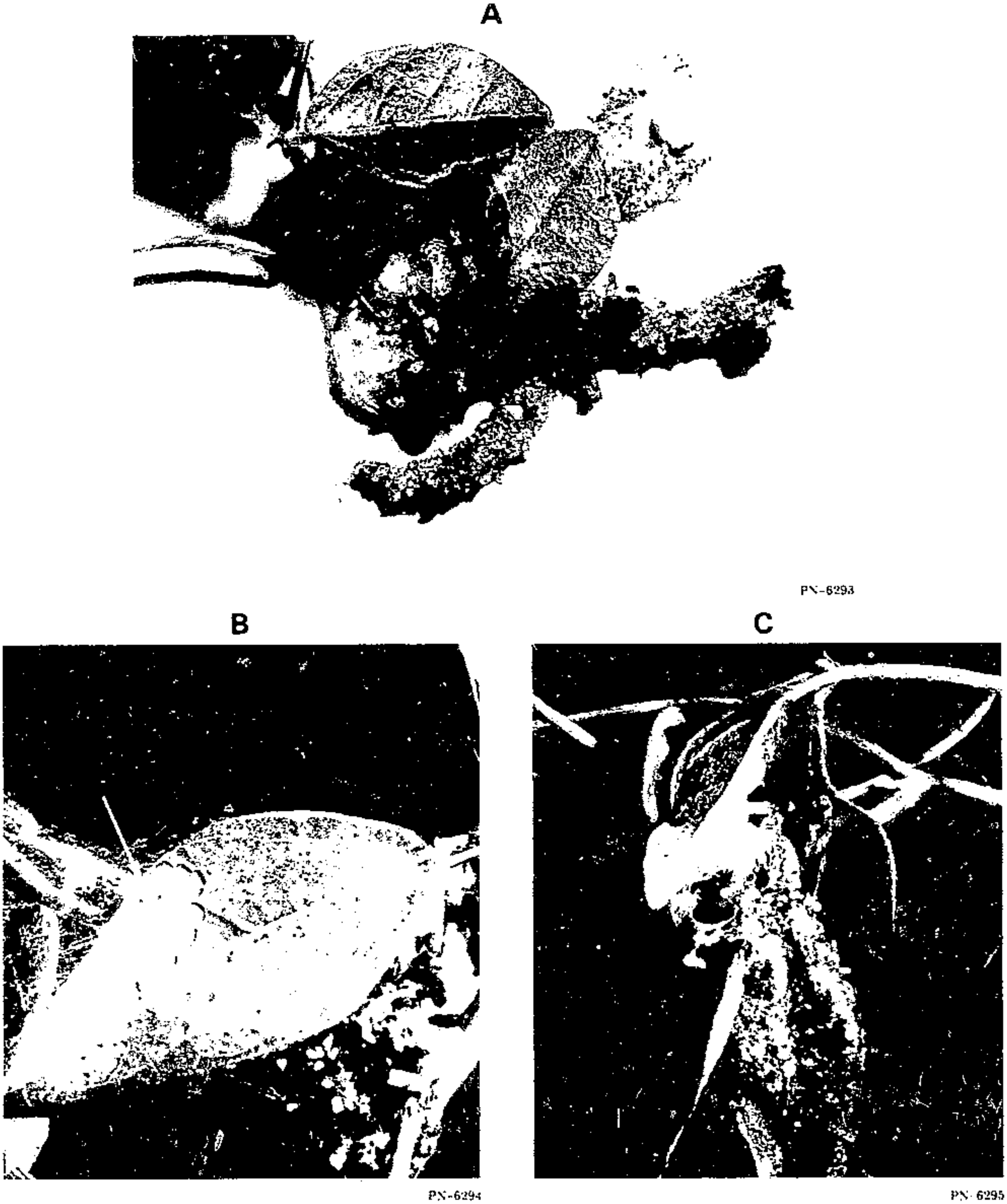


FIGURE 169.—*Ufa rubedinella* (Zeller) and cowpea (*Vigna luteola* (Jacquin) Bentham): *A*, Soil tubes of insect attached to leaflets (Riviera Beach, Fla., 14-V-73); *B*, epidermis and mesophyll of part of one leaflet (arrow) eaten by partially grown larva (Riviera Beach, Fla., 14-V-73); *C*, soil tubes of large larvae attached to damaged leaflets (Vero Beach, Fla., 20-V-73).

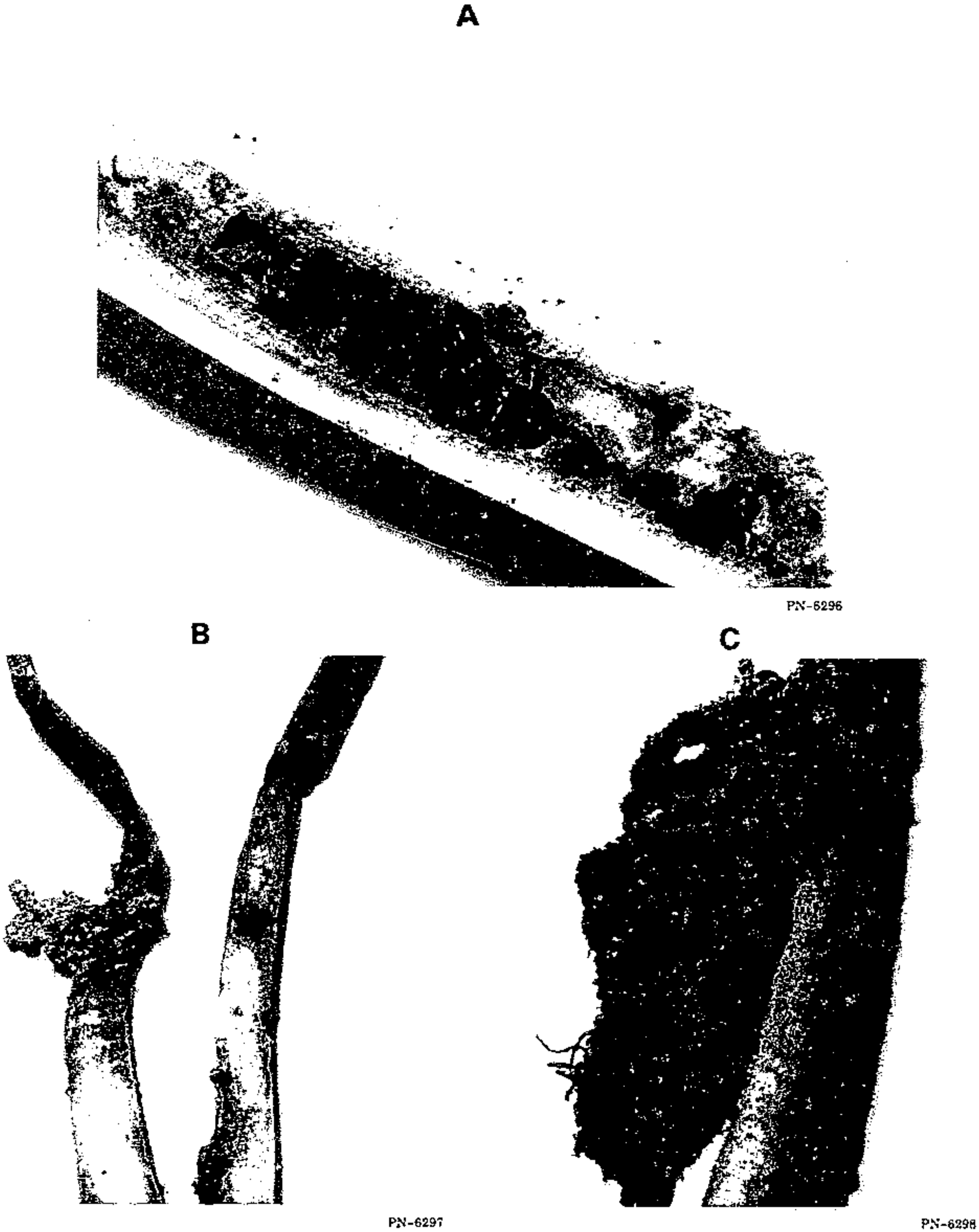


FIGURE 170.—Lesser cornstalk borer (*Elasmopalpus lignosellus* (Zeller)) and snap bean (*Phaseolus vulgaris* L.): *A*, Last instar within stem (Clayton, N.C., 24-VIII-74); *B*, seedlings killed by larvae (Clayton, N.C., 24-VIII-74); *C*, stem infested with late instar; larva has made several different sized soil tubes attached to host near soil surface where it enters plant to feed (Baton Rouge, La., 5-IX-72).

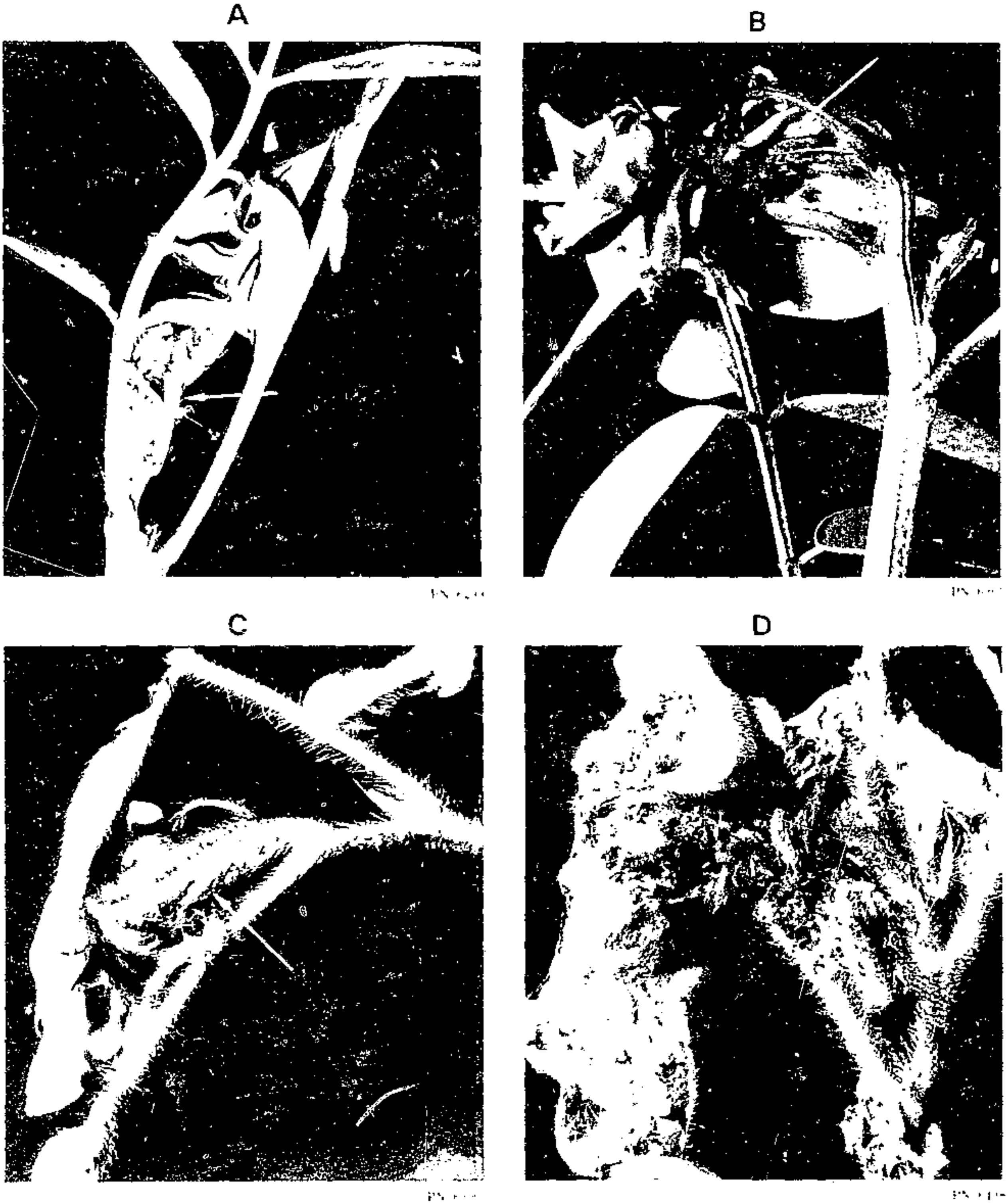


Figure 171.—*Metephestia simplicula* Zeller and indigo (*Indigofera suffruticosa* Miller): *A*, Shelter (arrow) of partially grown larva on plant terminal (Perrine, Fla., 7-IX-74); *B*, shelter (arrow) of last instar on terminal (Homestead, Fla., 7-IX-75). *M. simplicula* and indigo (*I. hirsuta* L.): *C*, Shelter (arrow) of partially grown larva on terminal (Fort Pierce, Fla., 11-IX-74); *D*, shelter of several last instars on terminal (Port Salerno, Fla., 8-IX-75).

INDEX TO LEGUMINOUS HOST PLANTS

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END