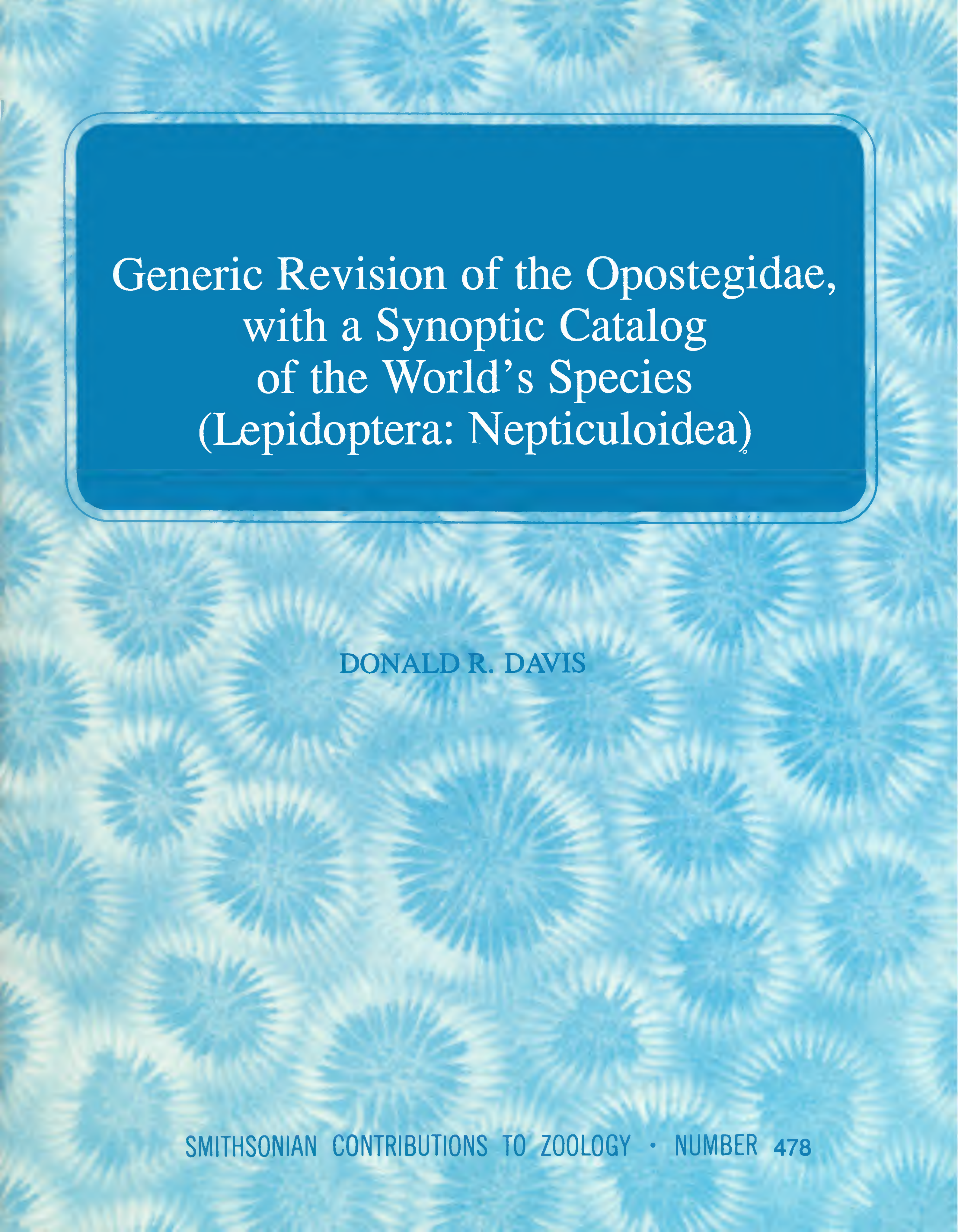

Generic Revision of the Opostegidae, with a Synoptic Catalog of the World's Species (Lepidoptera: Nepticuloidea)

DONALD R. DAVIS

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY • NUMBER 478

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Generic Revision of the Opostegidae, with a Synoptic Catalog of the World's Species (Lepidoptera: Nepticuloidea)

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ABSTRACT

Davis, Donald R. Generic Revision of the Opostegidae, with a Synoptic Catalog of the World's Species (Lepidoptera: Nepticuloidea). *Smithsonian Contributions to Zoology*, number 478, 97 pages, 320 figures, 1 map, 2 tables, 1989.—Larval, pupal, and adult morphology, biogeography, and generic classification of the monotrysian family Opostegidae are reviewed. Three new genera, *Notiopostega*, *Eosopostega*, and *Paralopostega* are proposed, and the former subgenus *Pseudopostega* Kozlov is raised to generic status. Also described for the first time are four new species, *Notiopostega atrata* from Chile, *Eosopostega issikii* from Japan, *Opostegoides malaysiensis* from Malaysia, and *Opostega afghani* from Afghanistan. A synoptic catalog listing 106 specific names grouped under the above six genera is also included. Information relating to the type, type locality, and general collecting data is provided for each name. The text is supplemented by numerous SEM photographs and line drawings of larval, pupal, and adult morphological structures.

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Contents

Generic Revision of the Opostegidae, with a Synoptic Catalog of the World's Species (Lepidoptera: Nepticuloidea)

Donald R. Davis

Introduction

Largely because of their small size and relative rarity, the monotrysian family Opostegidae has received little attention from lepidopterists. As one indication of past taxonomic inactivity, until 1985 only one generic name had been proposed within this cosmopolitan family. Overall morphological similarity, especially in wing venation, as well as the paucity of workers interested in this family have undoubtedly been instrumental in the universal recognition of *Opostega* as the sole genus. Their wing venation has undergone what could be considered maximum reduction in a fully alate moth, to such an extent so as to be essentially the same for all opostegids. Because this was the principal generic criterion of earlier workers, particularly for Edward Meyrick, no further subdivision of the family seemed justified.

The present study is intended as a preliminary review of the family and of the proposed genera. A more ambitious species revision, although highly desirable, was not considered feasible at this time because of the unavailability or rarity of several species. Table 1 illustrates how poorly represented in collections most of the 106 names proposed thus far are. Nearly 55% of the species were described from a single specimen, and of these approximately 55% (or 30% of the total 106 names) were represented only by the female. For many opostegid species the female offers little if any useful information for specific diagnoses. Meyrick and Walsingham together are responsible for 60% (total of 64) of the opostegid names, and of these at least 70% were founded on unique specimens. The great majority of their types (64%) are represented by unique females. Most likely it will remain impossible to know with any confidence what these names truly represent until males have been properly associated with the female types.

To complicate matters further, the present type depositions of nearly 10% of the names are unknown, with the distinct possibility that most of these types have been destroyed. The identities of a few lost types (e.g., *Pseudopostega auritella* (Hübner)) do not appear to present any confusion for the moment, but neotypes for all verified missing types should be designated eventually. Another serious problem not addressed in Table 1 is the physical condition of the extant types. Several that I have examined are missing abdomens, which in this sparingly or variably marked group is often tantamount to having the entire specimen destroyed.

Obviously, considerably more fieldwork is greatly needed. From my experience, such an effort will require both a concentrated level of activity and considerable time as well. Although the family is widely distributed and present on every continent except Antarctica, many species appear to be almost as rare in nature as they are in collections. On the basis of mostly UV light trap sampling, I have found continental tropical wet forests to be often depauperate in Opostegidae (as was the case on one Amazonian survey). One notable exception, the wet forests of the small West Indian island of Dominica, produced at least six species. The latter collection, when compared to the known neotropical fauna of only 18 species is another indication of how poorly collected and studied are the Opostegidae. As is generally true for many families of moths, large series of single species of Opostegidae can be expected in arid or semi-arid habitats. A single night's collecting south of Ciudad Victoria, Mexico, for example, resulted in over 40 specimens within two hours of an undescribed *Pseudopostega*. Some species are diurnal, which sometimes are best collected through rearing. *Notiopostega atrata*, new species, from southern Chile may be such an example. Rearing is especially needed to fill in the huge gaps in our knowledge concerning the biology of this family, which currently is based upon less than 8% of the known species.

Although I have presented a rather bleak picture regarding early collections and descriptions, it should be recognized that many specimens have been assembled over the last few decades. But for most species, all that is known must be

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TABLE 1.—Analysis of type series composition in Opostegidae.

Source	Total names proposed	Unique type	Possible uniques (syntypes?)	Unique ♀ type	Syntypes all ♀	Types lost?
World	106	58	3	32	2	10
Meyrick	53	35	1	25	0	0
Walsingham	11	10	0	4	0	0

gleaned from the original type material, which too often remains represented by a single example.

The following four species formerly included in *Opostega* are hereby removed from that genus and placed in the Lyonetiidae. Although their new generic placements must be considered tentative, for the present it seems best to assign them to the genera below. I am indebted to E.S. Nielsen for the information regarding the misplacement of the two Australian species and to G.S. Robinson for his confirmation of my observation of *"Opostega" leucoprepes* as Lyonetiidae.

Bucculatrix centrospila (Turner), new combination (= *Opostega centrospila* Turner, 1923:179). Male lectotype (present designation), Mount Tambourine [Tamborine], Queensland, Australia; 4 November 1911 (Turner), ANIC. Two syntypes.

Petasobathra ishnophaea (Meyrick), new combination (= *Opostega ishnophaea* Meyrick, 1930:7). Female lectotype (present designation), Bombay, India; 2 October 1921 (Maxwell), BMNH. Two syntypes. This species could be a synonym of *Petasobathra sirina* Meyrick, 1915, from Bengal, India, but the genitalia were not compared.

Leucoptera phaeopasta (Turner), new combination (= *Opostega phaeopasta* Turner, 1923:180.) Female holotype, Coolangatta, Queensland, Australia; 10 September 1921 (Turner), ANIC.

"Lyonetia" leucoprepes (Bradley), new combination (= *Opostega* leucoprepes Bradley, 1961:160, pl. 7:9. Male holotype, Honiara, Guadalcanal; 8 September to 10 October, BMNH. Robinson (in litt.) has further noted that *leucoprepes* appears closely allied to both *"Lyonetia" eratopa* Meyrick from Java and *"L." praefulva* Meyrick from India. Although *leucoprepes* is not congeneric with true *Lyonetia*, the species has been placed in this genus pending a determination of its proper position within the Lyonetiidae.

Because many of the currently recognized 104 species were not examined, the following generic revision must be considered as preliminary. Undoubtedly, numerous species and possibly more genera remain to be discovered. Although a species treatment was not the intention of this study, a few species other than the types of genera have been included to illustrate more of the diversity observed. The nearctic Opostegidae will be treated in a forthcoming volume on the Nepticuloidea in the "Moths of North America" series. Eventually I hope to revise the neotropical species, but only following several more years of intensive fieldwork.

ACKNOWLEDGMENTS.—This report is part of a continuing series by the author on the biosystematics of leafmining Lepidoptera, originally funded by the former Smithsonian Research Foundation. I am indebted to several individuals for their assistance in providing essential information or loans of critical material. In this regard I wish particularly to thank Donald Azuma of the Academy of Natural Sciences, Philadelphia, Pennsylvania; Giorgio Baldizzone of Asti, Italy; Vitor Becker of Planaltina, D.F., Brazil; Graham Griffiths, University of Alberta, Edmonton, Canada; H-J. Hannemann of Humboldt University, Berlin, DDR; Eberhard Jäckh of Hörmanshofen, West Germany; F. Kasy, of the Natural History Museum, Vienna, Austria; Tosio Kumata of Hokkaido University, Sapporo, Japan; Hiroshi Kuroko, formerly of the University of Osaka Prefecture, Sakai, Japan; Scott Miller of the Bernice P. Bishop Museum, Honolulu, Hawaii; Ebbe Nielsen of CSIRO, Canberra City, Australia; Gaden Robinson, Klaus Sattler, Malcolm Scoble, and Kevin Tuck of the British Museum (Natural History), London, England; Kenneth Spencer, Cornwall, England; Lajos Vari of the Transvaal Museum, Pretoria, South Africa; Joël Minet and Pierre Viette, of the National Museum of Natural History, Paris, France. I owe special thanks to R. Scott Cameron of the Texas Forest Service, Lufkin, Texas and his former student at the Southern University of Chile, in Valdivia, Patricio Carey Briones, for data and specimens of *Notiopostega atrata*, the most interesting opostegid discovered thus far. The illustrations for this paper were executed by Biruta Akerbergs Hansen, Vichai Malikul, Ann Szymkowicz, George Venable, and myself. Eleanore Buckner assisted in preparing the distributional map. I wish to thank Victor Krantz of the Smithsonian Photographic Laboratory and Susann Braden, Walt Brown, and Brian Kahn of the Scanning Electron Microscope Laboratory for their much appreciated photographic assistance. The final draft of the manuscript was prepared by Silver West, and Don Fisher of the Smithsonian Institution Press edited the manuscript, created typeset galleys, and prepared camera-ready page repro. I am grateful to J.F. Gates Clarke, Ebbe S. Nielsen, and Erik J. van Nieukerken for their comments on the manuscript and to Ludmila Kassianoff of the Smithsonian Institution for translation of critical Russian literature. Finally, I wish to acknowledge the cooperation of the institutions listed below and to indicate their acronyms as used in this study.

ANIC	Australian National Insect Collection, CSIRO, Canberra, Australia
ANSP	Academy of Natural Sciences, Philadelphia, Pennsylvania, USA
BMNH	British Museum (Natural History), London, England
BPBM	Bernice P. Bishop Museum, Honolulu, Hawaii
FRIM	Forest Research Institute of Malaysia, Kepong, Selangor, Malaysia

MGAB	Muzeul de Istorie Naturala "Grigore Antipa," Bucharest, Romania
MHNS	Museo Nacional de Historia Natural, Santiago, Chile
MSNT	Museo Civico di Storia Naturale di Terrasini, Palermo, Italy
NHMV	Naturhistorisches Museum, Vienna, Austria
UHIC	University of Hawaii Insect Collection, Honolulu, Hawaii
UOP	Entomological Laboratory, University of Osaka Prefecture, Sakai, Japan
USNM	collection of the former United States National Museum, now deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA
ZIL	Zoological Institute, Academy of Sciences, Leningrad, USSR
ZMHB	Zoologisches Museum, Humboldt Universität, Berlin, Germany (DDR)

Biology

DISTRIBUTION.—Although the described species of Opostegidae appear relatively evenly dispersed in all seven biogeographical regions of the world, closer examination reveals obvious collecting bias. More attention to pantropical areas can be expected to shift these statistics significantly. The species totals for the seven regions, from north to south are: Palearctic (19), Nearctic (9), Oriental (16), Australian (18), Pacific (8), Ethiopian (15), and Neotropical (18). Except for one new species described herein from Malaysia, all species reported from the Oriental Region are known only from India and Sri Lanka. Similarly, most of the species from islands of the Pacific (6 of 7) are known only from Hawaii. No species is known to occur in more than one region.

The monotypic genera *Notiopostega* and *Eosopostega* are restricted to the temperate Valdivian Forest of Chile and southern Japan, respectively. *Opostegoides* is widespread but mostly palearctic in distribution, with two species occurring in Malaysia and India/Taiwan (Oriental Region), at least one in Australia, and one across the northern United States and Canada. Until more specimens and particularly males are available for dissection, it will be difficult to ascertain the generic placement and, consequently, the ranges of the other genera. *Paralopostega* includes all Hawaiian species and is not known to occur elsewhere. *Pseudopostega* shows all indications of being the largest, most widespread genus in the family. Representatives (some unnamed) are known from the Holarctic, Neotropical, Ethiopian, Oriental, and Australian regions. Several yet unstudied species currently residing in *Opostega* probably belong in this genus. *Opostega* is well represented from the palearctic, absent from the New World, and only questionably present in the other four regions. In addition to *Opostegoides* and *Pseudopostega*, at least one other genus (undescribed) occurs in Australia. In this paper it is referred to simply as "genus A."

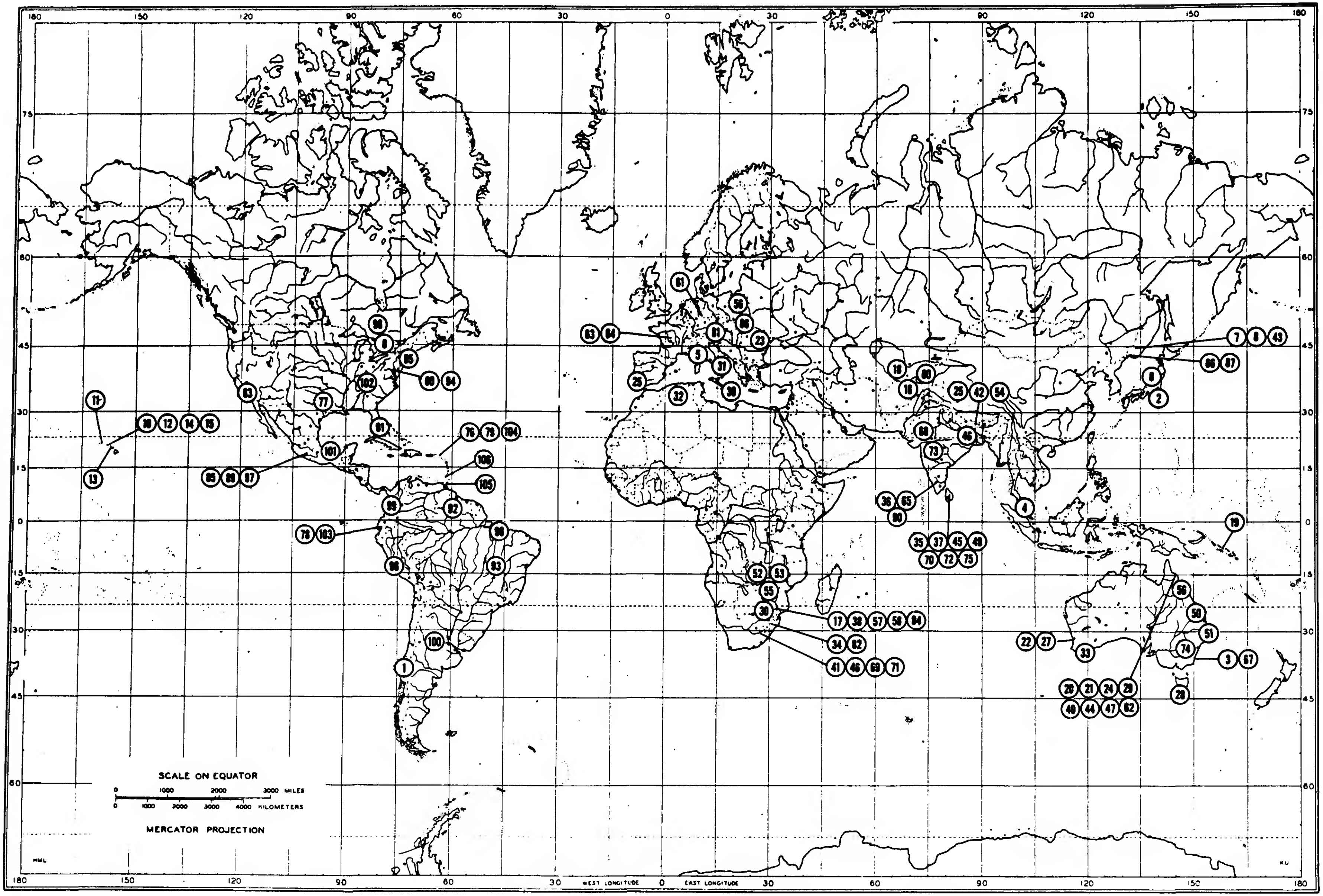
LIFE HISTORY.—Relatively little has been published on the biology of this family. Hosts, representing a broad spectrum of plant families (Betulaceae, Fagaceae, Polygonaceae, Ranunculaceae, Rutuceae, and Saxifragaceae) dispersed among five angiosperm orders are known for approximately 10% of the opostegid species. Some uncertainty persists regarding a few of these records.

Grossenbacher (1910) presented one of the earliest and, still, one of the few detailed reports on the biology of an opostegid. Unfortunately, in his paper the subject species was misidentified by A. Busck as *Opostega nonstrigella*, a misnomer repeated by Heinrich (1918) and later authors. Forbes (1923) misdetermined the same species as *Opostega albogalleriella* var. *quadristrigella*. Genitalic dissection of one of Grossenbacher's original specimens in the Smithsonian Institution clearly has shown the species to be *Opostegoides scioterma*, the same species reported by Rosenstiel (1960) damaging gooseberry in Oregon and identified therein as *Opostega* sp. near *nonstrigella*.

According to Grossenbacher (1910), the eggs are deposited on the bark of currants and gooseberries (Saxifragaceae: *Ribes* species) in New York's Hudson Valley from approximately the last week of April until mid May. *Ribes grossularia* L., *R. nigrum* L., and *R. sativum* Syme (= *vulgare*) were listed as hosts. The larvae mine under the bark in the cambial cylinder for about four to six weeks until mid to late June. Both new spring shoots and canes from the previous season's growth are attacked. The mine is a slender, linear tunnel, which normally curves at both upper and lower ends to form a narrow ellipse approximately 7 to 20 cm in length. Grossenbacher observed 2 to $2^{1}/_{4}$ elliptical rounds by the larva before emerging to pupate. When the larva completes a circle, it normally reinvades the initial mine and continues feeding and enlarging it. Rosenstiel likewise reported a single ellipse involving two parallel mines from 10 to 25 cm long. Grossenbacher always found the crescent-shaped exit hole nearer the basal rather than the distal turn of a mine, generally within 1 or 2 cm of the former and usually after the basal turn had been passed.

It is not clear exactly how much host injury is caused by the larva of *Opostegoides scioterma*. Cross sections of infested stems show small dark spots or flecks, variously referred to as medullary spots, pith flecks, Markflecken, etc. (Kumata, 1984), in successive cambium rings. Grossenbacker observed that 15% to 20% of the mined shoots wilted and died shortly after larval emergence from one *Ribes* species. He encountered heavy infestations on some hosts with larvae present in 85% to 95% of their canes. The most serious effect on the plants seems to be from the introduction and spread of pathogenic organisms, fungi in particular, through the exit holes.

After dropping to the ground, the larva eventually constructs



MAP 1.—Type localities of the 106 proposed names of Opostegidae, listed in the numerical sequence followed in the catalog of species. ®1961 by University of Chicago, Department of Geography.

a flattened, oval, densely woven, cream to brown cocoon (Figure 69) in the upper soil layer. Grossenbacher was able to collect several cocoons by sifting the soil around the bases of infested plants. The pupal stage may last about two to three weeks, with the adults emerging before mid July.

Several questions remain concerning the life history and particularly voltinism of this and other nearctic species. Grossenbacher's assumption of a spring oviposition period for *Opostegoides scioterma*, coupled with his observations of a midsummer adult emergence period, presented major inconsistencies, which he attempted to answer. He assumed there to be a single generation but noted spring larvae of different sizes with the smallest larvae always mining the newest growth. Because Grossenbacher never found larvae or new mines after mid July, he suggested that either the adults emerging in mid summer were long lived and overwintered, or that emergence from some pupae was delayed until the following spring. Adult records of *O. scioterma* do not support an early spring oviposition (i.e., flight) period, although it is uncertain as to how thorough the spring sampling of adults has been. The earliest record I have for this species is 18 June, with nearly all records occuring after 25 June and ceasing on 3 August (N=43). The flight periods of other North American opostegid species vary considerably. Of the species with ample collecting data, *Pseudopostega bistrigulella* demonstrates greatest indication of a bivoltine life cycle. Specimens (N=63) from southern California fly from 16 March until 22 May and northern Arizona specimens (N=53) from 13 July until 20 August. Currently these two disjunct populations are believed to represent the same species, although biseasonal records are not known at either site. *Pseudopostega kempella*, known only from Key Largo, Florida, shows a late fall flight period (8 October 8 November, N=13). Other Florida species have been captured over several seasons, including January, February, May, and July.

Kumata (1984) has investigated the life history of *Opostegoides minodensis* in Japan. The larvae mine the cambium of *Betula platyphylla* var. *japonica*, creating slender elliptical mines similar to *O. scioterma* but perhaps with more anastomosing occurring between the parallel mines. Kumata found evidence for only one generation a year with the adults emerging from the end of June to mid July, or approximately the same period as *O. scioterma*. Based upon the relative development of the mine as seen in cross sectional views of infested birch stems, it was determined that *O. minodensis* overwinters as early- to mid-instar larvae. Mine traces, or pith flecks, were found on both sides of the winter ring layer, with the smaller, younger mines always on the inner side of the ring and the larger, more mature mines on the outside. In addition to other discrepancies, these observations indicate an early summer oviposition period for temperate *Opostegoides*, in contrast to the spring period hypothesized by Grossenbacher.

Other than the two preceding species of *Opostegoides*, the larva of only one other holarctic opostegid has been reared. Stainton (1868:132) and Sorhagen (1886:301) report the larva of *Pseudopostega auritella* as a stem miner on *Caltha palustris* L. (Ranunculaceae). Sorhagen describes the larva as light green and as spinning a strong white cocoon. Pelham-Clinton (1976:270) shows evidence that the two accounts may actually pertain to the same discovery, and thus may constitute the only larval record of a European opostegid in over a century.

Warren (1888) reportedly reared two adult *Opostega salaciella* incidentally from *Rumex acetosella* L. (Polygonaceae) without observing any larvae or larval damage. In a similar situation, Pelham-Clinton (1976:269) mentions an incidental emergence of this species from a mixture of potted plants including *Rumex acetosella*. Possible hosts of other European opostegids are even more tenuous. Warren (1888) lists possible hosts for *Opostega spatulella* as *Ulmus* and *Mentha* for *Pseudopostega crepusculella*.

The Hawaiian *Paralopostega* present an interesting divergence from the previously reported life histories in that all six species are leafminers on *Pelea* (Rutaceae). The leafmining habit may eventually be found to occur in other tropical Opostegidae. Not all of the Hawaiian hosts listed in the synoptic catalog represent actual rearing records. The association of some hosts, consequently, is questionable. As illustrated by Swezey (1921), the mines appear characteristic for each species but are generally serpentine and occur on the upper leaf surface. The tortuous, lengthy, and extremely slender mine of *Paralopostega filiforma*, for example, is abundantly distinct from the shorter, more compact, sinuous mine of *P. serpentina*. Swezey also reports that the larva of *P. filiforma* eventually mines into the cambium of the petiole. The mines of *P. callosa* terminate in a peculiar, circular, callous-like structure about 12 mm in diameter. To form this the larva mines in a small perfect circle and continues to tunnel in a spiral pattern inside the outer ring until the center is reached. The upper epidermis of this area proliferates, and the larva feeds beneath it until maturity. Pupation is similar to other Opostegidae and occurs on the ground in a brownish, oval cocoon.

The most detailed study of any opostegid was conducted on a new genus and species, *Notiopostega atrata*, described herein. Although much of the biological information on this Chilean moth currently resides in an unpublished thesis (Carey, ms), a summary of that research was published (Carey et al., 1978). An even briefer synopsis is included in the present paper following the species description, and little will be repeated here. A chronology of the life cycle is illustrated in Figure 70. The eggs are deposited on the undersides of the leaves of *Nothofagus dombeyi* (Mirbel) Oersted, commencing in early September. Normally only one egg is laid per leaf, and most of the oviposition sites are concentrated in the upper third to one half of the tree crown (Figure 71). Upon hatching, the larva bores into the leaf and continues mining into the petiole and cambium layer of the terminal branch, eventually reaching the main trunk. The larva continues in a characteristic zig-zag course down the trunk—sometimes all the way to the ground—a total distance of up to seven meters. Normally before reaching the tree base, the larva turns 180° and mines upwards a short distance (Figure 72). There it forms a small aestivation chamber where it molts into the sixth and last instar. The feeding pause in *N. atrata* is probably directly associated with the rather abrupt morphological changes that occur between the fifth and sixth instars. Such pauses may be characteristic for most, if not all, members of the family. Sometime between mid March and early April the larva leaves the chamber and continues down the old mine a short distance where it then bores through the bark and drops to the ground. Pupation occurs in a flattened oval cocoon amidst the leaf litter and above the soil. Immediately prior to adult emergence, the pharate adult forces itself part way out through a large transverse slit in one end of the cocoon. Adults begin to emerge in late August, or whenever the daily ambient temperature approaches 18°C in the early spring (Carey et al., 1978).

Adult Opostegidae vary in activity from diurnal to nocturnal. Most species are readily attracted to light (gas lamps, incandescent, and ultraviolet) indicating a crepuscular to nocturnal activity. *Pseudopostega crepuscular* normally flies at dusk (hence its name) between 8 and 8:30 P.M. (Zeller, 1848), but on cloudy days it may fly earlier in the afternoon (Stainton, 1854). Banks (1890) observed *Opostega salaciella* swarming over low vegetation between 7 and 8 P.M. This species has also been collected on one occasion in numbers at gas light (Stainton, 1868). *Opostega spatulella* has been observed flying as early as 4 P.M. and as late as 6 to 8 P.M. (Barrett, 1877; Cransdale, 1877). In North America virtually all the species have been collected at ultraviolet lights, sometimes in large numbers. It is safe to assume, however, that little effort has been made to collect these species during the day and particularly at dusk. Perhaps the most diurnal member of the family is the southern Chilean *Notiopostega atrata*. The adults fly during the day in the early spring, but Nielsen (in litt.) has collected the species in light traps. Their nearly black coloration is undoubtedly an adaptation toward this habit. It is interesting to note that the darkest of the Hawaiian *Paralopostega* is also diurnal (Perkins, 1913). However, melanic variation in otherwise normally white species is known to occur in this family (Eyer, 1966). Little is known about the activity of the other, more typically white Hawaiian species, and even less is known about the remaining tropical species.

Adult Opostegidae may be the most thigmotactic of any Lepidoptera. Live moths have been observed to burrow their way into small crevices for concealment. Certain aspects of their morphology, particularly the enlarged antennal scape (or eyecap) that can completely cover and thus protect the eye and the generally depressed body are apparent adaptations for this behavior (see page 13). The development of densely spinose setae on the hindlegs (a synapomorphy of the Nepticuloidea) is probably a further adaptation for a burrowing type of behavior.

Few natural enemies of Opostegidae have been reported. In Carey's rather extensive study (Carey, ms), the only mortality observed was caused by arachnids attacking larvae as they exited and descended to the ground for pupation. The only records of parasites I am aware of are Eulophidae (Swezey, 1921) and the two eulophid rearings mentioned by Zimmerman (1978:241) of *Euderus metallicus* (Ashmead) by J.W. Beardsley and *Pauahiana lineata* Yoshimoto by Swezey—all from unidentified Hawaiian *Paralopostega*.

Pith flecks, or the injury produced by cambium miners as viewed in cross sections of woody stems or trunks, is similar in Opostegidae and certain Agromyzidae (e.g., *Phytobia*, Kumata, 1984). As a result, identifications based solely on larval mines can be difficult and unreliable. Even their larvae can be confused, as was done by Knigge and Bonnemann (1969), who illustrated the larva and attributed the injury caused by *Notiopostega atrata* to an "undetermined species of Agromyzidae." Süss and Müller-Stoll (1975) proposed *Palaeophytobia platani* as a new genus and species of Agromyzidae solely on the basis of pith flecks observed in fossilized plane trees (*Platanus*) from the Hungarian Miocene. Considering the confusion between the cambium mines of these two insect orders, as well as the fact that no pith flecks are known from extant *Platanus*, currently one can only assume the ordinal placement of this name. It is possible that *Palaeophytobia platani* could represent the earliest record of Opostegidae. However, Kenneth Spencer, an authority on the Agromyzidae, has indicated (in litt.) that the cambium mines of Agromyzidae are sufficiently distinct to separate from those produced by either Coleoptera or Lepidoptera. Spencer agrees with the well-researched results of Süss and accepts the injury caused by *Palaeophytobia* as that of an agromyzid.

Morphology

An understanding of comparative morphology is fundamental to the determination of systematic relationships of all taxa. For many families of Lepidoptera, including Opostegidae, attention to this basic requirement has been superficial or altogether lacking. To supplement the following phylogenetic discussions and systematic descriptions, a review of certain adult and larval morphological structures is warranted.

ABBREVIATIONS.—Following is a list of the abbreviations used in the illustrations.

A	abdomen (abdominal segment)
AA	anterior apophysis
AC	anapleural cleft
Ae	aedoeagus
AfC	afferent (= transport, internal) canal of spermatheca
Am	anepisternum
AP	anal papilla
APF	anteriomedial process of furcasternum
Ar	arolium
As	anus

ATA	anterior tentorial arm
B	basalare
Bm	basisternum
CA	cephalic apophysis
CAV	costal apophysis of valva
CB	corpus bursae
CL	cucullar lobe
CO	common oviduct
CS	coxal suture
DS	ductus spermathecae
Ea	eucoxa
EC	efferent (= fertilization, external) canal of spermatheca
ED	ejaculatory duct (ductus ejaculatorius)
EF	epicranial fossa
En	epimeron
FA	furcal apophysis
Gn	gnathos
Go	gonopore
H	hypostoma
HR	hypostomal ridge
i	angle of inclination
J	juxta
JF	jugal fold
K	katepisternum
LCS	lateral cervical sclerite
Lg	legula of haustellum
LO	labial operculum
LP	labial palpus
Lpa	laterophragma
LR	lateral ridge
ML	mesal lamella of metafurcasternum
Mn	meron
Os	oviporus (= ostium oviductus)
P	postnotum (= phragma)
PA	posterior apophysis
PeS	pseudempodial seta of pretarsus
Pf	pectinifer
PlS	pleural suture
PMP	pronotal median plate
PPP	pronotal posterior plate
Prm	pre-episternum
PS	precoxal sclerite
Pu	pulvillus
PWP	pleural wing process
S	sternum of abdomen
SA	sensillum ascoideum
SAF	secondary arms of fucasternum
SC	sensillum chaeticum
Se	subalare
Si	socii
Slm	scutellum
Sm	scutum
SR	subdorsal retinaculum
T	tergum of abdomen
Ta	tegula
TpA	tergopleural apodeme
Tr	transtilla
U	uncus
UP	unguitractor plate
Vm	vinculum
Vn	venula (of 2S)

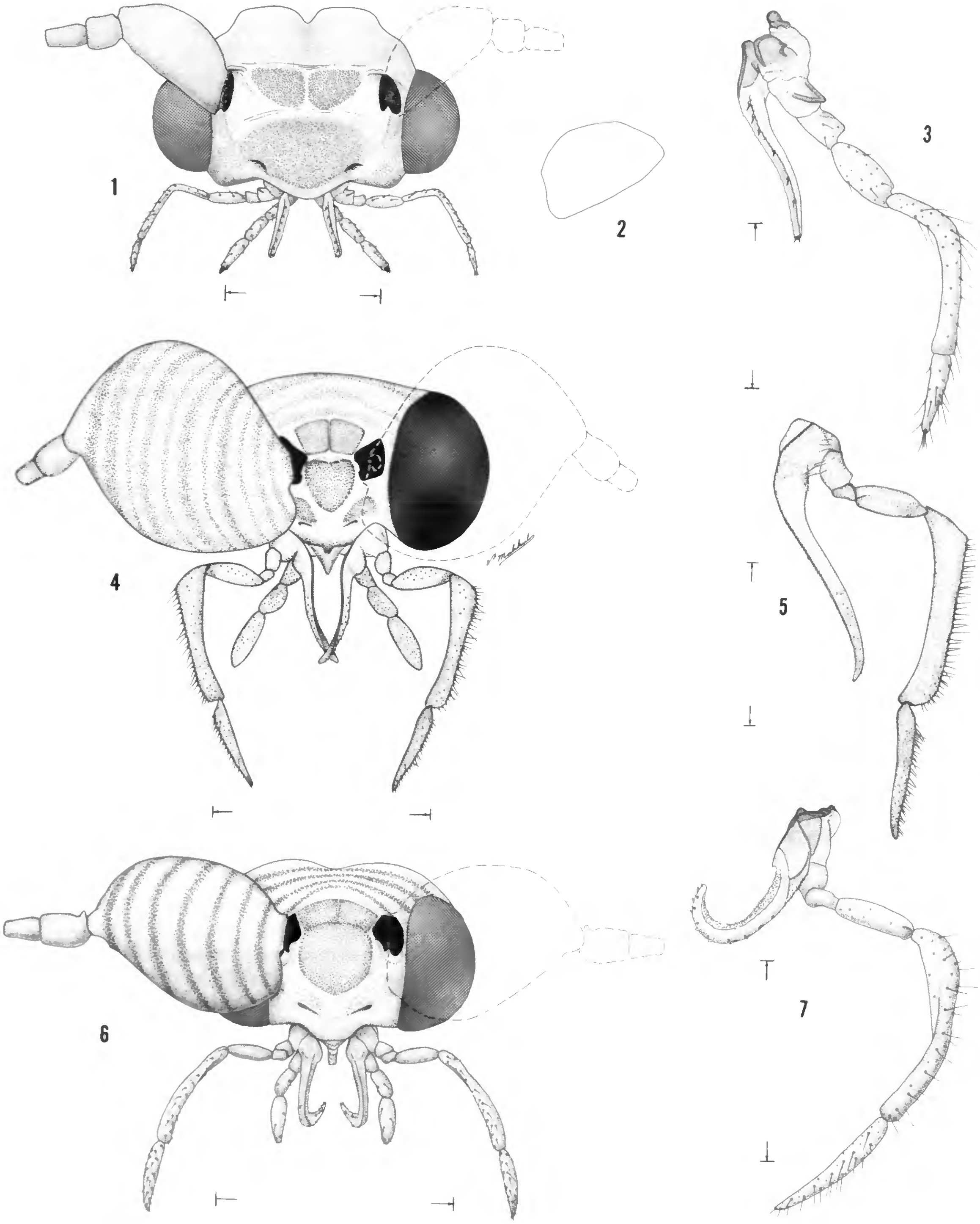
ADULT

Head: The general features of the head, including scale vestiture, are similar among all Opostegidae except *Notiopostega*. Most of the frons and vertex typically bear a tuft of erect piliform scales (Figure 212). Posterior to the vertex the scales are flat, broad, and normally arranged in definite, clustered rows, which tend to be more anastomosed in *Opostega salaciella*. The head posterior to the vertex of *Notiopostega* differs significantly in being raised to a thin, bicrenulate, transverse occipital ridge that is more sparsely covered with relatively slender, scattered scales. The lower frontal region of all Opostegidae is naked except for scattered microtrichia that show some variation in arrangement and density between taxa (Figures 73, 138, 192, 214).

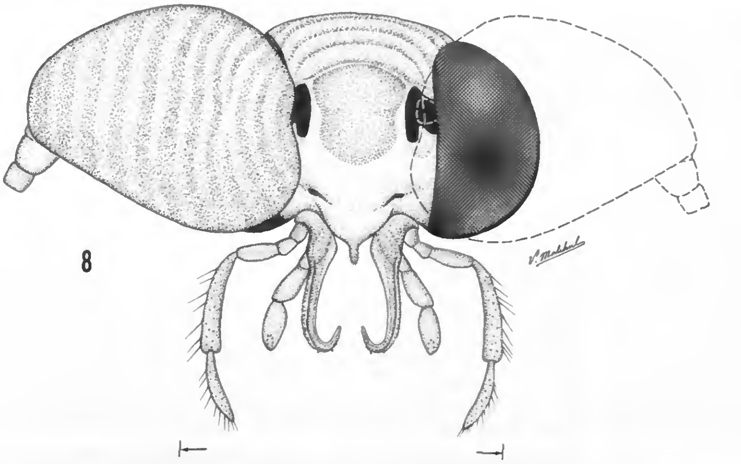
Ocelli are lacking in all Opostegidae as they are in nearly all Monotrysia. The compound eyes of *Notiopostega* are unusually reduced in size, with an interocular index (Davis, 1975a:5) of only 0.5 compared to 0.8 to 1.2 in other opostegid genera. Eye reduction in *Notiopostega* probably represents a subsequent adaptation to greater diurnal activity (Powell, 1973:8). The cornea is naked in this family, with no evidence of interfacetal microsetae. Resolution of corneal subnipples was not possible.

The antennae are relatively long, approximately 0.7 to 0.9 the length of the forewing, and vary in segmentation from 46 to 85. One of the most conspicuous features of this family, which it shares with Nepticulidae, is the greatly enlarged scape, or eyecap (Figures 1, 4, 6, 8, 10, 12). In repose the scape is capable of covering the entire eye, thereby affording maximum protection. Reduction of the scape in *Notiopostega* appears correlated with corresponding reduction of the compound eye. In all genera except *Notiopostega*, where they are randomly scattered, the broad, flat scales covering the scape (Figures 212, 213) are arranged in 7 to 12 compound bands, each consisting of 2 to 4 densely compacted, scattered rows. Located at the dorsal base of the scape is a concentration of Böhm bristles (Schneider, 1964) consisting of approximately 6 to 10 minute sensilla chaetica less than 7 µm long (Figure 227). These sensilla probably function as proprioceptors and are similar to the "hair plates" present near major articulation points in most insect groups (Pringle, 1938; Sutcliffe and McIver, 1976:1782). Böhm bristles also occur at the base of the antennal pedicel (Figure 222) in *Pseudopostega bistrigulella*.

The most unique, diagnostic feature of the opostegid antenna is the presence of three typically palmately branched sensilla ascoidea on nearly all flagellomeres (Figures 77, 143, 194,



FIGURES 1–7.—Adult head structure. *Notiopostega atrata*, new species: 1, anterior view (0.5 mm); 2, antennal scape, dorsal view; 3, maxilla (0.25 mm). *Eosopostega issikii*, new species: 4, anterior view (0.5 mm); 5, maxilla (0.25 mm). *Opostegoides scioterma* (Meyrick): 6, anterior view (0.5 mm); 7, maxilla (0.25 mm). (Scale lengths in parentheses.)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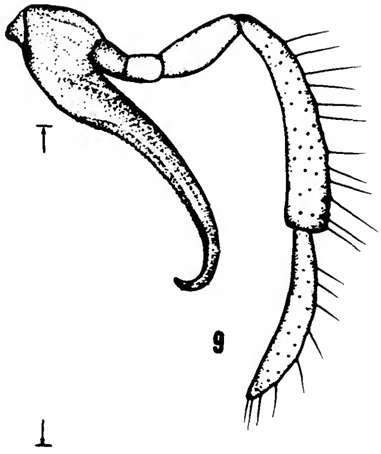
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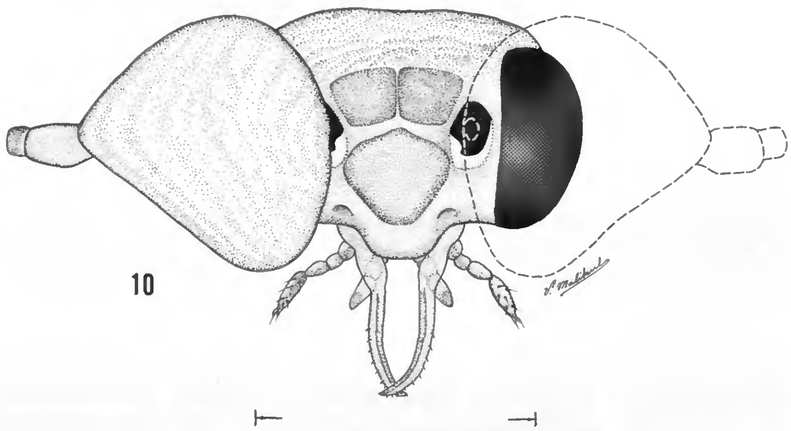
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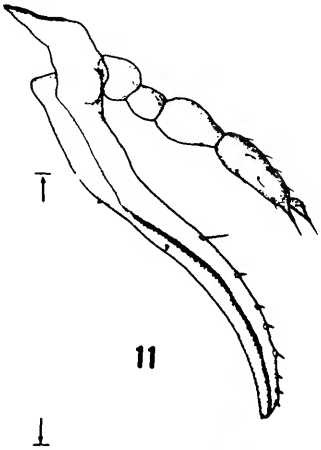
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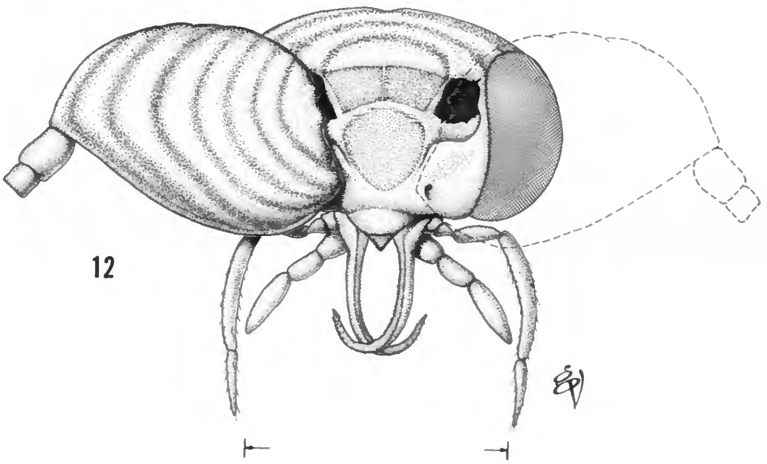
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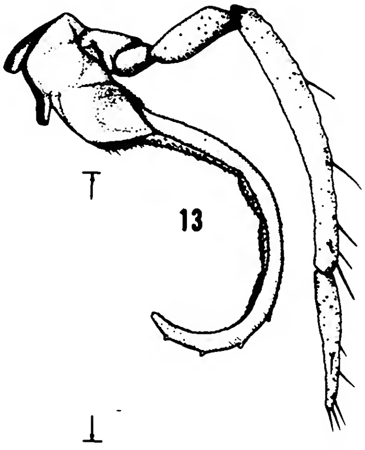
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FIGURES 8–13.—Adult head structure. *Paralopostega callosa* (Swezey): 8, anterior view (0.5 mm); 9, maxilla (0.25 mm). *Opostega salaciella* Treitschke: 10, anterior view (0.5 mm); 11, maxilla (0.25 mm). *Pseudopostega bistrigulella* (Braun): 12, anterior view (0.5 mm); 13, maxilla (0.25 mm). (Scale lengths in parentheses.)

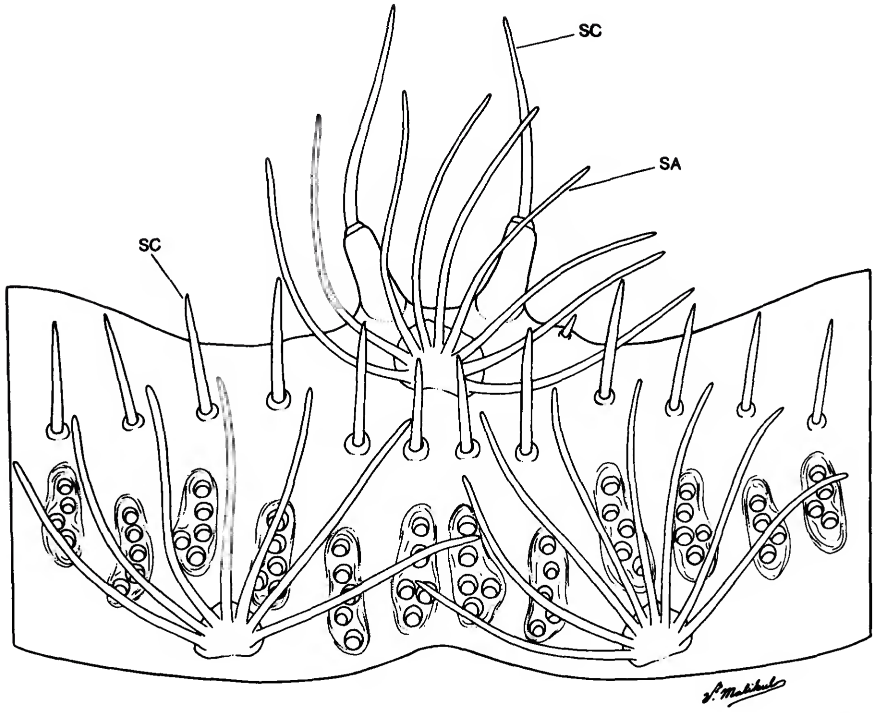
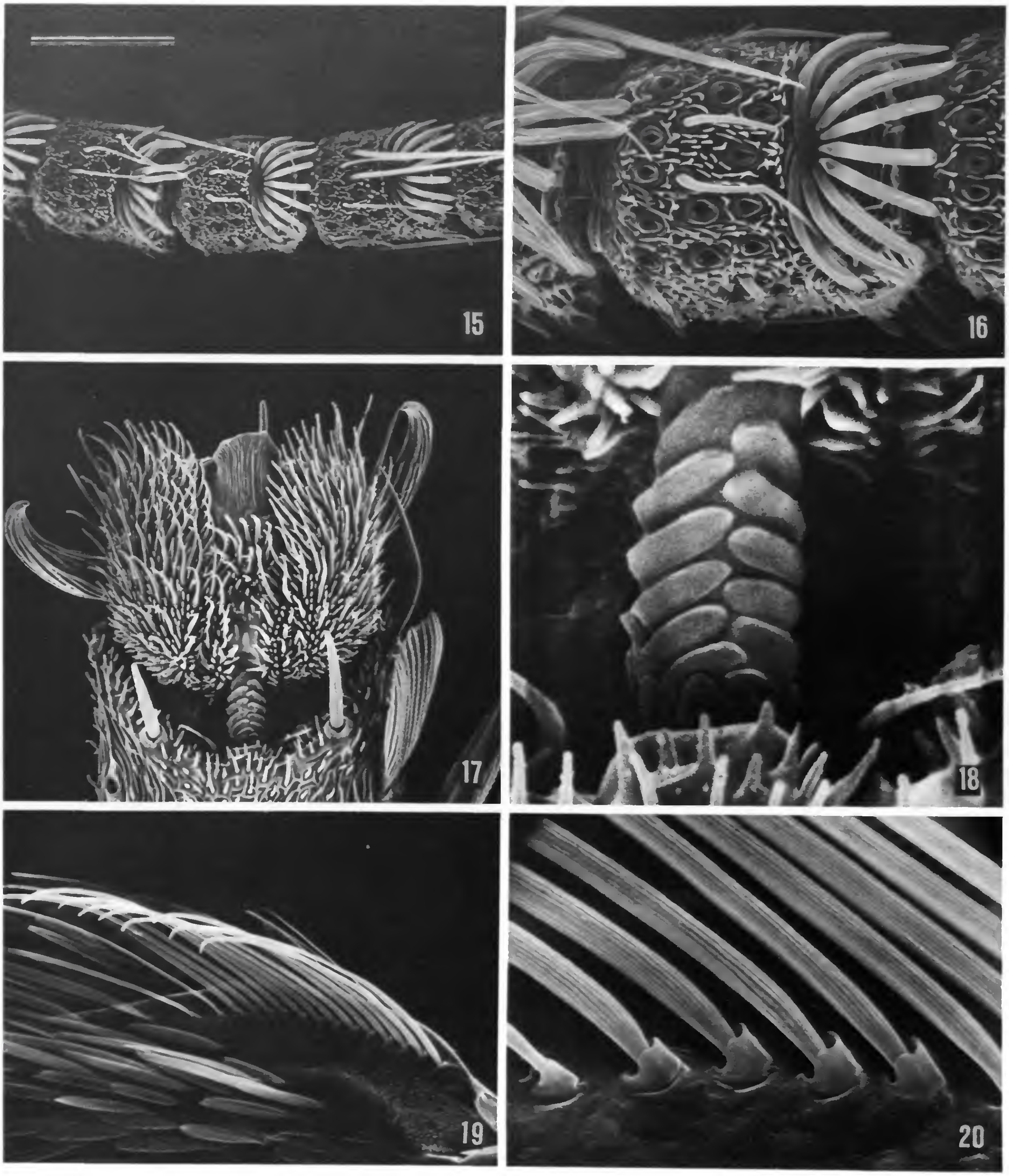


FIGURE 14.—*Pseudopostega bistrigulella* (Braun), schematic distribution of antennal sensilla on a single flagellomere.

224–233). Their general structure suggests they serve as olfactory receptors. As shown in Figure 14, the standard arrangement of these sensilla in both sexes of all species examined is for a single mid-dorsal sensillum near the distal margin of each flagellomere and a basal, lateral pair. Nieukerken and Dop (1987) report only one pair of sensilla ascoidea (at apex and base of each segment) in *Opostega salaciella* and *auritella*, thus differing from my observations for the same species. The first and second antennal segments (scape and pedicel) are devoid of sensilla ascoidea. The number sometimes varies on the third segment (first flagellomere) according to species and sex. In *Notiopostega* the customary three sensilla are present except when the the segment itself may be incompletely subdivided thereby producing an atypical number of sensilla (Figure 77). Greatest variation was observed in *Pseudopostega bistrigulella* (Figures 224–233). The single male and female examined of that species demonstrated ascoid sensillar variations on both the third and fourth segments, with those of the male being slightly more reduced. The third segments of both sexes possessed a single mid-dorsal ascoid that was eight-branched in the female and only single in the male. This segment also differed from all other flagellomeres in possessing a basal, dorsal ring of short spines in both sexes. Segment four in the female possessed a normal triad of sensilla ascoidea compared to the reduction of one lateral male ascoid to a solitary filament as in the preceding segment. The other lateral member in the male was four-branched. The only other variation observed from the basic pattern was on the apical flagellomere, which bore either two or three, branched ascoids. Only once was a supernumerary sensillum observed (Figure 228) that appeared homologous to an unbranched ascoid sensillum.

Most sensilla ascoidea possess from 4 to 10 elongate arms arising from an unsocketed, relatively large disk (Figure 226). The branches can be almost 60 µm in length in *Notiopostega* and slightly over 2 µm in diameter, although for smaller species the sensilla are approximately half that size. The walls of those in *Notiopostega* (Figure 78) are relatively thick (0.43 µm), or between a third or fourth the diameter of the filament. The surfaces of most sensilla ascoidea examined bear minute, longitudinal grooves with pits or pores present in the grooves (Figure 227). In *Notiopostega* the surface differs in possessing scattered microtubercules in lieu of pitted grooves (Figure 78).

The homology and, consequently, correct name for all branched sensilla is uncertain. Within the Lepidoptera, only the Micropterigidae and Mnesarchaeidae (Gibbs, pers. comm.) possess similar sensilla (Figures 15, 16). They were first discussed and figured by Bodine (1896) who, not realizing their



FIGURES 15–20.—Morphological details. *Micropterix thunbergella* Fabricius: 15, antenna (60 µm); 16, detail of sensillum ascoideum (26 µm). *Ectoedemia phleophaga* Busck: 17, ventral view of mesothoracic pretarsus (17.6 µm); 18, detail of unguitractor plate (3.8 µm); 19, pseudofrenular setae of female hindwing (133 µm); 20, socket bases of pseudofrenular setae (25 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 15.)

sensory function, thought they were scales. In the micropterigid genera examined, a single opposable pair arising from each flagellomere appears to be the typical arrangement. Similarly branched sensilla apparently do not occur in any other order except Diptera. Wells (1984) does not mention their presence in the Trichoptera she studied, but a thorough review of antennal sensilla in that order has yet to be done. Le Cerf (1926) described the sensilla in Micropterigidae further and considered them the same as those found in *Pericoma* (Psychodidae). In Diptera ascoid sensilla have been reported primarily in Psychoididae (Feuerborn, 1922; Tonnoir, 1922) where they occur usually in pairs with single, Y-shaped, or palmately branched arms, with some variation noted according to sex. Wirth and Navai (1978) illustrate a 6-branched sensillum in a species of Ceratopogonidae. Unfortunately, dipterists have applied several names to this sensillar type, including "ascoids" (Feuerborn, 1922), "filets sensorials" (Tonnoir, 1922), "geniculated spines" (Perfil'ev, 1966), as well as additional names for other types of filamentous sensilla. As an attempt to simplify the rather confused terminology, Wirth and Navai (1978) considered these all to be homologous variations of sensilla trichodea. They defined the latter as possessing thin, often translucent walls and arising not from sockets, as do sensilla chaetica, but from clear areas in the integument. The opostegid branched sensillum agrees in part with the above criteria, but it differs in possessing relatively thick walls.

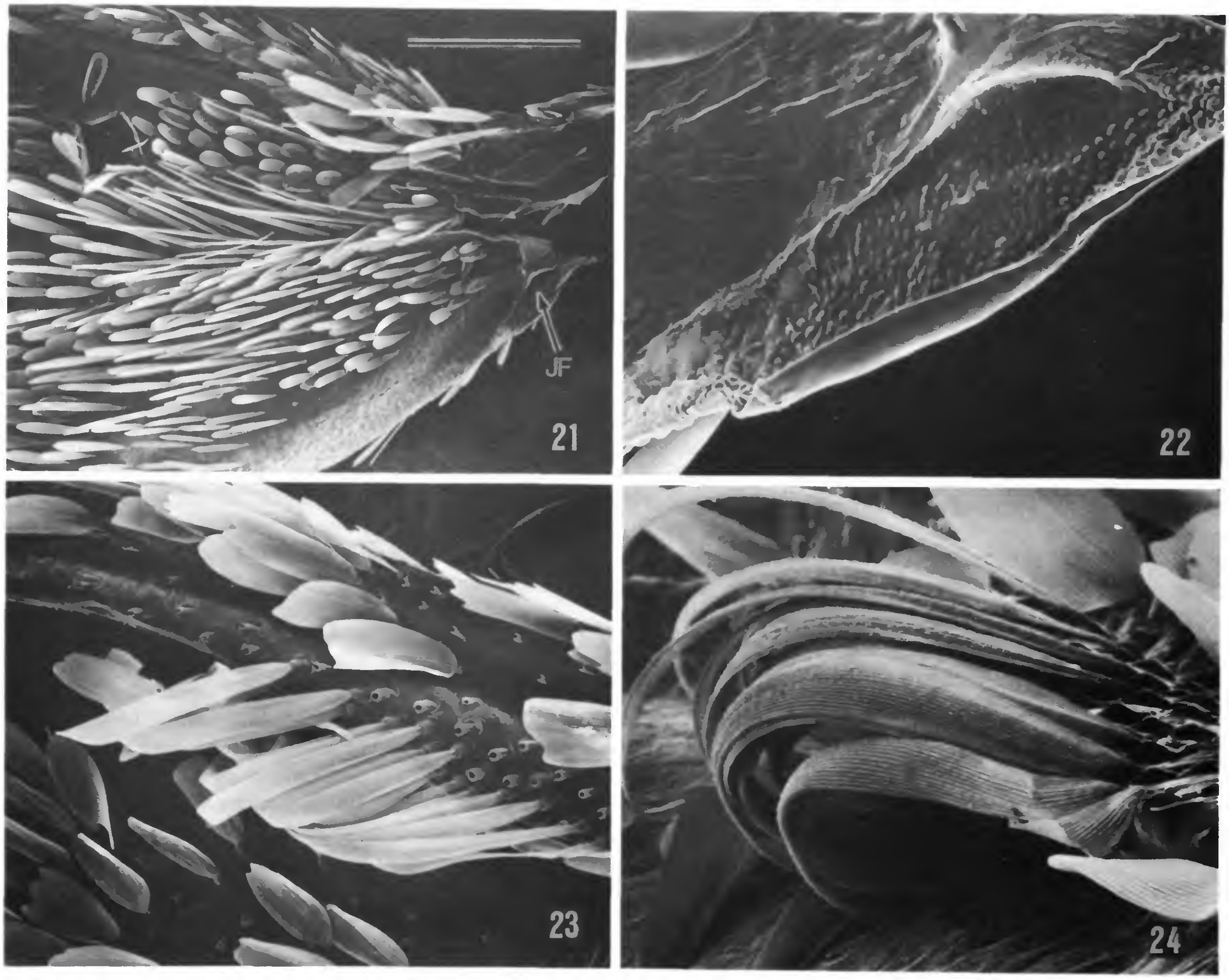
The presence of sensilla ascoidea in only a few families of Diptera and three distantly related families of Lepidoptera suggest independent and parallel development from a basic type common to both orders (i.e., from sensilla trichodea). Because there currently exists little evidence to disprove their basic homology, I have maintained (in a more formal sense) the term previously used for this morphologically variable but often superficially similar sensillum. The even more variable sensillum vesiculocladum present in Nepticulidae, the sister group of Opostegidae, is quite distinct from sensilla ascoidea. Instead of being free, the branches of a sensillum vesiculocladum appear throughout as outgrowths of the integument (Nieukerken and Dop, 1986).

An alternative nomenclature for arthropod chemosensilla has been proposed by Altner (1977) that is currently followed by many if not most morphologists (e.g., Zacharuk, 1980). Altner's system avoids the often frustrating questions of homology by classifying chemosensilla on structural features associated with function. Although circumventing some problems of nomenclature, as in the case of sensilla ascoidea, Altner's topological approach offers little assistance to the systematist who must still attempt to evaluate character relationships based on homology. If my superficial observations are correct, opostegid sensilla ascoidea present another problem using a topological classification. Following Altner's system, the sensilla ascoidea of *Pseudopostega* (Figure 227) could be referred to as branched, multiporous chemosensilla with pitted grooves, or BMPG. Although certainly homologous, the *Notiopostega* sensilla (Figure 78) possess a different cuticular surface that perhaps would be best termed as a branched, multituberculate type (BMT), thereby suggesting more distinction than merited.

In addition to the complement of three sensilla ascoidea, each flagellomere distad to the third segment in Opostegidae possesses a basal band of 12 plates, each bearing three to six slender, bidentate scales (Figures 14, 75, 223). A corresponding row of 12 relatively short sensilla chaetica encircle the distal half of the segment. A similar configuration of scales and sensilla chaetica exists in Nepticulidae (Nieukerken and Dop, 1987). Besides the basic pattern just described, additional sensilla chaetica occur randomly near the apical margin of most segments. Most conspicuous is an elongate, mid-dorsal pair that arise from short pedicels (Figure 14). The number occurring in this group varies from 0 to 2 between each segment (Figures 230–233). In addition to the presence of three sets of sensilla ascoidea and the absence of sensilla vesiculoclada, the opostegid antenna further differs from that of Nepticulidae in lacking sensilla coeloconica and microtrichia.

The labrum is poorly developed in Opostegidae with no evidence of pilifers (Figures 1, 4, 6, 8, 10, 12). Likewise mandibles are absent as they are in the Nepticulidae I have examined, although Scoble (1983:10) describes them as being reduced. The haustellum is reduced in all species and rarely exceeds the length of the five-segmented maxillary palpus. A food channel is not well developed. The haustellum may not function as a suction tube but instead more as a lapping-sponging organ. Bordering the channel are single rows of slender, anterior and posterior legulae (Davis, 1986:42). As in many families, the legulae bordering the anterior margin are usually larger. The surface of the channel is usually smooth and occasionally slightly wrinkled. A series of short sensilla styloconica arising from slightly raised pedicels (Figure 219) occur mostly over the distal half of the haustellum to the apex. The maxillary palpus is elongate and geniculate in all opostegids examined except *Opostega salaciella* where it is reduced with greatly shortened fourth and fifth segments. It is not known if this type of maxillary palpus is typical for all true *Opostega*. The apex of the fifth palpal segment bears from one (in *O. salaciella*) to five long setae often accompanied by numerous shorter spines (Figure 217). The labial palpus is moderately long, with greatest reduction occurring in *O. salaciella*. The apical sensory setae of segment III vary in number (from 10 to 25) as well as in length. The apices of these sensilla are normally swollen slightly.

Thorax: Adult Opostegidae possess a flattened (depressed) body form. This is particularly evident in the pterothorax (Figure 45) where the segments have been tilted forward approximately 62° as indicated by their mesothoracic inclination (28°). I have determined the latter as the inner angle formed by a line drawn from the ventral end of the mesopleural suture through the base of the pleural wing process to where it intersects a horizontal line connecting the apices of the



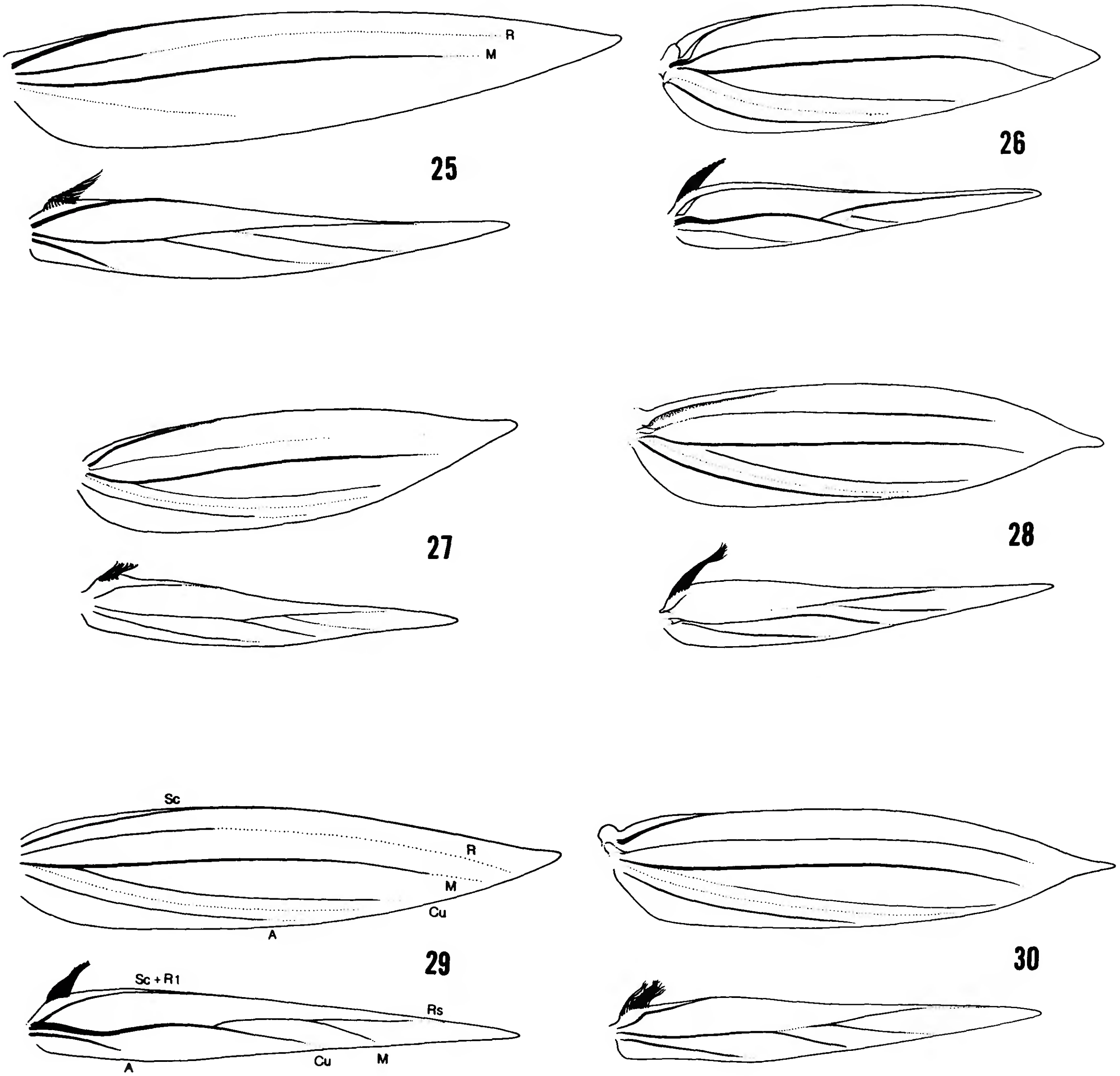
FIGURES 21–24.—Wing structure. *Ectoedemia heinrichi* Busck: 21, ventral view of base of female forewing (0.3 mm); 22, detail of jugal fold (46 μm). *Caloptilia serotinella* Ely: 23, retinaculum, ventral view of male forewing (100 μm); 24, lateral view of retinaculum (38 μm). (Scale length in parentheses; bar scale for all photographs = Figure 21.)

meso- and metapleural wing processes (Figure 46). The pleural wing processes were selected to represent the horizontal plane because they function as principal wing supports. The vertical (usually oblique) axis closely parallels the mesopleural suture, and the mesothorax was compared because it is the least reduced thoracic segment in Lepidoptera. The mesothoracic inclinations of representatives from other families are compared in Table 2. Measurements on some species were obtained from thoracic illustrations by Shepard (1930).

Body depression in Opostegidae is believed to represent a fundamental biological adaptation toward a more thigmotatic behavior as witnessed in other insects, notably cockroaches. Possessing this body type and behavior enables these small, but conspicuous moths to force their way into narrow crevices for

TABLE 2.—Mesothoracic inclination of select Lepidoptera.

Species	Family	Degree of inclination
Micropterix aruncella (Scopoli)	Micropterigidae	62°
Dyseriocrania griseocapitella (Walsingham)	Eriocraniidae	39°
Phassus huebneri (Geyer)	Hepialidae	55°
Adela purpurea Walker	Adelidae	45°
Tegeticula yuccasella (Riley)	Prodoxidae	60°
Ectoedemia phleophaga Busck	Nepticulidae	38°
Pseudopostega bistrigulella (Braun)	Opostegidae	28°
Sesommata trachyptera Davis	Palaephatidae	40°
Daviscardia coloradella (Dietz)	Tineidae	40°
Lagoa crispata (Packard)	Megalopygidae	72°



FIGURES 25–30.—Wing venation: 25, *Notiopostega atrata*, new species; 26, *Eosopostega issikii*, new species; 27, *Opostegoides scioterma* (Meyrick); 28, *Paralopostega callosa* (Swezey); 29, *Opostega salaciella* Treitschke; 30, *Pseudopostega bistrigulella* (Braun).

concealment. Believed associated with this behavior is the greatly enlarged antennal scape that probably serves to protect the cornea from damage when the moth enters restricted space, as well as the spinose legs that aid in propelling the moth in such a microhabitat.

As discussed by Minet (1984), the prosternum of Opostegidae is reduced to a narrow intercoxal basisternum (Figure 43), thus resembling in structure the prosterna of those moth families below the Eulepidoptera grade. Although a distinct precoxal bridge similar to that preserved in Nepticulidae is absent in Opostegidae, a vestige of that bridge in the form of a precoxal sclerite (Figure 43) does persist. The pronotum appears uniform among all species and thus is characteristic for the family in possessing a deeply divided median plate (PMP) and a posterior plate (PPP) with lateral wing-like processes.

The mesofurcasternum is similar in most genera in possessing a pair of short conical furca arising apically or subapically from the secondary furcal arms (Figures 31, 34). The subapical pair are much smaller and bear a single elongate tendon. An even larger pair of tendons arise from the bases of the secondary furcal arms (Figure 44), as they do in several families of Lepidoptera. The anteromedial process (APF) is broad but generally reduced in length and without furcal apophyses.

The metafurcasternum in its general reduction represents a departure from the standard monotrysian form (Davis, 1986), which, however, is still preserved in the more generalized Nepticulidae. The anterior dorsal ridges are reduced and usually lack the normal, paired tendons. Similarly, the furcal apophyses are without attached tendons (Figures 32, 35). *Pseudopostega* is the only opostegid genus known to differ from this basic type. In this genus the furcal apophyses extend to fuse with the secondary arms of the metafurcasternum (Figure 49), thus representing an independent parallelism to the similar condition that has developed in the Prodoxinae, Tischeriidae, and a few ditrysian families.

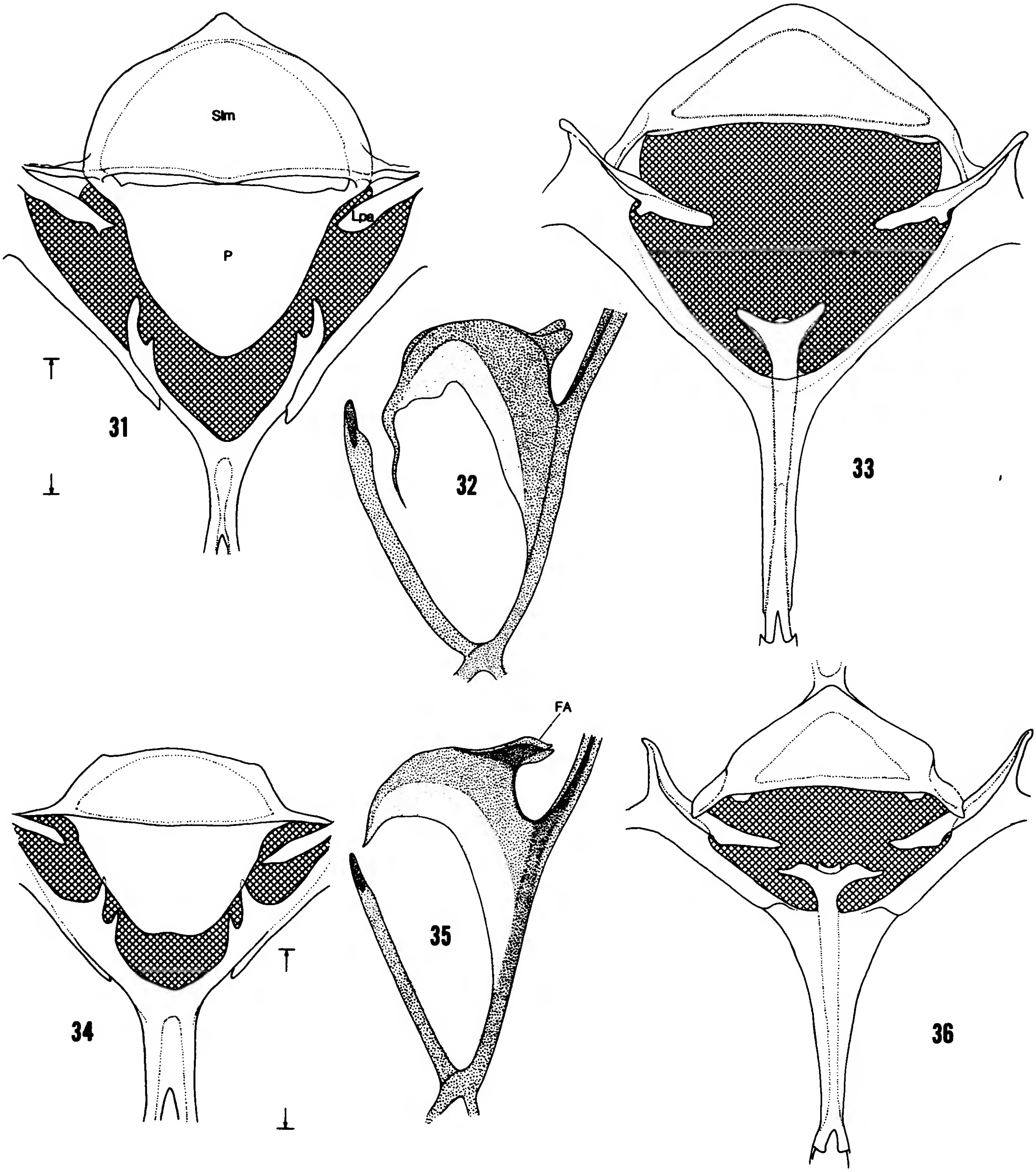
As previously mentioned, the wing venation of Opostegidae (Figures 25-30) is the most reduced of any fully alate moth. Only 3 to 4 unbranched veins are present in the forewing, accompanied by the complete absence of crossveins and closed cells. Greatest reduction has occurred in *Notiopostega* in which vestiges of only Sc, R, and M remain. The other genera also possess CuA, which arises from the base of M. In addition, *Pseudopostega bistrigulella* and probably other species possess a faint vestige of A. In no opostegid does any vein reach the apex or terminal margin. As is true in Nepticulidae (Braun, 1917), CuP is absent, as determined by stained preparations. What appears as CuP is the anal fold.

Over most of the forewing the scales are smooth and broad with smoothly rounded to serrate or dentate apices (Figures 202, 206). Little variation from this standard type occurs except for a few scattered piliform scales (Figure 208) usually obscured by the much broader scales. Ultrastructure of the broadest scales with serrated apices is relatively uniform, characterized by low ridges and often with minute perforations or windows in the upper lamella. The longitudinal ridges may surpass the terminal edge slightly, thus imparting a serrated appearance. Broad scales with sharply lobed or dentate apical margins frequently exhibit (Figures 202, 203) alternating high and low longitudinal ridges (i.e., ridge dimorphism) commonly observed in Hepialoidea (Kristensen, 1978) and Palaephatidae (Davis, 1986). The Opostegidae appear to be devoid of conspicuous sex scaling on the wings or elsewhere over the body that does occur in several Nepticulidae.

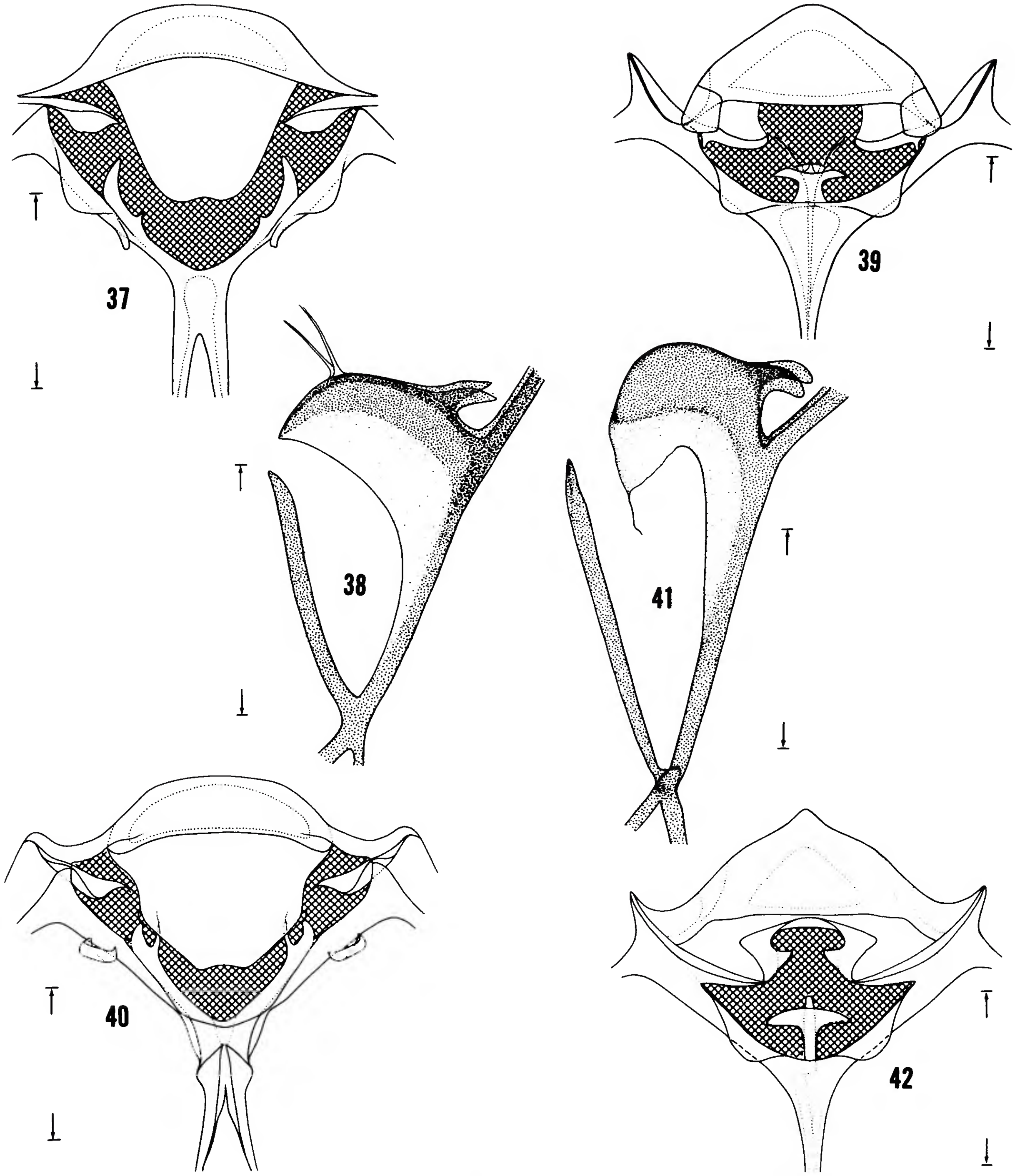
In contrast to most monotrysian families including the sister group Nepticulidae, the wings of Opostegidae possess only scattered remnants of microtrichia. Except for *Notiopostega* where they are sparsely scattered over the distal two thirds of both dorsal and ventral forewing surfaces (Figure 80), microtrichia are generally absent from the dorsal wing surfaces of Opostegidae. They are best preserved on the underside of the base of the forewing, especially in those areas largely devoid of scales in the subcostal region and along the hindmargin (Figures 140, 162, 200, 234). The latter intermesh with corresponding microtrichia on the metanotum to form a secondary wing-coupling mechanism (Common, 1969). The subcostal concentration of microtrichia is well developed in *Opostegoides* and *Opostega* but much less so in *Pseudopostega*. Microtrichia are typically absent from the ventral surface of the hindwing except for a small concentration along the extreme base of the subcostal vein. Microtubercules (Figure 82) likewise are restricted to certain wing areas, usually being most concentrated near the wing bases.

The primary wing-coupling mechanism in Opostegidae is remarkable in having lost the frenulum in both sexes. All that remains is a peculiar set of subcostal pseudofrenular setae, also present in all female and some male Nepticulidae. The presence of these modified pseudofrenular scales constitute one of several synapomorphies for the Nepticuloidea. As in the Nepticulidae, the pseudofrenular setae in Opostegidae arise in a single, closely set row (Figures 83, 209, 248, 249) ranging from as few as four to nearly 20 in number. These setae are stiff, slightly curved and either uncinate or twisted at the tip (Figures 84, 145, 205, 211). Detailed examination (Figure 85) reveals their basic scale morphology. The retinaculum in both sexes is the subdorsal type (Tillyard, 1918; Braun, 1924) formed by a row of subacute, rigid scales along the ventral base of the forewing medial vein (Figures 116, 117). The longitudinal ribs of these scales, like those involved in coupling functions that I have observed in other families, are without scutes (Figures 119, 120). The primary purpose of scutes on these ribs is to provide flexibility to the scale; their absence increases rigidity. Although the shelf-like ventral fold of the forewing costal margin (Figure 235) is beyond the reach of the pseudofrenular setae when the wings are extended, these setae could be partially accommodated in this cavity when the wings are folded at rest. The reflexed costal ridge could also represent a vestige of a once more prominent and functional subcostal retinaculum.

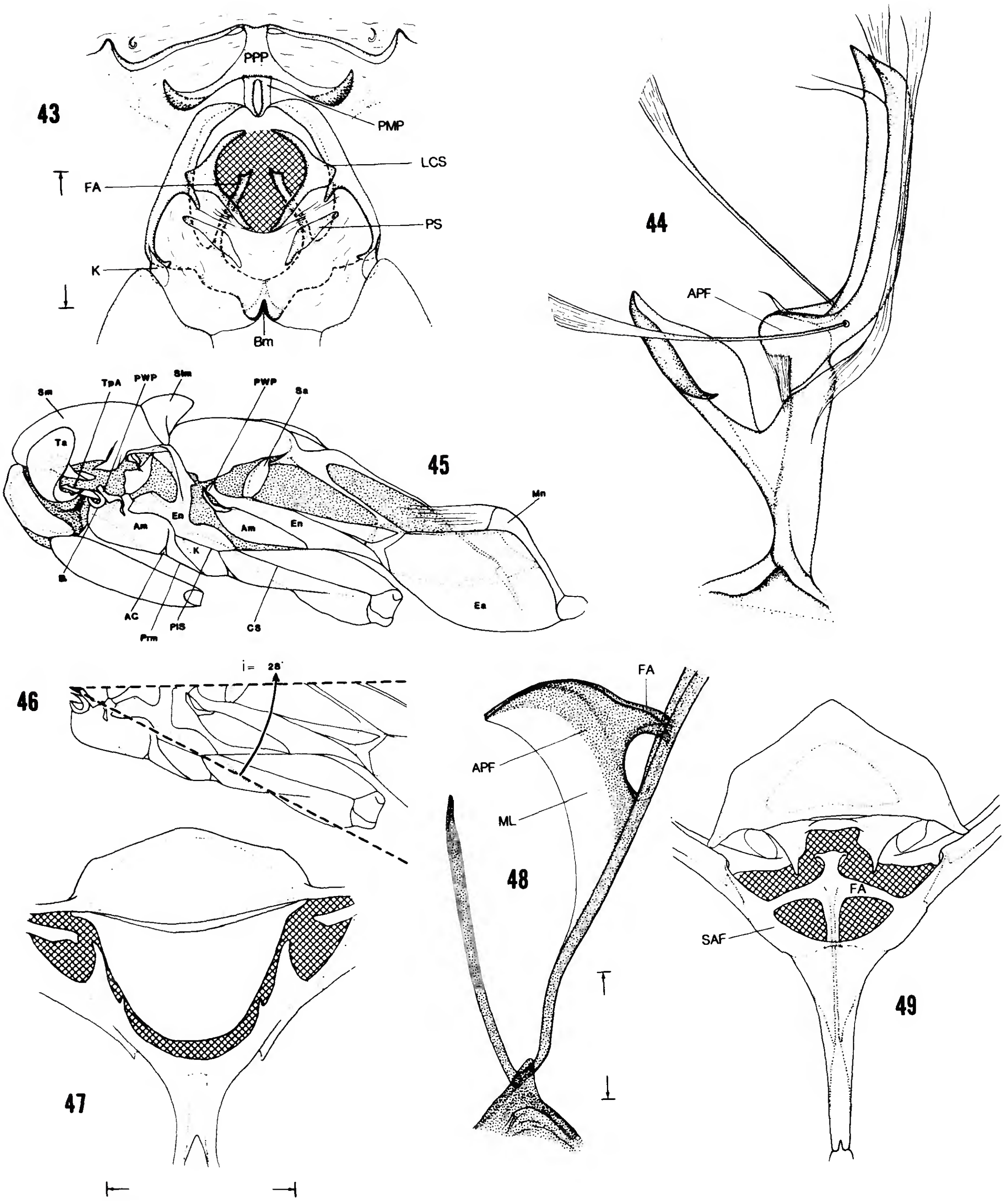
The legs of Opostegidae are uniform in structure throughout the family (Figures 50-55). The loss of the epiphysis and presence of semi-erect, spinose setae (modified scales; Figures 142, 199) are features shared with Nepticulidae. The mid- and hindtibiae are typical in possessing, respectively, one and two pairs of unequal spurs. The pretarsi of all legs are unspecialized in possessing simple claws, a moderately long, pseudempodial seta (Figure 86), a symmetrical pair of relatively large pulvilli, and a large arolium. The unguitractor plate is specialized and may constitute an autapomorphy for the family. In Opostegidae the transverse sections, or scutes, of the plate are undivided (Figures 88, 241), in contrast to the divided condition I have observed in all moth families examined thus far, including



FIGURES 31–36.—Thoracic structure. *Notiopostega atrata*, new species: 31, posterior view of mesothorax (0.3 mm); 32, lateral view of metafurcasternum; 33, posterior view of metathorax. *Opostegoides scioterma* Meyrick: 34, posterior view of mesothorax (0.3 mm); 35, lateral view of metafurcasternum; 36, posterior view of metathorax. (Scale lengths in parentheses.)



FIGURES 37–42.—Thoracic structure. *Paralopostega callosa* (Swezey): 37, posterior view of mesothorax (0.3 mm); 38, lateral view of metafurcasternum; 39, posterior view of metathorax. *Opostega salaciella* Treitschke: 40, posterior view of mesothorax (0.3 mm); 41, lateral view of metafurcasternum; 42, posterior view of metathorax. (Scale lengths in parentheses.)



FIGURES 43–49.—Thoracic structure. *Pseudopostega bistrigulella* (Braun): 43, anterior view of prothorax; 44, lateral view of mesofurcasternum; 45, lateral view of thorax; 46, measurement of angle of mesothoracic inclination from Figure 45; 47, posterior view of mesothorax (0.3 mm); 48, lateral view of metafurcasternum; 49, posterior view of metathorax. (Scale lengths in parentheses.)

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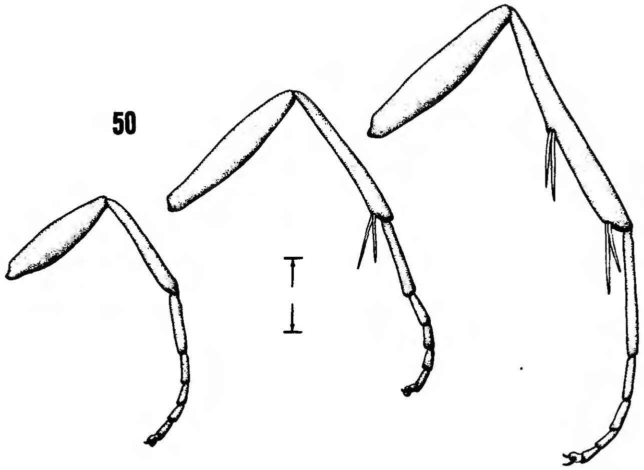

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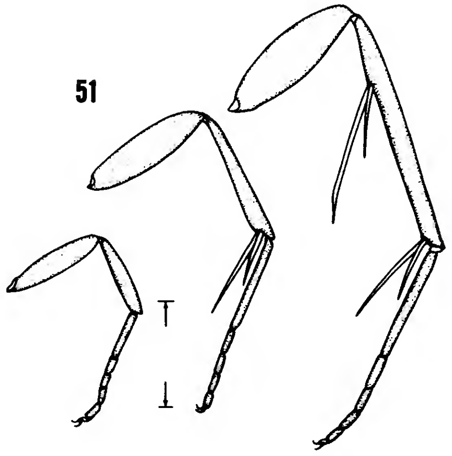

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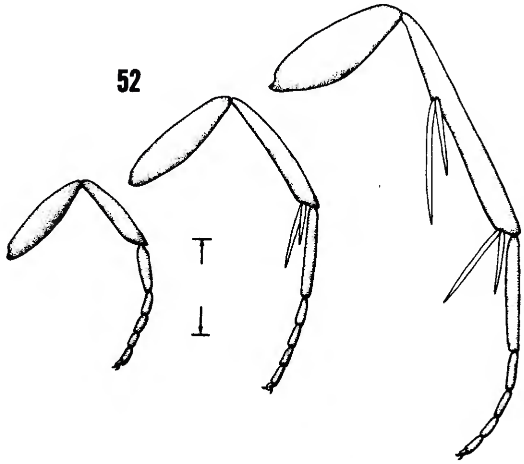

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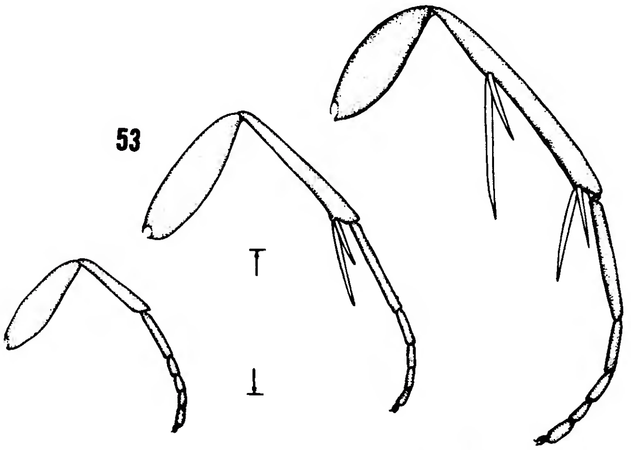

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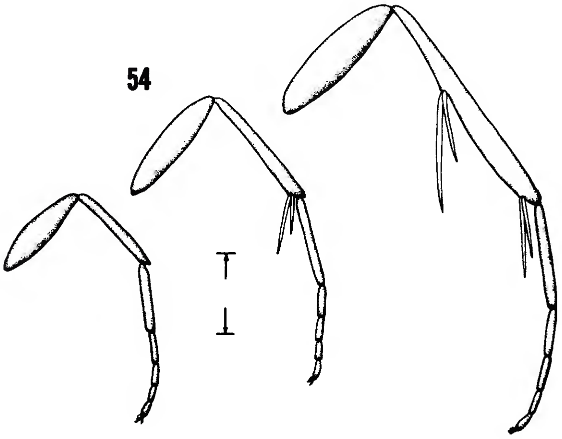

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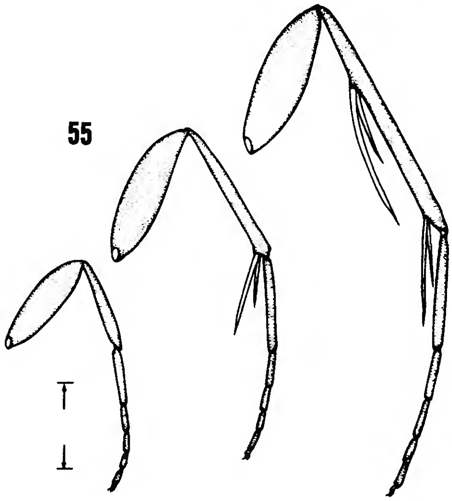


FIGURES 50–55.—Leg structure: 50, *Notiopostega atrata*, new species; 51, *Eosopostega issikii*, new species; 52, *Opostegoides scioterma* (Meyrick); 53, *Paralopostega callosa* (Swezey); 54, *Opostega salaciella* Treitschke; 55, *Pseudopostega bistrigulella* (Braun). (All scales = 0.5 mm.)

Nepticulidae. The unguitractor plate of Nepticulidae (Figure 18) resembles those of Eriocraniidae and Tischeriidae (Davis, 1986) in being relatively reduced with the scutes subdivided into two or three transverse ranks.

Abdomen: The abdomen in this family is relatively simple, without conspicuous sex scaling or sclerotized processes. Functional spiracles are present on A1–6 with faint vestiges sometimes persisting on A7 of the male. The first tergum (T1) resembles that of other Monotrysia, and the first sternum (S1) is lost as it is in all Lepidoptera above the homoneurous grade (Kristensen and Nielsen, 1980). A sclerotized tergal pleural connection (Kyrki, 1983) from T1 to S2 is absent in Opostegidae, but it is present in at least some Nepticulidae (Nieukerken, 1986). The second sternum (Figures 56–61) appears intact, without a distinct anterior fragment. It is generally weakly sclerotized with a pair of often interconnecting hyaline areas outlined by more sclerotized margins. The lateral margins tend to form somewhat variable, sinuate, or poorly defined anterolateral ridges (venula). Paired fenestrae are absent on S4 as they are in all Monotrysia except the females of most Nepticulidae (Davis, 1975b; Nieukerken, 1986). The last discernible tergite (A8) of the male abdomen is normally greatly reduced, usually consisting of a narrow transverse band. In one Australian group (genus A, Figure 290), this tergite is triangular, relatively large, and well set off from A7.

Kristensen and Nielsen (1980) found that the ventral diaphragm of *Opostega salaciella* differed considerably from all other non-ditrysian Lepidoptera examined. Throughout its length it comprises an almost solid sheet of close-set muscle fibers united by connective tissue that conceals the underlying nerve cord. The diaphragm is so extensive that it extends caudad to the terminal ganglion. Only two abdominal ganglionic masses occur in *O. salaciella* (Kristensen and Nielsen, 1981), compared to three in *Trifurcula* (Nepticulidae) and four in the Incurvarioidea. Because other species of Opostegidae have not been examined, it is unknown if these structures vary within the family.

Male Genitalia: The ninth abdominal segment typically forms a very narrow, complete ring in Opostegidae, without clear demarcation into a distinct tegumen (tergum) and vinculum (sternum). The ring is somewhat distorted in *Opostegoides*, but a complete ring is still maintained. The same segment in Nepticulidae can either be present as a complete ring, or separated into a distinct tegumen and vinculum (Scoble, 1983; Nieukerken, 1986). The anterior margin of the vinculum is smoothly convex in most species, but in *Opostegoides* and *Eosopostega* the margin is concave with prominent anterolateral projections in the latter that resemble the plesiomorphic condition present in numerous Nepticulidae and several homoneurous families.

Although many species have yet to be studied, it appears that some vestige of an uncus is preserved in Opostegidae, usually in the form of a narrow transverse band sometimes distinctly separated from the ninth segment. Usually more conspicuous is a pair of setigerous lobes (Figures 242, 297, etc.) that may represent socii (Eyer, 1963). *Eosopostega* is of interest in that it has preserved what is believed to be the plesiomorphic form (median and subacute) of the uncus (Figure 274), similar to that of the most primitive Nepticulidae.

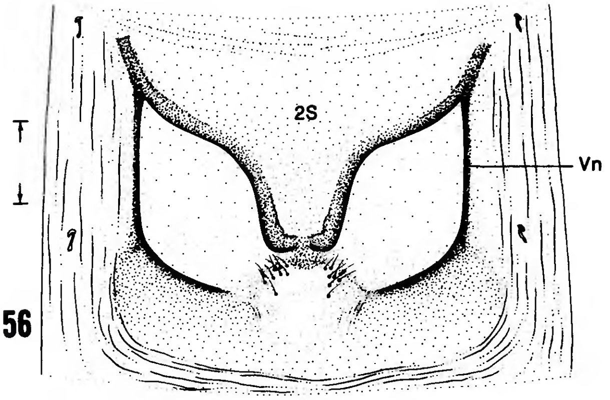
Frequently arising from the ventrocaudal margin of the ninth segment is a well-developed, somewhat complex sclerite (Figures 242, 281, 295, 299) variously termed the gnathos (Eyer, 1924; Pierce and Metcalfe, 1935), anellus (Eyer, 1963), gnathos-annellus (Eyer, 1967), and transtilla (Kozlov, 1985). Because of its definite association with the tegumen (Figures 287, 296) and only membranous connection elsewhere, as well as its dorsocaudal position to the aedoeagus (when present), I have considered this as the gnathos. It varies greatly in structure from weakly developed (*Notiopostega, Opostegoides*), weakly bifid (*Eosopostega*), or terminating in a strong, median process (*Opostega, Pseudopostega*). Eyer (1924) observed that the gnathos is strongly developed and supplied with a prominent median process in those opostegids that have lost a sclerotized aedoeagus. He probably concluded correctly that, in lieu of a normal intromittent organ, the gnathos has assumed this function.

The only occurrence of a true transtilla appears in a probable new genus of Australian species, which I refer to as "genus A." In two species examined, the transtilla consists of a pair of elongate, lateral sclerites weakly connected by a slender median bridge (Figure 289). It is intimately associated with the gnathos and, similar to the latter, lies dorsad to the aedoeagus.

A juxta (anellus of Pierce and Metcalfe, 1935) may be present or absent. When present it is normally in the form of a thin, broad plate ventrad to the gonopore or aedoeagus and partially fused to the vinculum. In *Pseudopostega* the juxta is reduced to a slender, median process. Although the juxta is sometimes closely associated with the gnathos (especially in *Opostega*), the two sclerites are entirely separated.

The most conspicuous feature of the opostegid valva is the pedunculate pectinifer (Janse, sensu latus, 1945; comb teeth, Pierce and Metcalfe, 1935). The pectinifer consists of a single transverse row of 16 to 59 blunt spines (Figures 243–245) compactly arranged along the distal margin of a prominent lobe that I refer to as the cucullar lobe (CL). Homologous pectinifers (either sessile or pedunculate) are also present in the Pectinivalvinae (Nepticulidae; Scoble, 1983), Heliozelidae, Adelidae (Nematopogoninae), Prodoxidae, and Cecidosidae. Pectinifers have also developed in a few genera of Gracillariidae.

Extending inward from the costal margin of the valva is a stout, often elongate process, which I have termed the costal apophysis (CA). In all genera except one, the costal margin of the valva continues in an almost straight line without interruption to the basal end of the apophysis (Figures 274, 284, 286, 295). One characteristic of the genus *Pseudopostega* is for the costal apophysis to be disarticulated from the valva as a



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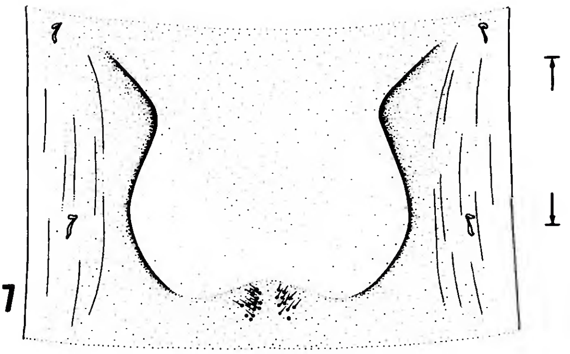

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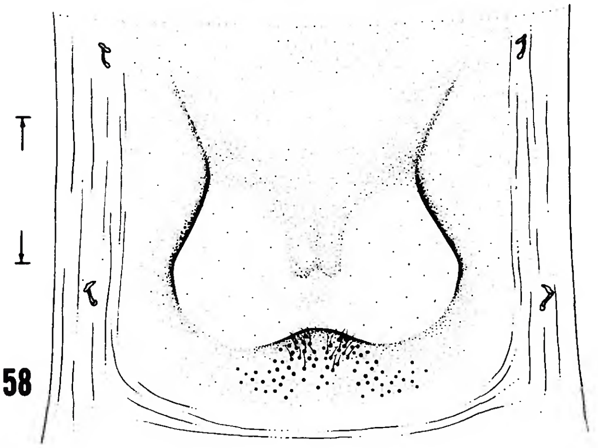

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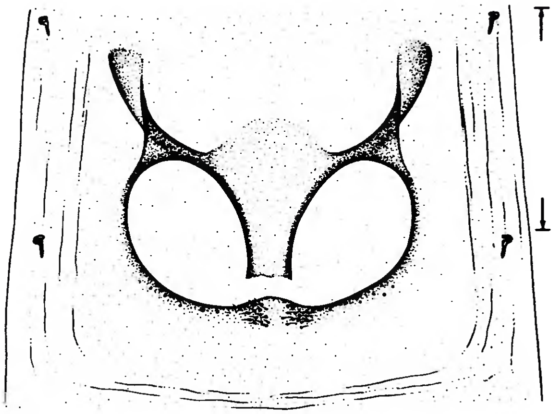

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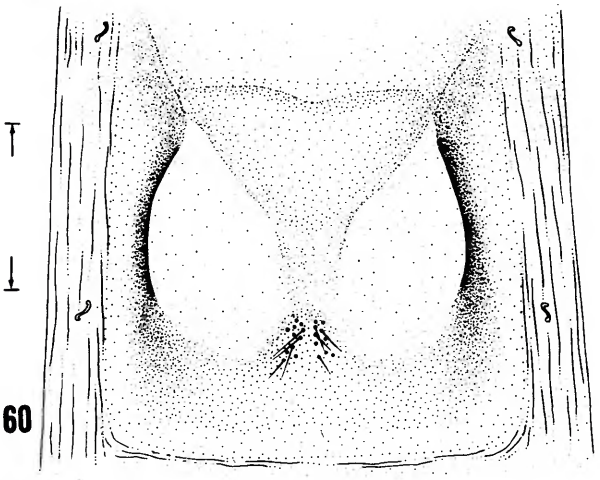

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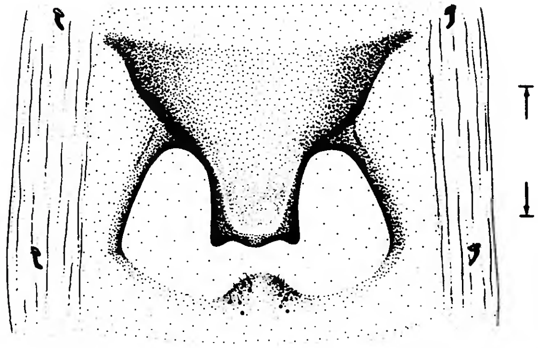

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FIGURES 56–61.—Ventral view of second abdominal sternum: 56, *Notiopostega atrata*, new species; 57, *Eosopostega issikii*, new species; 58, *Opostegoides scioterma* (Meyrick); 59, *Paralopostega callosa* (Swezey); 60, *Opostega salaciella* Treitschke; 61, *Pseudopostega bistrigulella* (Braun). (All scales = 0.25 mm.)

separate sclerite (Figures 297, 299, 301). From this sclerite arise two separate apophyses—a larger primary branch directed sharply anterior and a shorter secondary branch extending caudally to articulate with the anterolateral angles of the gnathos. It was probably this latter connection that prompted Kozlov (1985) to regard the gnathos as the transtilla. The similarly well-developed gnathos of *Opostega,* however, does not articulate with the valva.

An aedoeagus is either present or absent in Opostegidae. It is present in the more primitive genera (*Notiopostega,* an unnamed Australian genus ("A"), *Eosopostega, Opostegoides,* and *Paralopostega*) and absent in *Opostega* and *Pseudopostega.* In the latter two genera, the ejaculatory duct is usually elongate and undifferentiated (Figure 294).

Female Genitalia: For this discussion the female genitalia are interpreted as comprising the seventh abdominal segment together with the remnants of A8 and 9+10, and those portions of the internal reproductive system lined with ectoderm and thus preserved in KOH macerated preparations. As in Nepticulidae (Dugdale, 1974; Nieukerken, 1983), the relatively large seventh abdominal somite tends to envelope what remains of A8 through 10, thus often appearing (ventrally at least) as the terminal segment of the abdomen. Dugdale's reference (1974:136) to a large eighth segment sometimes present in Opostegidae actually was based upon a misidentified female of *Leucoptera spartifoliella* Hübner (Dugdale, 1988). The eighth tergite T8 is greatly reduced, usually preserved as a slender, dorsal band, and often supports a small pair of anal papillae (Figures 313, 315, 320). Arising subdorsally as they do from T8 or T9 in Opostegidae, these setose lobes may not be homologous to the anal papillae at the apex of T10 in ditrysian Lepidoptera. Erroneously believing the opostegid papillae to arise ventrally, Pierce and Metcalfe (1935) and later Eyer (1963) erred in calling these ostium pads. Anal papillae are known to be present in all Opostegidae except *Opostegoides,* but greatly reduced in *Notiopostega* and an unnamed Australian genus ("A"), with the female of *Eosopostega* still unknown. The eighth sternite is even more reduced than T8 in Opostegidae, with only vestiges evident in *Notiopostega* and *Opostegoides. Notiopostega* may be the only genus in this family with a partially sclerotized T9+10 preserved. One species of *Pseudopostega* from Dominica is atypical in possessing a relatively slender ovipositor (Figures 317, 318) with reduced anal papillae positioned far forward of the caudal end of the abdomen. To support the elongated ovipositor, this species has developed sclerotized, paired dorsal and ventral false apophyses within both the eighth tergum and sternum.

In some opostegid genera only the posterior apophyses remain, usually in the typical rod-shape form. In addition to posterior apophyses, *Opostega,* and to a lesser extent, *Paralopostega,* the Australian genus "A" and possibly *Notiopostega* possess a more lateral pair of shorter, stouter anterior apophyses that fuse with the eighth tergite as they do in Nepticulidae. Although the single pair of apophyses present in *Opostegoides* resembles the anterior pair just described (and were so named by Kuroko, 1982), I have interpreted these to represent the posterior pair (Figures 310, 311). The apophyses appear to extend beyond the eighth segment in *Opostegoides,* although this is difficult to discern.

The internal reproductive tracts generally agree with the non-ditrysian plan, particularly with the absence of the ductus seminalis and ventral junction of the common oviduct. The spermatheca is often disproportionately enlarged, usually arising well caudad from a membranous papilla. In some genera, especially *Opostegoides* and *Pseudopostega,* the typically intertwining afferent and efferent canals are intimately associated with the ductus bursae and may continue part way along its walls or even enter the bursa. In this regard, the internal morphology of female *Opostegoides malaysiensis* is particularly bizarre (Figure 309). The uniformly slender, efferent canal of this species arises from a distinct papilla immediately caudad to the vestibulum. The canal then proceeds anteriorly along the wall of the ductus bursae, as observed in a few other genera of Opostegidae. Beyond this point the spermatheca is modified like no other known insect. The efferent canal continues into a primary lobe of the corpus bursae and proceeds to spiral around its outer wall, constricting the girth of the bursa along the point of contact. Near the anterior end of the corpus bursae, the efferent canal enters the bursa where it becomes intertwined, in the normal lepidopterous manner, with the typically larger, more membranous afferent spermathecal canal. The latter is first evident inside the bursa at the caudal junction of the two lobes of the corpus bursae. It thus appears that the caudal ends of the two canals are well separated with the afferent canal possibly opening inside the corpus bursae. The afferent canal continues as a much convoluted tube down the center of the bursa to the anterior end of the latter where both canals converge. They then exit the bursa for some distance in the typical, intertwined association.

LARVA

As a result of numerous morphological specializations, the opostegid larva is one of the most interesting and complex larval forms in Lepidoptera. Because of this and also the fact that relatively little has been published on this group, I have tried to emphasize larval morphology, particularly with the inclusion of rather profuse SEM illustrations, in this review. The earliest and still one of the best studies of larval Opostegidae was by Heinrich (1918). The only significant reports since then have been an important paper by Kumata (1984, in Japanese) and a review by this author (Davis, 1987). The most recent discovery of note involving the larva of Opostegidae is that its development is hypermetamorphic to some degree. That is to say, the last larval instar (sixth?) differs significantly in morphology from all previous instars. Further details concerning this development are treated below as well as under the family and generic descriptions. Because little attention has been devoted to studies of immature larvae, it is not known if endophagous species of other families undergo a morphological change similar to that witnessed in Opostegidae. Pronounced hypermetamorphosis occurs throughout the Gracillariidae and Epipyropidae, and it would be of interest to investigate the more subtle developmental changes (e.g., labial modifications) in other families.

Head: The head structure of Opostegidae resembles no other moth larva, except very superficially the sapfeeding instars of Gracillariidae. In quite simple terms, the head capsule resembles a flattened cylinder with a much reduced set of mouthparts projecting beyond the anterior rim (Figures 90, 96, 101). The head is roughly triangular in shape, tapering somewhat anteriorly. Some of the most conspicuous features of the head capsule are the internal ridges, which consist of at least three sets: (1) the relatively broad, flat, adfrontal ridges (AR) that diverge slightly to the rear margin of the head where they articulate with the caphalic apophyses (CA); (2) a similar pair of ventral, hypostomal ridges (HR); and (3) the lateral ridges (LR) on either side of the head. At their caudal ends the lateral ridges divide to form more slender ridges that border the dorsal and ventral caudal margins of the head capsule to articulate with the posterior ends of the adfrontal and hypostomal ridges respectively. In addition, a somewhat abbreviated midventral ridge is conspicuous in *Opostegoides*. Between these ridges and posterior to the stomal ring (epistoma + pleurostoma + hypostoma), the cranial cuticle is thin and lightly sclerotized. The cranial apophyses are unique structures, probably analogous to the broad, nonarticulated projections arising caudally in the sapfeeding instars of Gracillariidae, which extend into the prothorax. Also extending into the prothorax is a pair of strong tendons that arise from the posterior end of the lateral ridges.

The chaetotaxy of the head is greatly reduced, with most setae lost. The precise homology of some of the remaining setae is questionable. Dorsally, only F1, C1, S1, and A1 are present in the final instar of all genera studied. C1 is present in *Opostegoides minodensis* but absent in *O. scioterma*. L1 is present in *Notiopostega* and *Opostegoides* but absent in *Paralopostega*. Ventrally only two cranial setae, SS1 and SS3, remain and these are present in all genera. In general, the chaetotaxy of immature (i.e., pre-ultimate instars) and mature larvae are similar except the relative sizes of the setae are much more reduced in the former.

The larval antennae of Nepticulidae and Opostegidae are very similar in structure. As shown by Heinrich (1918), the opostegid antenna is believed to be two-segmented, although the basal segment is difficult to observe and may be mostly membranous. Heinrich recognized a third segment in *Paralopostega*, that I have interpreted as a relatively simple but greatly enlarged basiconic sensillum (Figures 179, 191). My decision regarding the latter is based upon the similar, minutely pitted surface structure of this organ (Figure 180) as compared to the sensilla of other genera. Furthermore, if Heinrich's assertion was true, then such sensilla would have to be considered absent in this genus, which seems most unlikely. Both *Notiopostega* and *Opostegoides* possess very similar antennae bearing four much smaller basiconic sensilla of various sizes. Arising near the apical rim of the second segment are two elongate tactile sensilla of equal lengths. These are undoubtedly homologous to a similar pair in Nepticulidae.

Although Heinrich (1918) states there to be no traces of either ocellar pigment or lenses, a single unsually well-defined stemma is present in all genera (Figures 99, 178). Because of its extreme anterolateral position on the flattened head, the stemma is virtually impossible to detect without scanning electron microscopy.

The labrum is reduced in Opostegidae and bears two normal setae, M2 and 3, with the most lateral (M3) always the longest. These are probably homologous with the two pairs of labral setae typically present in Nepticulidae. The labrum is relatively unmodified in *Notiopostega* but deeply divided in *Opostegoides* and *Paralopostega*. Along the anterior margin of the labrum arise variously modified setae—a slightly more dorsal row (La 1–3) and a ventral row of three epipharyngeal setae (Figures 93, 132, 171). La 1–3 are spinose in *Notiopostega* and more simply lobed in *Opostegoides* and *Paralopostega*. The labrum and setae of the pre-ultimate instars of *Opostegoides minodensis* are much more reduced than those of the final instar (Figures 118, 132). In *Paralopostega*, development of the labrum does not appear to differ between instars.

The mandibles are unique among Lepidoptera in possessing a single enlarged, spinose seta (Figures 100, 127, 181) possibly in all instars, although no first instar larva has been examined. Heinrich suggests its function is that of a brush to sweep small particles of food into the mouth, or to clean the dorsal surface of the lower mouthparts. The mandibles are distinctly flattened, with 4–6 cusps.

Like most of the mouthparts, the maxilla is somewhat reduced. In *Opostegoides minodensis* reduction is even more pronounced in the pre-ultimate instars (Figure 135), but not so in *Paralopostega* (Figure 176). The last instar maxilla of the three genera studied appear quite similar with a densely spinose galea and a relatively simple palpus that lacks apical sensilla (Figures 95, 124). The palpus is probably consistently two segmented, although it is difficult sometimes to distinguish the smaller second segment from the unusually long apical segment. The palpiger is without setae, and the stipes bears two stout apical setae arising close together.

Of all the organs of the head, the labium changes the most during the transformation to the final instar. In all instars much of the labium, especially the postmentum, lies hidden beneath the hypostoma. Largely as a result of this, the normally elongate labial setae (La) are reduced to minute stubs. The mature larva possesses a tubular spinneret that is equally well developed in all genera. Heinrich (1918) described and illustrated a reduced spinneret in a Hawaiian *Paralopostega*, but it is evident from his figure that what he examined was in fact a pre-ultimate stage that lacks a spinneret. Likewise, the labial palpus agrees in all genera in possessing an extremely short, squat, basal segment with a single stout, elongate seta approximately two-thirds the length of the spinneret (Figures 95, 125, 189). From the anterior rim of the prementum (labial stipes) along the inner side of each palpus arise a pair of relatively large premental setae. All instars prior to the last lack labial palpi, premental setae, and a spinneret. *Paralopostega* possesses a relatively large opening to the labial gland, which is normally closed by a semicircular to triangular flap of tissue, or labial operculum (Figures 175, 177). The presence of a similar opening was not apparent in the single immature larva of *Opostegoides minodensis* available, which agrees with Kumata's illustration (1984, fig. 18) showing no aperature present.

The ventral closure of the head in Opostegidae involves totally different sclerites than that present in the sapfeeding instars of Gracillariidae. In the latter, much of the venter of the head consists of the postmentum with the paired hypostomal sclerites extremely reduced, well separated, and positioned near the rear of the head (Jayewickreme, 1940). It is uncertain as to what sclerites comprise the venter of the opostegid head, but none involve the labium. The triangular plates of the hypostoma (H) are thickened and pushed so far forward that they project on either side of the labium (Figures 94, 112, 159). Midventrally the paired plates do not fuse to form a continuous bridge but merely touch. No ventral sutures are apparent but the longitudinal, slightly divergent hypostomal ridges are conspicuous as well as a shortened, midventral ridge of uncertain homology present in some genera. Heinrich (1918) considered the midventral region between the hypostomal ridges and caudad to the hypostomal plates to be the gula. This sclerite is not known to occur in Lepidoptera, except perhaps in some hesperiid larvae (Gerasimov, 1952). The cuticle between the hypostomal ridges is the thinnest of the entire head, appearing membranous in most preparations. Perhaps no sclerite is represented but instead only membrane derived from the hypostomal ridges and cervical region. Heinrich also refers to a "hole" in the hypostoma that does not exist. As he correctly surmises, this is the epicranial fossa (EF), a socket into which the mandibular condyle articulates. Relying solely upon standard slide dissections, one can mistake this well-defined cavity as an opening to the outside. SEM photographs (Figures 94, 120, 148) clearly show it to be closed ventrally.

Developments involving the tentorium are the most puzzling of all the structures in this strange head. As Heinrich discovered, the tentorial bridge in Opostegidae has become greatly modified to form a complete, well-sclerotized ring situated near the rear of the head (Figure 113). The anterior tentorial arms (ATA) extend closely parallel or even slightly convergent all the way forward to the midcaudal margin of the epistoma, in contrast to their normal insertion midway along the adfrontal suture in other Lepidoptera. Also extending anteriorly from the tentorial ring to the hypostoma is a pair of less rigid, more ventral apophyses (MTA?) that may represent the metatentorium of Gerasimov (1952). Extending posteriorly from the ring into the prothorax are two pairs of elongate tendons.

Thorax and Abdomen: The only conspicuous sclerotization over the body consists of a pair of slender, elongate pronotal sclerites similar to those present in Nepticulidae. The body form is extremely slender and apodal (Figures 89, 157). The only locomotory organs are paired ambulatory callosities on the venter of the meso- and metathorax, which appear capable of some inflation (Figures 106, 107, 153). Although the body setae are somewhat reduced in number, especially over the abdomen, most setae tend to be extremely elongate in the last instar. Body setae in the penultimate (fifth?) instar are much reduced in length. This was confirmed in one specimen of *Paralopostega callosa* in which the last instar was observed emerging from the penultimate exuvium. In some early instars the body appears almost naked except for minute, transverse, ridge-like spines (Figures 136, 183) most prevalent over the venter of the thoracic segments and first eight abdominal segments. Ridge spines appear to be present in all pre-ultimate instars but absent in the last instar. First instar larvae, however, were not examined. The integument of the final instar is usually densely covered with minute spines (Figures 104, 129, 130).

Systematic Relationships

The Opostegidae are somewhat of a phylogenetic paradox. Although decidedly primitive with regard to basic morphology, the members of this family demonstrate some of the most extreme specializations of any Lepidoptera. The general monotrysian morphology of the female reproductive system unequivocally positions this taxon among the more primitive non-ditrysian moths. Their wing venation, however, is the most reduced of any moth capable of flight. Similarly, the larva possesses a number of unique specializations that makes this form one of the most distinctive immatures among Lepidoptera.

The genus *Opostega*, derived from the Greek *opos* (eye) plus *stege* (roof), was proposed by Zeller (1839) for three European species recognized principally by their enlarged antennal scape that covers the eye. Until recently (Kozlov, 1985) no additional generic names had been added in this cosmopolitan complex, a period of nomenclatural conservatism unparalleled in the history of Lepidoptera systematics. Believed originally to be a member of the Tineidae, the placement of this taxon has fluctuated among at least four families within both Monotrysia and Ditrysia (Zimmerman, 1978). Meyrick (1893:479) first recognized the complex as a distinct group by proposing Opostegides as a subdivision of the family Tineidae. Later Meyrick (1895) placed *Opostega* near *Stigmella* (= *Nepticula*), a general relationship that has persisted down to the present and one which is no longer debated.

Although the monophyly of the Nepticulidae and Opostegidae is now firmly established (Scoble, 1982, 1983; Minet, 1984; Nielsen, 1985; Davis, 1986; Kozlov, 1987), their relative position within the suborder Glossata has recently been questioned (Minet, 1984). Criticism of Minet's proposal to consider the Nepticulina (Nepticulidae + Opostegidae) as more primitive than either Exoporia or Incurvariina has already appeared (Kristensen, 1984; Davis, 1986; Nieukerken, 1986) and will be only briefly mentioned here. Minet excluded Nepticulina from the Eulepidoptera (Incurvariina + Etimonotrysia (Tischeriidae) + Ditrysia) on the basis of their reduced prosternum (incomplete precoxal bridge) and lack of a cuticular subcostal retinaculum. The precoxal bridge is completely absent in the most primitive families below the heteroneuran grade. In Nepticulidae (the most plesiomorphous member of the Nepticuloidea) the precoxal bridge is clearly evident but incomplete (Minet, 1984, fig. 8). No connected bridge remains in Opostegidae (Figure 43; Minet, 1984, fig. 7), but a precoxal sclerite does persist, which I interpret as representing further reduction of this structure. In other words, I consider the conspicuous reduction of the precoxal bridge in Nepticuloidea as a secondary specialization (i.e., regression) and not the plesiomorphic condition.

A subcostal retinaculum typically consisting of a flap-like cuticular extension of the wing is the plesiomorphic condition in the frenate moths (Eulepidoptera). In the Nepticuloidea, a functional, subcostal retinaculum is present only in the males of Nepticulidae where it consists of a dense cluster of curved, rigid scales (Braun in Forbes, 1923). In addition, Braun also observed in some Nepticulidae a slight flap-like outgrowth or overfolding from the subcosta in the area of the retinacular scales. A similar ridge-like fold is also present in Opostegidae (Figure 235), even though the frenulum has been lost in both sexes in this family. A retinaculum similar to the nepticulid type has developed independently in the Gracillariidae. As in the Nepticulidae, the retinaculum of the male gracillariid consists of a slight subcostal fold from which arises a series of stout, curled scales (Figures 23, 24), which grasp the frenulum. Consequently, similar to the prosternum, the polarity of the entire wing-coupling mechanism in Nepticuloidea appears to indicate secondary reduction within the Monotrysia from the plesiomorphic form in Incurvariina to the most derived type in Opostegidae.

Another plesiomorphy attributed to the Nepticulidae that supposedly differs from the condition in other frenate moths is the retention of a jugal lobe (fibula), as reported by Braun (1919; in Forbes, 1923): "present in females of the more primitive genera." Braun (1924) later repeats the same observation and illustrates a female forewing of *Ectoedemia heinrichi* to show the "fibula." A well-defined jugal lobe comparable to that found in Eriocraniidae or Hepialidae is not present in the females (nor males) of *E. heinrichi* that I have examined, although a minute cleft at the termination of the jugal fold (Figure 22), as also shown by Braun, does exist. Undoubtedly too much phylogenetic importance has been placed on Braun's dubious statement. Hennig (1953, fig. 9), for example, relied principally upon this character in his separation of Nannolepidoptera (Nepticuloidea) from the Eulepidoptera. Minet (1984:145) likewise emphasized the phylogenetic significance of the jugal "lobe" in Nepticulidae. Considering the uncertainty of Braun's observations (Scoble, 1979) together with Sharplin's (1963) detection of the jugal fold in all Monotrysia as well as in some Ditrysia, the significance of this character diminishes appreciably.

I have recognized the monophyly of the Monotrysia principally on the similar, derived morphology of the metafurcasternum (Davis, 1986). The conservative morphology of this complex structure and its general lack of diversity at the species and often generic level has been observed previously (Brock, 1971). The metafurcasterna of the Incurvarioidea, Nepticulidae, and Palaephatidae are all remarkably similar and quite distinct from that characteristic of the Dacnonypha and Exoporia. Various modifications of the basic monotrysian form occur in Prodoxidae, Cecidosidae, Opostegidae, and Tischeriidae.

Within the division Monotrysia, all superfamilies are remarkably distinct, unequivocally monophyletic, but exhibit few shared features with adjacent outgroups. Consequently, the relationships of the four superfamilies are still uncertain because of the paucity of undisputed synapomorphies. Among these isolated groups, the affinities of the Tischeriidae (Tischerioidea) are the most uncertain. Their sister group position to the Nepticuloidea (Davis, 1986) has been largely determined on regressive characters that could represent convergences among paraphyletic groups. The females of Tischeriidae appear to share at least two synapomorphies with Palaephatidae, including (a) reduction of the female frenular setae to 2–4, and (b) the presence of a medial ridge at the caudal apex of A10. Because the tischeriid ovipositor ridge lacks campaniform sensilla, its true homology with the sensory ridge in Palaephatidae had been questioned (Davis, 1986).

The Opostegidae has recently been partitioned by Kozlov (1987) into two subfamilies, Opostegoidinae and Oposteginae. The justifications for these subdivisions are in part based on the presence of an aedoeagus, reduction of the anal papillae, and particularly upon the more plesiomorphic condition of the three sets of muscles within the male valvae of *Opostegoides*. Kozlov found these muscles (m3, m5, and m6) all present in Nepticulidae, Tischeriidae, and *Opostegoides minodensis*, but reduced (m5 and m6 absent) in *Opostega kuznetzovi*. The establishment of subfamilies based on the foregoing characters may be somewhat premature, because the composition of the "Opostegoidinae" is more complex than envisioned by Kozlov. The Hawaiian *Paralopostega*, for example, possess an aedoeagus as well as anal papillae. It would appear that the relative development of the valvar musculature would hold true for most of the genera not examined by Kozlov if what he has stated is correct: that the muscles lacking in *Opostega kuznetzovi* (m5, m6) are those involved with movement of the aedoeagus, which is absent in both *Opostega* and *Pseudopostega*. The development of these muscles in *Paralopostega*, whose aedoeagus is reduced, remains a question.

Phylogeny of Opostegidae

A cladogram of the Opostegidae is proposed in Figure 62. Synapomorphies 1 through 9 are those summarized by Davis (1986:59, numbers 22–30). The major features of Nepticulidae were recently reviewed by Scoble (1983) and Nieukerken (1986). The relative isolation of Opostegidae is reflected in the large number of synapomorphies (numbers 10–28) known, of which only the most diagnostic are listed. A majority of these structures are autapomorphies within the Monotrysia and several are unique within the Lepidoptera. The first eight synapomorphies (10–17) for Opostegidae refer to the highly modified larval stage; numbers 16 through 28 represent adult structures.

10. *Ecdysial line absent in all instars.* The practical result of this specialization is that the head capsule does not split during final ecdysis (Hinton, 1948) but is instead shed intact anteriorly.

11. *Adfrontal ridges reduced (i.e., flattened) and divergent posteriorly.* Autapomorphic. In other Lepidoptera these project as internal ridges that converge on or before the epicranial notch or are connected posteriorly by a transverse ridge (as in Nepticulidae).

12. *Articulated, cephalic apophyses present.* Autapomorphic. These structures are not known to occur in any other lepidopterous larva.

13. *Lateral ridge present.* Autapomorphic. A similar thickened ridge along the side of the cranium is not known elsewhere in the order.

14. *Hypostoma situated at anterior rim of head capsule.* Autapomorphic. This constitutes the most anterior development of the hypostoma in Lepidoptera.

15. *Tentorial bridge modified to form a sclerotized ring.* Autapomorphic within Lepidoptera.

16. *Spinneret absent in all instars except last.* Possibly autapomorphic within the Monotrysia but needs to be studied in other families, particularly Nepticulidae.

17. *Mandible with one spinose seta.* Autapomorphic within Lepidoptera.

18. *Wing venation reduced with all veins simple and unbranched.* Autapomorphic within Lepidoptera.

19. *Microtrichia reduced.* In Nepticulidae the plesiomorphic condition prevails in that these minute spines are densely scattered over the membranes of both fore- and hindwing (Scoble, 1983). Microtrichia are largely restricted to the ventral base of the forewing in Opostegidae.

20. *Frenulum lost in both sexes.* A single compound frenulum, coupling with a subcostal retinaculum, is preserved in the males of Nepticulidae (Braun, 1924; Scoble, 1979).

21. *Subcostal retinaculum lost.*

22. *Antennal flagellum typically with three sets of sensilla ascoidea per* segment. Autapomorphic.

23. *Antenna without sensilla coeloconica.* These are present in a somewhat reduced state in Nepticulidae.

24. *Precoxal bridge reduced to a small, free precoxal sclerite.* An incomplete precoxal bridge is present in Nepticulidae (Minet, 1984).

25. *Pretarsus with unguitractor scutes undivided* (i.e., one scute per rank). Each transverse rank of these scutes is subdivided into 2 or 3 rows in Nepticulidae. Autapomorphic.

26. *Ventral diaphragm forming a nearly solid sheet of fibers across nerve cord* (Kristensen and Nielsen, 1980). Autapomorphic. This feature and the following are based on examination of only one species of Opostegidae.

27. *Caudal nerves of terminal nerve cord ganglion with elongate common* stem (Kristensen and Nielsen, 1981).

28. *Pectinifer of male genitalia supported on elongate pedicel.* A very generalized, sessile pectinifer is present in the most primitive Nepticulidae, Pectinivalinae (Scoble, 1982, 1983).

The southern temperate, monotypic genus *Notiopostega* is the most dinstinctive taxon in the family. The principal characteristics of the genus are as follows:

29. *Compound eye reduced in size.* This and the following character in association with the uniformly dark pigmentation of *Notiopostega atrata* are probably adaptations for a primarily diurnal, early seasonal habit. The relatively larger eye present in Nepticulidae and all other Opostegidae is believed to represent the plesiomorphic condition.

30. *Antennal scape reduced.* The scape is greatly enlarged in all other Opostegidae and in all Nepticulidae except for a few of the most derived genera.

31. *Transverse occipital ridge present.* All other Opostegidae possess smoothly rounded crania.

32. *Scale vestiture of scape randomly scattered.* The plesiomorphic condition in other Opostegidae and Nepticulidae is for these scales to be arranged in definite rows.

Synapomorphies linking the remaining five genera are uncertain, in part due to the absence of larval material. Immatures for three (*Eosopostega, Opostega,* and *Pseudopostega*) of the five genera are unknown. Based on larval information of *Opostegoides* and *Paralopostega*, the following apomorphies may apply to all last instar larvae of this clad.

33. *Larval labrum divided.*

34. *Epipharyngeal setae of larval labrum digitate.*

35. *Larva with chaetotaxy of A9 reduced* (SV1 absent).

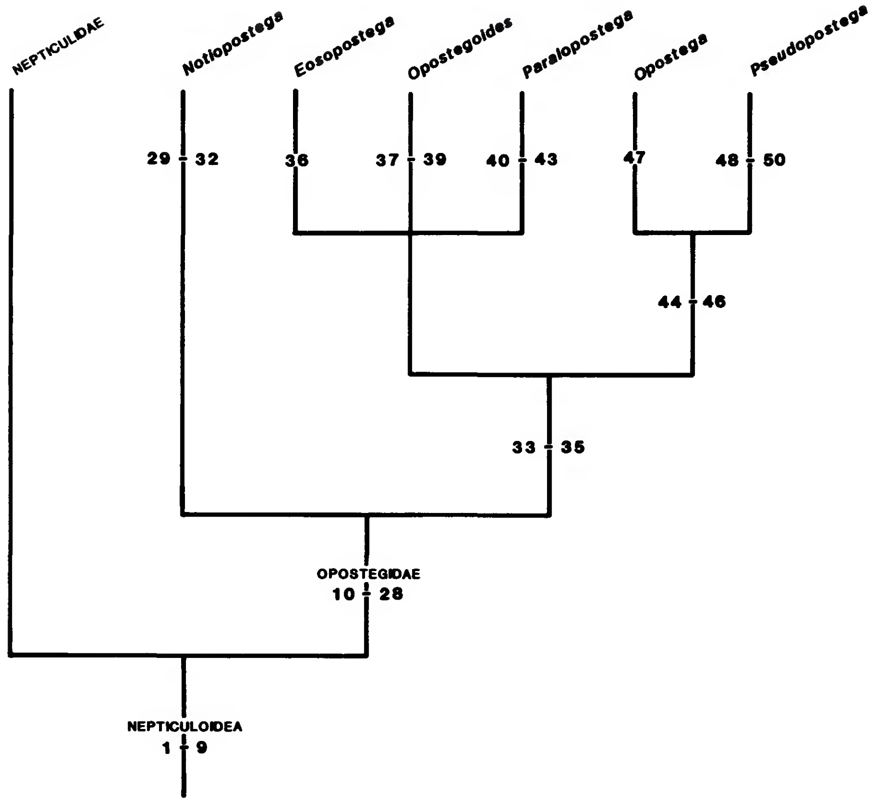


FIGURE 62.—Hypothetical phylogeny of the genera of Opostegidae. Numbers 1 through 50 refer to apomorphic character states described in text.

It has not been possible to determine the precise relationships of what are believed to represent three of the four most primitive genera. Although the larval stage appears most informative in this regard, the larva of *Eosopostega* is unknown. The leafmining habit and presence of a labial operculum in the early instars could be characteristics of *Paralopostega*, or these features may eventually be found to occur widely through the family. The three genera are best separated on the basis of male genital morphology, but these characters exhibit some homoplasy (as they frequently do in Lepidoptera) and are difficult to polarize. The most characteristic features of these genera are as follows:

36. *Uncus attenuated into a subacute, simple process.* The uncus in *Eosopostega* resembles the plesiomorphic form in Nepticulidae. The typical condition for this structure in Opostegidae is for it to be reduced and relatively truncate.

37. *Pedicel of pectinifer greatly extended.*

38. *Gnathos extremely reduced to a slender transverse band.* The reduction of the gnathos in *Opostegoides* parallels that in *Notiopostega*. In Nepticulidae, the gnathos is normally well developed but can be secondarily reduced or absent in a few species (Scoble, 1983).

39. *Female with anal papillae absent.* Dorsal anal papillae are present in all other Opostegidae although greatly reduced in *Notiopostega.*

40. *Valva with distal end attenuated far beyond base of pedicel.* Similar valvae occur in some Australian species that are not congeneric with *Paralopostega.*

41. *Aedoeagus reduced.* In *Paralopostega* the aedoeagus is less than half the length of the valva compared to usually equal to the length of the valva in other genera with this organ.

42. *Juxta V-shaped, tapering toward vinculum.* In *Opostegoides* the juxta is broader at its base.

43. *Larval antenna with number of basiconic sensilla reduced to one large cone.* The antenna of *Notiopostega* and *Opostegoides* are similar in possessing four much smaller sensilla.

As first noted by Eyer (1924) the Opostegidae can be subdivided into two groups, those members with an aedoeagus and those without. The absence of an aedoeagus, associated with a pronounced development of the gnathos, characterizes *Opostega* and *Pseudopostega*. This division probably agrees with Kozlov's (1987) recognition of two subfamilies (Opostegoidinae and Oposteginae), although it has not been determined if the valvar muscles of the other genera with aedoeagi agree with the pattern observed in *Opostegoides*.

44. *Aedoeagus lacking.*

45. *Male genitalia with muscles m5 and m6 absent* (Kozlov, 1987).

46. *Gnathos enlarged, typically with an attenuated or furcate median process from caudal margin.* In this clad the relative development of the gnathos exceeds that attained in any other opostegid or nepticulid.

Although *Opostega* and *Pseudopostega* are easily distinguished, a few of the diagnostic characters for *Opostega* (e.g., the presence of anterior apophyses in the female ovipositor) could be plesiomorphic. The development of the juxta, however, differs from all other genera except *Paralopostega*, where it is believed to represent an independent, convergent development.

47. *Juxta a broad plate, narrowing toward vinculum.*

Monophyly of *Pseudopostega* is well documented by the following:

48. *Metafurcal apophyses fused to secondary arms of metafurcasternum.* Except for Tischeriidae and most prodoxine genera, the metafurcal apophyses project free in Monotrysia (Davis, 1986).

49. *Basal apophysis of valva in male genitalia separate from valva.* This basal articulation may be unique within Lepidoptera. In all other Monotrysia, at least, similar apophyses (when developed) are continuous with base of valva.

50. *Juxta reduced to a slender midventral spur or absent.* In *Opostega* the juxta forms a broad, thin plate.

OPOSTEGIDAE Meyrick, 1893

OPOSTEGIDES Meyrick, 1893:479.

TYPE GENUS.—*Opostega* Zeller, 1839.

ADULT.—Mostly white moths, rarely light brown or fuscous, ranging in general size from extremely small to moderately small, with a forewing length of 1.8 mm to 8.3 mm. Antennal scape normally greatly enlarged, usually exceeding diameter of eye; flagellomeres with three sensilla ascoidea per segment. Wings lanceolate; venation extremely reduced with no branched veins; microtrichia generally absent except on the underside of the base of the forewing. Frenulum absent in both sexes but with 5-18 stout pseudofrenular setae. Male genitalia either with or without aedoeagus. Female genitalia of the monotrysian type, with a single genital opening and ventral oviduct.

Head: Vestiture variable; vertex typically rough with erect piliform scales possessing minutely bidentate apices; most of frons and top of cranium posterior to vertex covered with broad, flat scales possessing 3-5 dentate apices. Lower frons naked except for a variable scattering of microtrichia. Cranium usually round, with a bicrenulate ridge in *Notiopostega*. Antenna filiform, elongate, 0.7-0.9 the length of forewing, 46-85 segmented; scape usually greatly enlarged (reduced in *Notiopostega*), varying in maximum width from 0.76 to 1.5 × the vertical diameter of eye; vestiture of scape variable; scales broad, flat, and usually arranged in 7-12 compacted rows (scattered in *Notiopostega*); pedicel (2nd flagellomere) with scattered scales and without specialized sensilla; all other flagellomeres distad usually with a single band of slender, deeply bidentate scales per segment, each band actually composed of a dense cluster of 3-5 scales arranged longitudinally; all flagellomeres distad to pedicel except apical segment with three sets of sensilla ascoidea—a basal, lateral pair and a single apical one dorsally; each sensillum typically palmately branched, with 4-10 branches, rarely unbranched; sensilla coeloconica absent. Compound eye small to large; interocular index 0.5-1.2; eye index 0.6-1.1; microsetae absent from eye. Ocellus absent. Pilifer absent. Tentorium without dorsal arms. Mandibles absent. Maxillary palpus elongate, geniculate, 5-segmented with penultimate segment the longest; apex of fifth segment simple, with 2-4 elongate sensilla chaetica. Haustellum generally short, less than maxillary palpus in length and 0.75-1.5 × the length of labial palpus. Labial palpus 3-segmented, short; apical segment with a terminal sensory pit containing approximately 20-30 slender, grooved, chemosensilla.

Thorax: Depressed, relatively broad. Prosternum reduced to a slender intercoxal lamella; precoxal bridge absent but with vestigial precoxal sclerite. Mesofurcasternum with furcal apophysis paired and moderately developed; inner apophysis considerably smaller, approximately 0.2-0.5 the length of lateral pair. Anteromedial process of metafurcasternum with anterodorsal ridges poorly developed and without conspicuous tendons; furcal apophysis usually short, free, and directed dorsocaudally, fused to secondary arm of metafurcasternum in *Pseudopostega*. Forewing lanceolate; greatest width ranging from 0.20-0.23 that of length; apex acute; microtrichia generally restricted to the base of the ventral surface of forewing; also sparsely scattered over dorsal distal two-thirds of forewing in *Notiopostega*. Venation extremely reduced with no branched veins and no crossveins; usually four major veins present (Sc, Rs, M, CuA, and sometimes A) in addition to anal fold in lieu of CuP; CuA absent in *Notiopostega*. Retinaculum largely consisting of densely concentrated row of rigid scales from ventral base of Cu. Hindwing lanceolate; greatest width about 0.14-0.17 that of length; microtrichia generally absent, or only small vestiges scattered at base; a uniform series of 4-18 subcostal pseudofrenular setae arising from dorsal base; venation extremely reduced with all veins simple and only Sc, Rs, M, Cu, and A preserved. Proleg without tibial epiphysis.

Midtibia with a single pair of unequal apical spurs. Hindtibia with two pairs of unequal spurs, one pair from apex and another, usually longer pair from basal 0.25–0.5 of tibia.

Abdomen: Without specialized vestiture or processes. Spiracles present on A1-6, normally absent on A7-8, although faint vestiges occasionally evident on A7 of male. First sternite absent. Second sternite large but weakly sclerotized and without apophysis; a bilateral pair of faint, sinuate venulae diverging cephalically; these usually with a secondary lateral branch from middle. Eighth segment of female with a fully developed tergite and sternite.

Male Genitalia: Uncus reduced, usually consisting of a slender band, or bridge, between a small pair of widely separated setose lobes (socii?), or a single, median connate lobe in *Eosopostega*. Tegumen reduced to a narrow dorsal ring. Vinculum usually a narrow, rounded ventral ring, which is concave or deeply excavated in *Opostegoides* and *Eosopostega*. Gnathos present as a narrow ventral arch in *Notiopostega* and *Opostegoides;* moderately developed and rounded in *Paralopostega;* well developed and deeply arched in *Opostega, Pseudopostega,* and *Eosopostega*. Transtilla usually absent (present in one Australian genus, "A"). Valva usually with a slender apophysis inward from costal margin; apophysis usually fused to valva, but articulated in *Pseudopostega;* basal half of valva usually broad with a slender pedicel from distal half supporting an elliptical cucullar lobe; distal margin of lobe pectinate, consisting of a single, dense row of 16–59 short, peg-like spines. Valva usually terminating in a broadly rounded lobe slightly distad of cucullar pedicel; tapering to a slender, elongate lobe in *Paralopostega*. Juxta either absent, or, if present, consisting of a broad, membranous plate. Aedoeagus usually absent, present in *Notiopostega, Opostegoides, Paralopostega,* and *Eosopostega*.

Female Genitalia: Ovipositor of the non-piercing type, short to nearly truncate and barely extending beyond seventh segment. Seventh segment well developed, but simple, without spines or other processes. Dorsal anal papillae usually present, bilobed, and setigerous, absent in *Opostegoides*. Anterior apophysis absent in all genera except *Opostega* and *Paralopostega* where it is short and stout. Posterior apophysis always present, either short or elongate. A single genital opening (oviporus) present and separated from anus; oviporus situated terminally due to extreme reduction of A8, 9+10 and usually partially enclosed by A7. Ductus bursae usually with membranous walls and poorly defined vestibulum; vestibulum more developed in *Opostegoides* and with lightly sclerotized dorsal wall. Spermatheca variously developed, sometimes surpassing length of corpus bursae; spermathecal papilla usually present and membranous; efferent canal coiled and usually elongate; afferent canal varying from poorly developed in *Notiopostega* to relatively inflated in *Opostegoides*. Corpus bursae usually enlarged, reduced in *Notiopostega;* a well-defined signum absent but inner walls usually variously covered with minute spicules. A9+10 rarely sclerotized, with no evidence of a ninth sternite.

EGG.—Cylindrical, elongate-oval; up to 1.1 mm long and 0.55 mm in diameter. Chorion smooth and transparent. Color whitish, turning yellowish with age (Carey, ms).

LARVA.—Mature larvae small to medium, 8–25 mm. Body whitish (in alcohol), extremely elongate and slender, cylindrical, and apodal. Spiracles circular. Larval development slightly hypermetamorphic, with pre-ultimate instars possessing greatly reduced body setae, relatively smooth cuticle, and reduced or absent labial appendages.

Head: Prognathous, extremely depressed, usually whitish with reddish brown longitudinal lines corresponding to sclerotized internal ridges. Epicranial notch only slightly developed. Adfrontal ridges and frontoclypeus diverging posteriorly to vertex. Ecdysial line obsolete and adfrontal sclerite not defined. A well-developed lateral ridge present with dorsal branch continuing around lateral margin of cranium to termination of adfrontal ridges on vertex and ventral branch turning anteriorly to hypostoma. A pair of prominent cranial apophyses extending internally from posterior end of adfrontal ridge into prothorax. Stemmata reduced to 1 pair, situated far forward just posterior to antenna. Antenna reduced, apparently two-segmented; an equal pair of long sensilla chaetica arising near apex; number of basiconic sensilla either four small ones of various size or a single large sensillum in *Paralopostega*. Setae of vertex reduced to a pair of pores (Va and Vb) on either side of adfrontal ridge. Cranial setae greatly reduced in number with only F1, C1, A1, S1, L1, and SS1 and SS3 present. Labrum reduced, variously modified, either guadrate and simple or deeply divided with digitate margins (Figure 171). Mandibles with 4–6 cusps; a single, spinose mandibular seta present. Maxilla and labium greatly reduced in size due to forward migration of hypostoma nearly as far anteriorly as labrum; maxilla and labium more developed and more setose in last instar than in pre-ultimate stages. Spinneret, labial palpus, and labial seta present in last instar, absent in previous instars; the latter instead with a simple opening to the labial gland that is normally closed by a triangular operculum (Figures 175, 177); opening to labial gland may be absent in at least some instars (Figure 134). Gula very thin and expanded over most of ventral surface of cranium.

Thorax: Pronotum with a pair of elongate, sclerotized bars longitudinally extended near dorsal midline. D group bisetose on T1-3. L group trisetose on T1, bisetose on T2-3. Only one coxal seta present on T1, 2 pairs on T2-3. Legs absent; a pair of ventral ambulatory calli present on T2-3 of last instar; calli not developed in pre-ultimate instars. Primary setae elongate and cuticle over most of body densely covered with minute spines in last instar; pre-ultimate instars with greatly reduced setae and nearly naked cuticle except for minute, ridge-like spines over dorsum and venter of T2-3 and venter of A1-8; ridges more reduced dorsally on thorax and appearing granular on venter and dorsum of T1.

Abdomen: Cuticle smooth, naked except for primary setae and minute spinules. Pinnaculae absent to poorly defined.

Chaetotaxy reduced; D1 and L3 absent on A1-10; SD2 and L2 absent on A9; SV2 absent on A1-10; SV1 either present or absent on A9. Dorsum of anal segment either with 2 pairs of setae or none. Prolegs and crochets absent.

PUPA.—Maximum length 5.5 mm; width 2.5 mm. Adecticous, obtect, and incomplete. Body slightly depressed, relatively smooth except for concentrations of minute spines mostly on abdominal tergites 2-8 (Figures 64, 67); primary setae and spines absent. Head broadly rounded. Antenna with greatly enlarged scape, except moderately enlarged in *Notiopostega*. Antenna, and hindleg usually extending to or sometimes surpassing caudal end of abdomen. All coxae flat and exposed. Abdomen with functional spiracles on 1-6, vestigial on 7 and 8. A9+10 smooth, without cremaster.

Key to the Genera of Opostegidae

1. Male genitalia with aedoeagus 2
   Aedoeagus absent 5
2. Predominantly dark fuscous moths with reduced antennal scape [Figure 1]; width of scape less than eye diameter . . . . *Notiopostega*, new genus
   Predominantly white moths with greatly enlarged scape [Figures 4, 6, 12]; width of scape greater than eye diameter 3
3. Male genitalia with uncus well developed and tapering to a single median apex [Figure 276] . . . . *Eosopostega*, new genus
   Uncus poorly developed and truncate [Figures 281, 286, 292] 4
4. Male genitalia with a very slender, often difficult to detect gnathos [Figure 281]; vinculum with anterior margin concave. Female genitalia without anal papillae . . . . *Opostegoides*
   Gnathos more developed; vinculum convex [Figure 286]. Female with a pair of setose anal papillae . . . . *Paralopostega*, new genus
5. Male genitalia with inner costal apophysis fused to valva [Figure 292]. Metafurcal apophysis free [Figure 42] . . . . *Opostega*
   Sclerite bearing costal apophysis articulated to valva [Figure 296]. Metafurcal apophysis fused to secondary arm of meta-furcasternum [Figure 49] . . . . *Pseudopostega*

Notiopostega, new genus

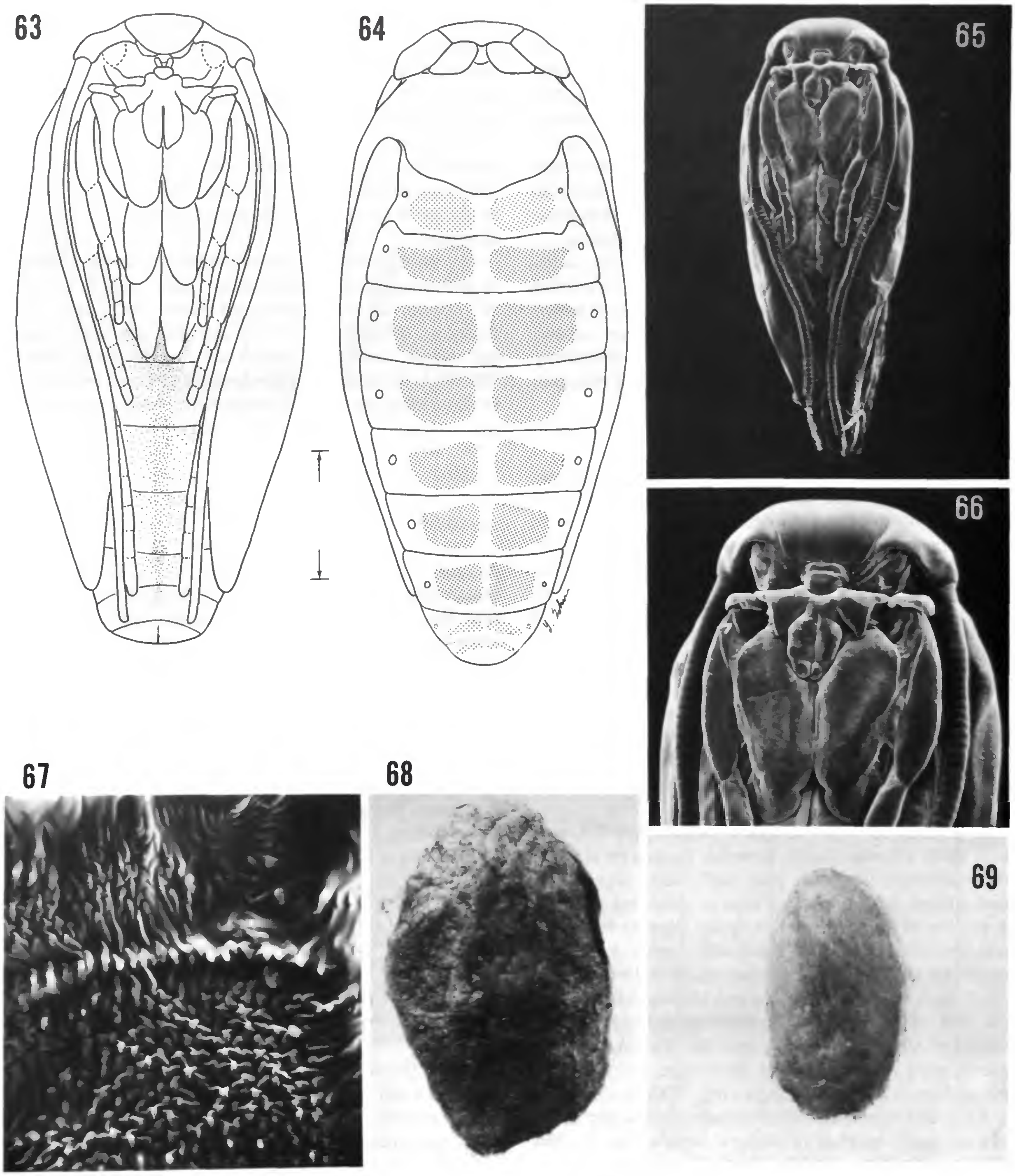
TYPE SPECIES.—*Notiopostega atrata*, new species.

ADULT.—Small moths with lanceolate wings; antennal scape moderately enlarged; male with partially sclerotized aedoeagus; metafurcal apophyses free; length of forewing: 5.0-8.3 mm.

Head: Vestiture mostly rough, consisting of piliform scales with acute apices; scales smooth from vertex to cranial ridge and irregularly arranged. Lower frons smooth and naked except for a sparse scattering of microtrichia (Figure 73). Cranial vertex produced to form a thin, bicrennulate ridge immediately anterodorsal to occiput. Antenna approximately 0.7-0.8 the length of forewing, 80-85 segmented; scape moderately enlarged, greatest width 0.76 the vertical diameter of eye; scales irregularly arranged; sensilla ascoidea with 5-10 branches. Eye reduced, interocular index approximately 0.5, eye index 1.1. Maxillary palpus elongate, approximately 1.6× the length of labial palpus; ratio of segments from base approximately 0.5:0.5:0.9:2.3:1.0; segment I with a broad, acute process. Haustellum reduced, about 0.4 the length of maxillary palpus. Labial palpus moderately short, exceeding length of haustellum.

Thorax: Forewing lanceolate; greatest width approximately 0.2 that of length; apex acute; microtrichia generally reduced, extremely small and mostly concentrated over distal two thirds of forewing (dorsal and ventral) and largely absent from basal regions; venation extremely reduced, with only vestiges of Sc, R, M, and A present; CuA and CuP absent. Hindwing lanceolate, greatest width approximately 0.17 that of length; microtrichia greatly reduced, largely confined to anal area; approximately 18 pseudofrenular setae present; venation extremely reduced, with only Sc, Rs, M, Cu, and A present and unbranched. Metathoracic furca with apophyses moderately developed, free, terminating in rounded knobs. Proleg with tibia about 0.65 the length of tarsal segments. Midleg with apical spurs of nearly equal lengths, one being about 0.9 the length of other. Hindleg with two pairs of unequal spurs, one member of each pair about 0.7 the length of other; basal pair situated near middle of tibia; spurs relatively short; longest spur about 0.57 the length of first tarsal segment; hindtibia densely covered with long spinose setae, as is dorsum of tarsus I; tibial setae more appressed and tibia less spiny in appearance than in other genera.

Abdomen: Six functional pairs of spiracles present; spiracles of A7 vestigial, those of A8 absent.



FIGURES 63–69.—Pupae and cocoons. *Notiopostega atrata*, new species: 63, ventral view of pupa (1 mm); 64, dorsal view of pupa; 65, ventral view of pupa (1.5 mm); 66, detail of head (0.75 mm); 67, second abdominal tergum (100 µm); 68, cocoon, length 6 mm. *Opostegoides scioterma* (Meyrick): 69, cocoon, length 3.5 mm. (Scale lengths in parentheses; bar scale for photographs = Figure 65.)

Male Genitalia: Uncus reduced, consisting of a single, broadly truncate, setigerous lobe nearly 0.5 the width of the genital capsule. Tegumen reduced to a narrow dorsal ring. Vinculum a narrow ventral ring. Gnathos vestigial, reduced to an extremely narrow arch. Valva with internal apophysis vestigial and fused to base of costa; cucullus arising from apical third of valva on a slender pedicel and then abruptly enlarging; outer margin of cucullus bearing a densely spined pectinifer consisting of approximately 45 spines. Juxta membranous. Aedoeagus present, stout, nearly twice the length of valva.

Female Genitalia: Anal papillae extremely broad, developed as a slightly bilobed setigerous ridge on T9. Posterior apophysis well developed, elongate and stout. Anterior apophysis absent. Anus and oviporus with separate external openings. Corpus bursae reduced in size; walls completely membranous, without signum. Spermathecal papilla enlarged, nearly equaling length of corpus bursae.

LARVA (Figures 89-115).—Length of largest larva 20 mm; maximum diameter 1.1 mm (in alcohol).

Head: Maximum width 0.8 mm. Color white (in alcohol) with three pairs of dark reddish brown longitudinal lines corresponding to the internal ridges; a short median frontal ridge sometimes evident between frontal setae. Antenna with four sensilla basiconica of different sizes from large to minute, and two elongate sensilla chaetica of equal lengths. Setae F1 and C2 extremely short. Labrum reduced but of general quadrate form; M1 greatly reduced; L1-3 present and spinose. Three pairs of elongate, epipharyngeal setae present. Mandible with four cusps; mandibular seta moderately spinose.

Thorax: Prothorax with XD1 arising above XD2 and remote from D1. SV2 present on meso- and metathorax.

Abdomen: L2 reduced in length. Ninth segment with five pairs of primary setae; SV1 present. Tenth segment with two pairs of dorsal setae.

PUPA (Figures 63-67).—Length of largest pupa 5.5 mm; greatest width 2.5 mm. Cuticle brownish fuscous (in alcohol) nearly transparent; abdomen pale buff. Body slightly depressed, smooth, without primary setae or spines but with two large patches of scattered minute spines dorsally on A1-8, densest concentration on A2-7 and with narrow, midventral concentration of similar minute spines on A2-8. Head broadly rounded; galea triangular. Antenna and hindlegs extending to caudal end of abdomen, sometimes slightly shorter or surpassing it. All coxae clearly exposed, flat. Abdomen without transverse rows of spines except for minute, serrated ridge visible on dorsum of A2 under higher (e.g., 200×+) magnification; A1-8 with scattered, minute spines concentrated along midventer; paired patches of slightly larger spines located dorsally on either side of midline from A1 to 9. A10 smooth, cremasteral spines absent.

ETYMOLOGY.—The generic name is derived from the Greek *notios* (southern) prefixed to the generic stem *Opostega*, in reference to the extreme austral distribution of this taxon. It is feminine in gender.

DISCUSSION.—*Notiopostega* exhibits the most divergent morphology of any genus of Opostegidae. The only known species, *N. atrata*, new species, possesses the darkest coloration and largest size of any opostegid. The antennal scape is noticeably reduced as are the tibial spurs and venation. It shares a sympleisiomorphy with *Opostegoides, Eosopostega,* and *Paralopostega* in the retention of an aedoeagus. The larva of *Notiopostega* appears to be the most generalized in the family, as indicated by its less modified labrum and more complete chaetotaxy.

The male genitalia of *Notiopostega* most resemble those of an unnamed Australian group that I simply refer to as "genus A." Adults of two undescribed species of genus A are illustrated (Figures 258-260), along with the male genitalia and eighth abdominal tergite of one of these (Figures 289-291). No names for these taxa are proposed because most of the Australian Opostegidae have not been examined. The uncus in genus A is poorly differentiated as a small, rounded, setose lobe situated immediately dorsad of a pair of small, laterally expanded lobes of the tergumen. The gnathos is moderately developed, slightly arched caudally, and closely associated with a slender pair of lateral sclerites, which I consider to represent a transtilla (Figure 289). The paired sclerites of the transtilla are weakly connected by a thin median bridge that is nearly inseparable from the gnathos. In addition, both species of genus A examined possessed distally extended lobes of the valvae, similar to that developed in *Paralopostega* (Figure 286). The presence of a transtilla, flared tegumenal lobes, and perhaps an enlarged, triangular eighth abdominal tergite (Figure 290) constitute a few of the synapomorphies of genus A. The female genitalia of this apparently monophyletic group resembles that of *Notiopostega* in possessing short relatively, stout posterior apophyses, rudimentary anterior apophyses, and greatly reduced anal papillae. In contrast to *Notiopostega,* the eye and scape are well developed, as in the other genera of Opostegidae.

Notiopostega atrata, new species

FIGURES 1-3, 25, 31-33, 50, 56, 63-68, 70-115, 250, 274, 275, 306, 307

Opostega species.—Carey, ms:3.—Carey, Cameron, Cerda, and Garda, 1978:151.

Notiopostega atrata Davis, 1987:353 [nomen nudum].

ADULT (Figure 250).—Length of forewing: male, 5-6 mm; female 6.4-8.3 mm. Small, relatively unicolorous moths with bronzy fuscous forewings and paler, more grayish hindwings. Aedoeagus preserved in male.

Head: As described for genus. Uniformly grayish fuscous except for pale yellowish white scales covering part of dorsal surface of scape.

Thorax: Pronotum and forewing uniformly dark grayish fuscous with a slight bronzy luster. Hindwing with scales of similar color but appearing lighter, more gray because of

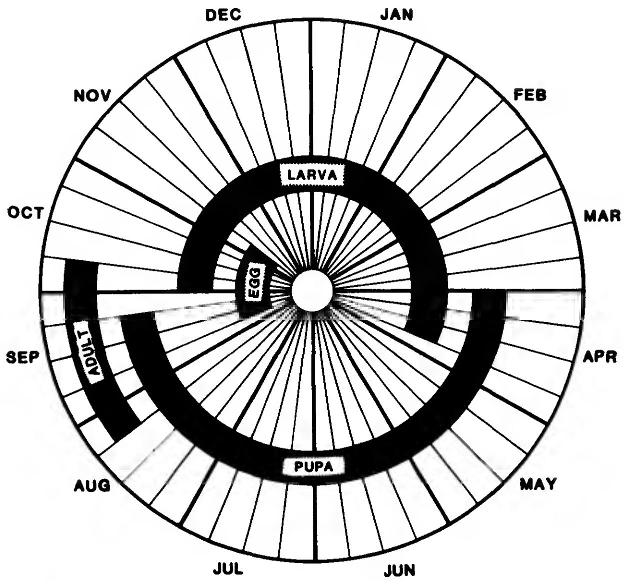
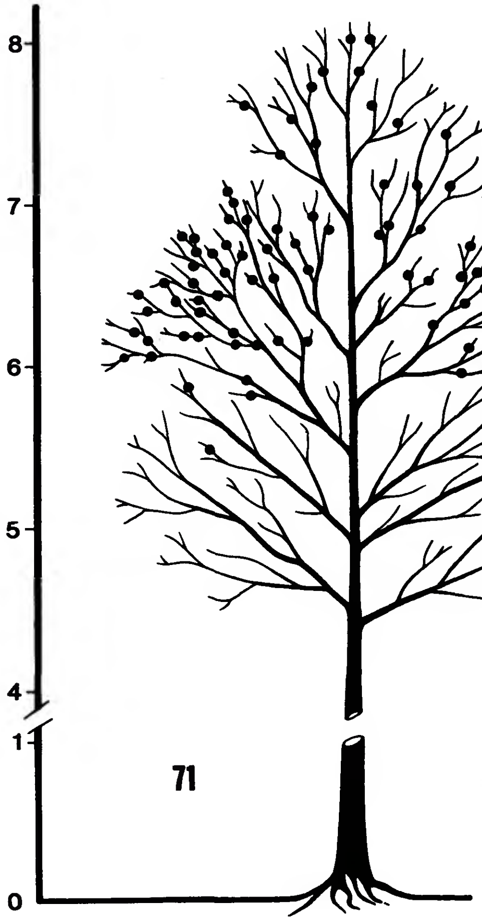


FIGURE 70 (left).—Seasonal life cycle of *Notiopostega atrata*, new species. (Modified from Carey et al., 1978.)

FIGURES 71, 72 (below).—*Notiopostega atrata*, new species: 71, distribution of oviposition sites in upper crown of *Nothofagus dombeyi* (Mirbel) Oersted; 72, basal trunk of *Nothofagus dombeyi* showing final stages in larval biology. (Modified from Carey, ms; scales in meters.)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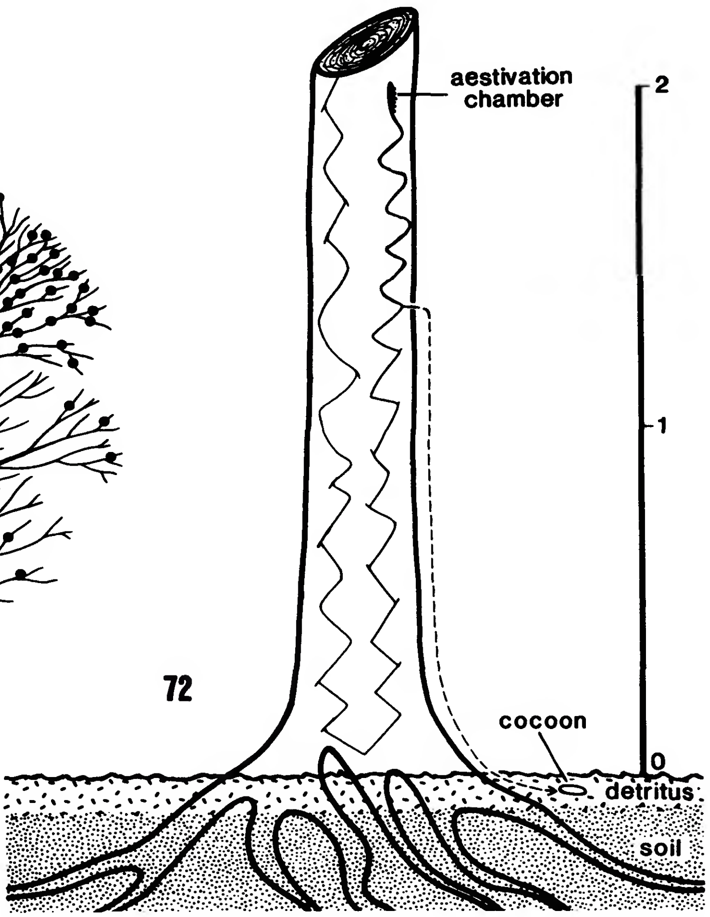
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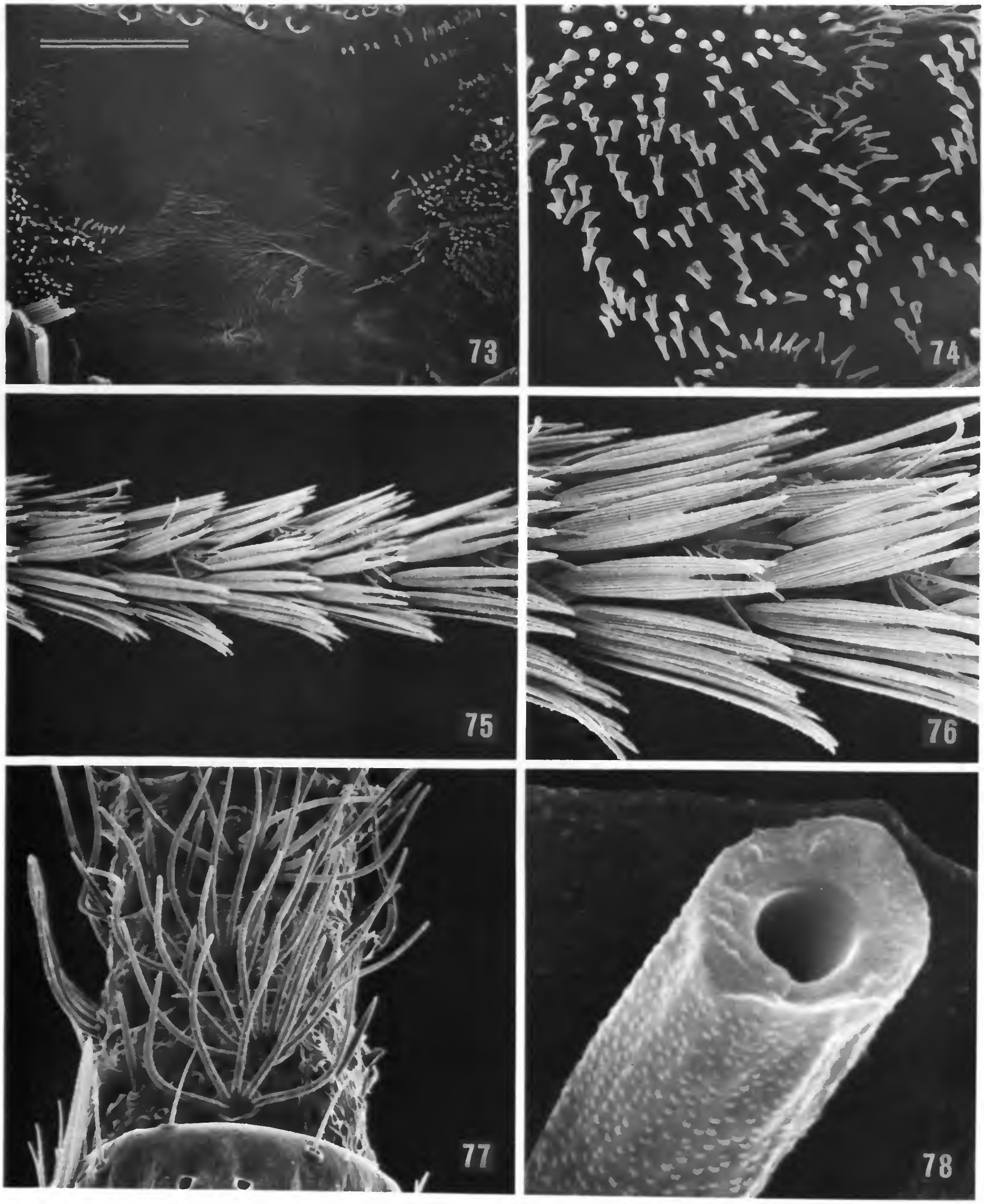
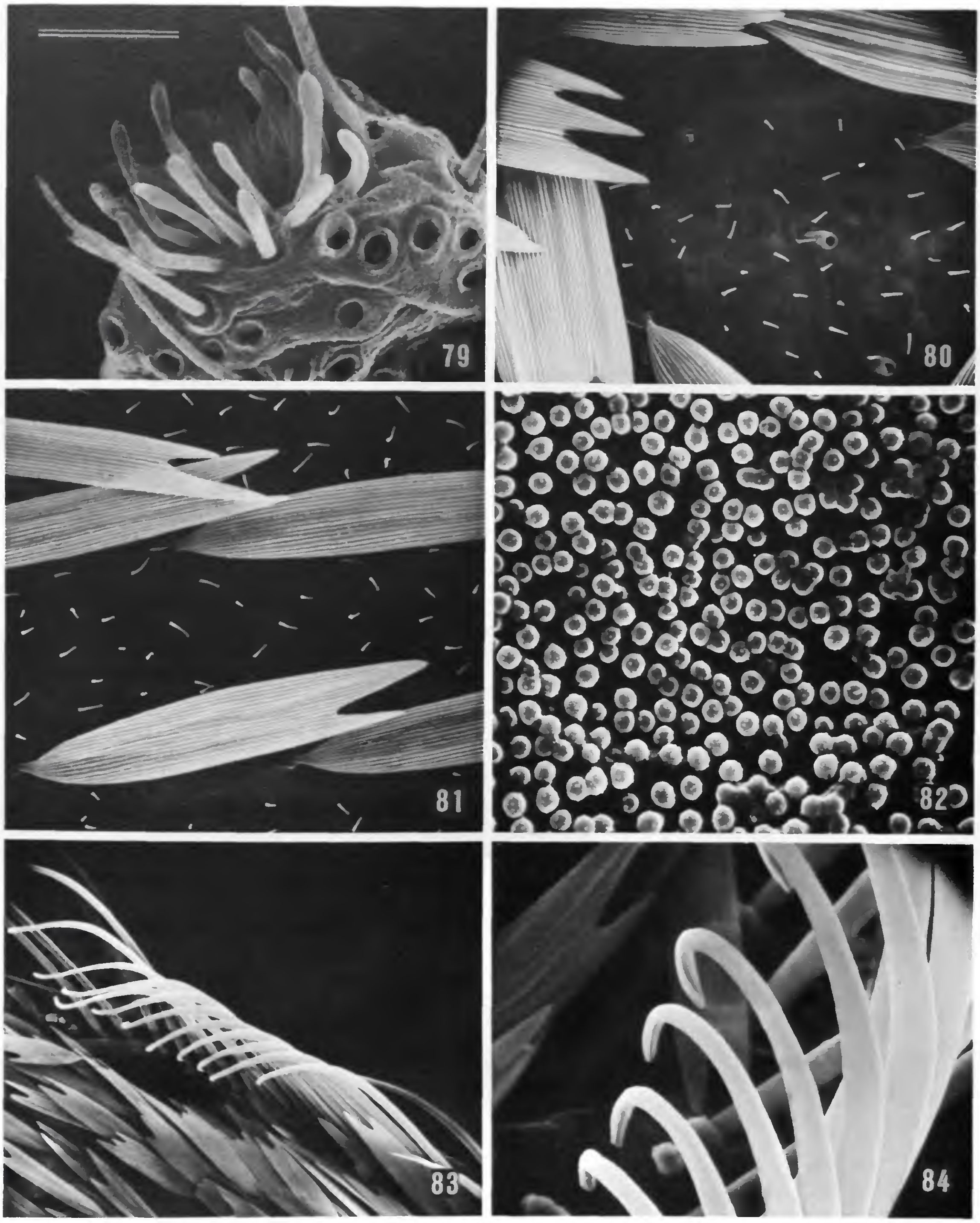
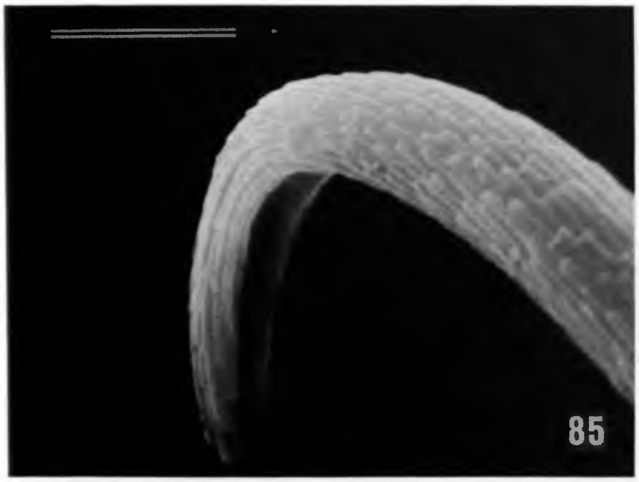


FIGURES 73–78.—*Notiopostega atrata*, new species: 73, lower frons below scale vestiture (43 μm); 74, detail of microtrichia at lower edge of frons (Figure 73) (10 μm); 75, scale vestiture at middle of antenna (75 μm); 76, detail of antennal scales (38 μm); 77, sensilla ascoidea near base of flagellum (38 μm); 78, cross-sectional view of branch of sensillum ascoideum (1.2 μm). (Scale lengths in parentheses; bar scale for all photographs = Figure 73.)



FIGURES 79–84.—*Notiopostega atrata*, new species: 79, sensory sensilla at apex of labial palpus (13 µm); 80, microtrichia on discal area of ventral forewing (40 µm); 81, microtrichia at distal third of dorsal hindwing (38 µm); 82, dense concentration of microtubercules at dorsal base of hindwing (2.5 µm); 83, pseudofrenular setae of hindwing (120 µm); 84, apices of pseudofrenular setae (30 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 79.)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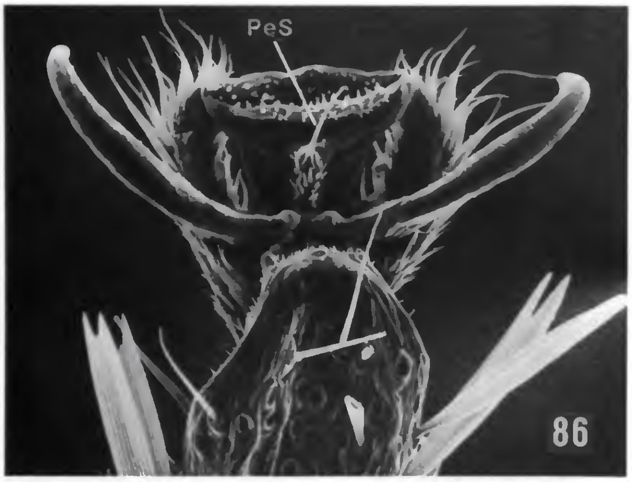

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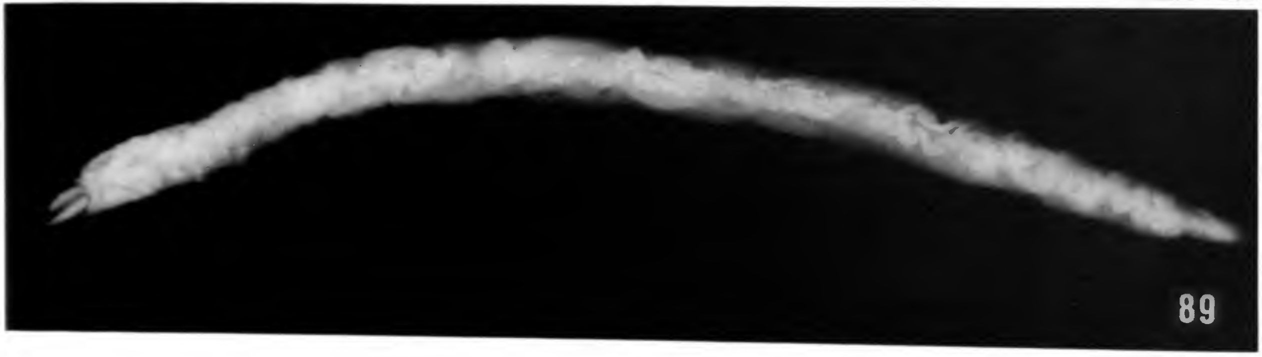
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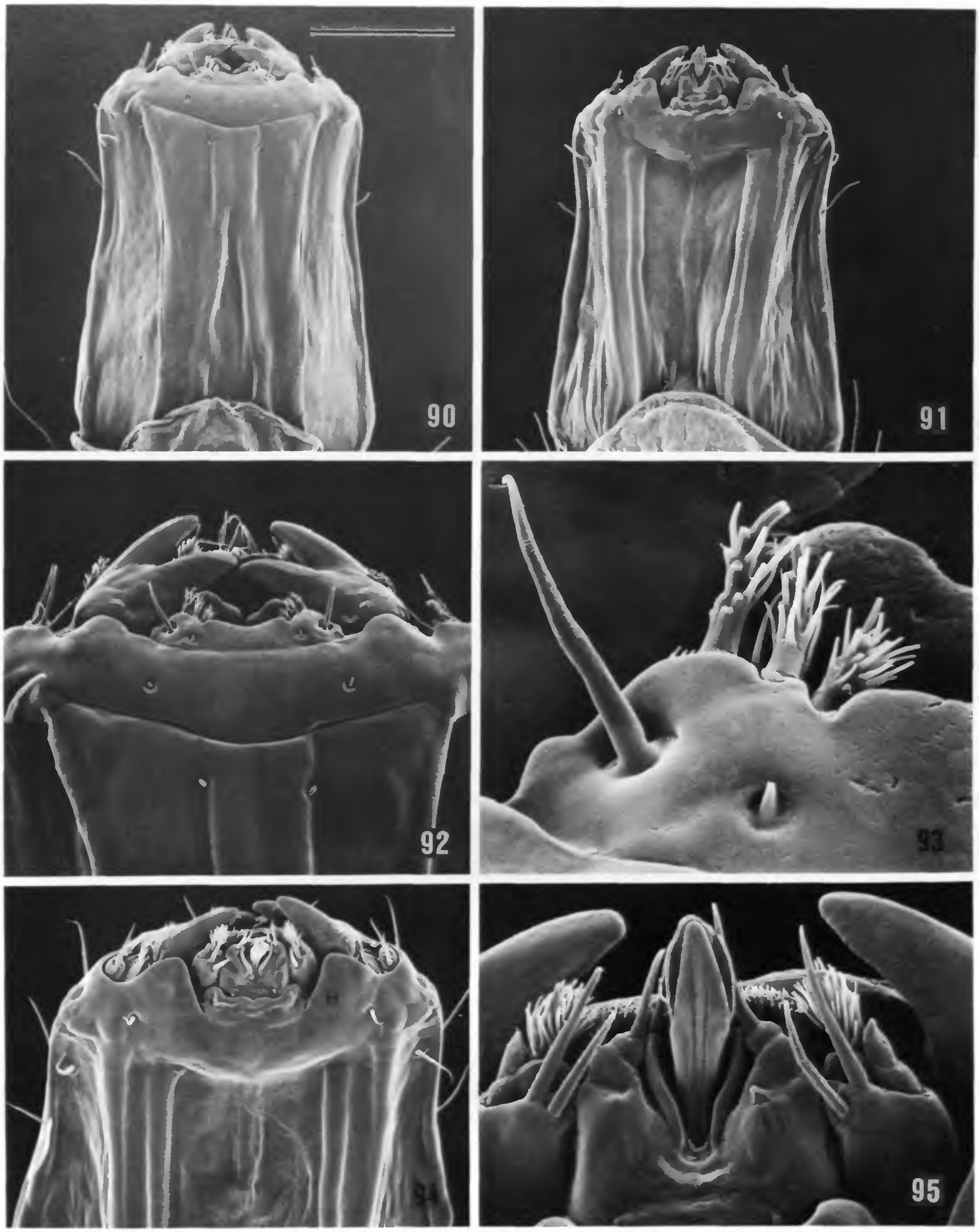
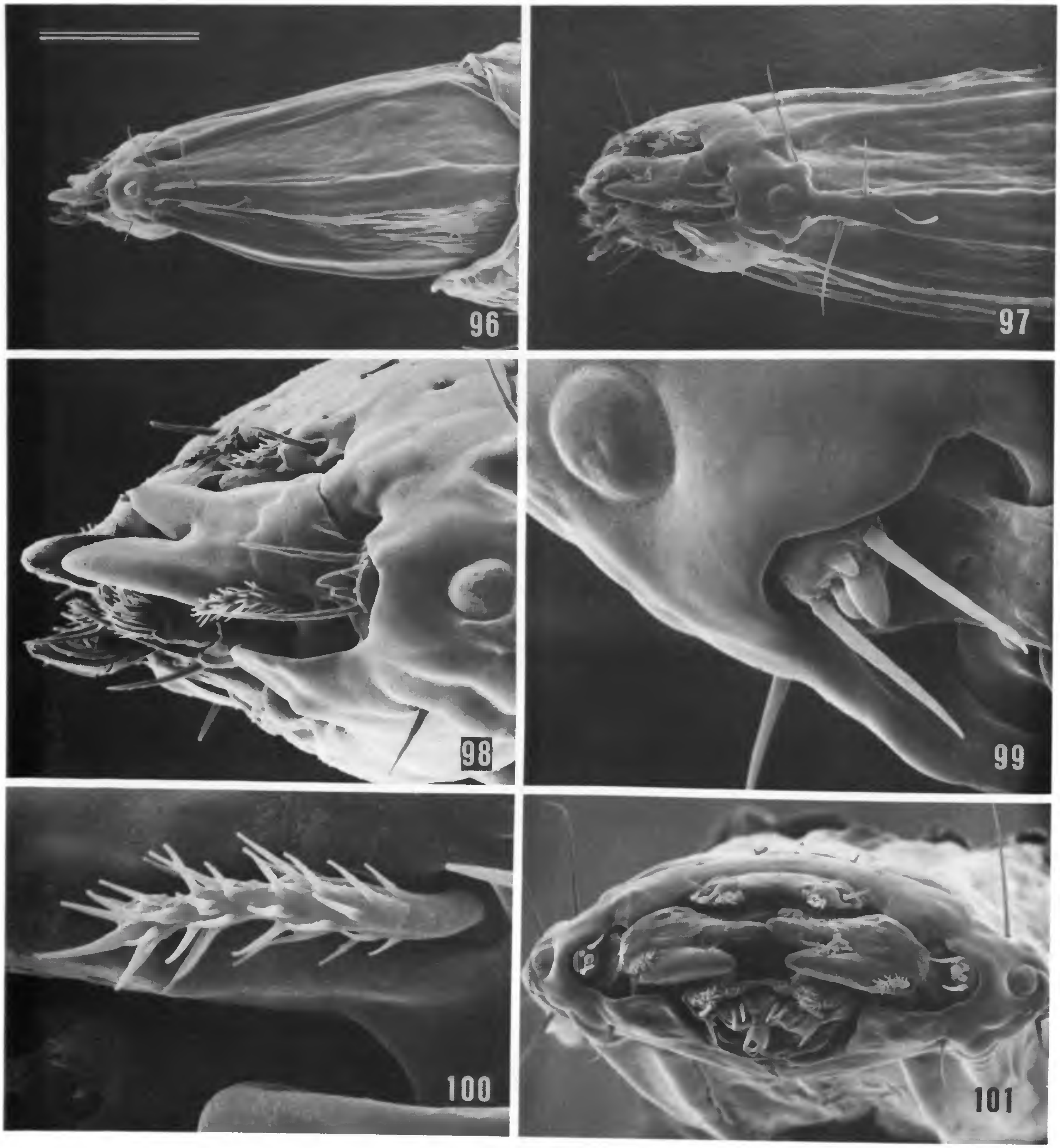
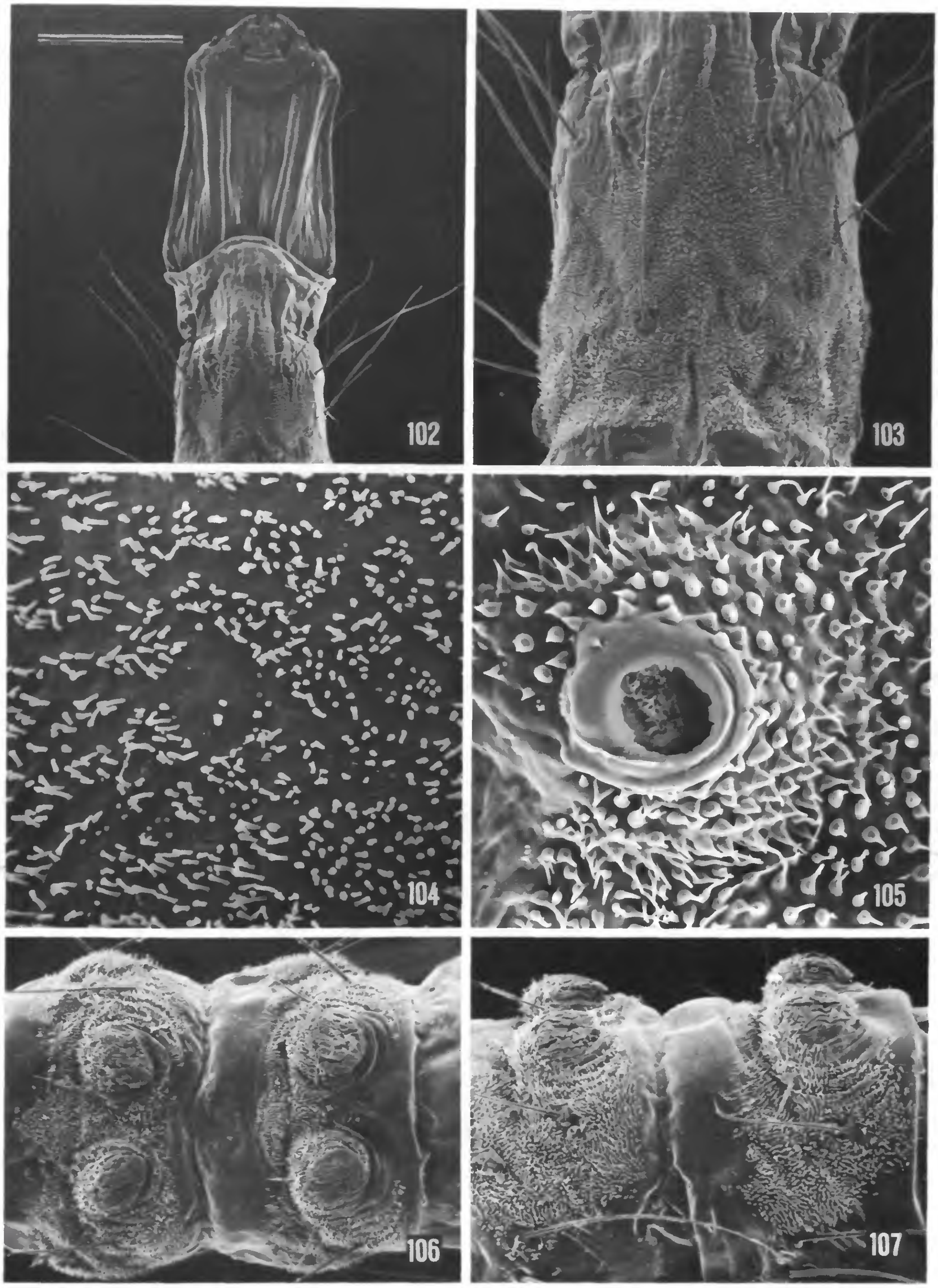
FIGURES 85–89.—*Notiopostega atrata*, new species: 85, detail of apex of pseudofrenular seta (6 µm); 86, dorsal view of metathoracic pretarsus (38 µm); 87, ventral view of Figure 86 (38 µm); 88, detail of unguitractor plate (6 µm); 89, larva, length 20 mm. (Scale lengths in parentheses; bar scale for photographs = Figure 85.)



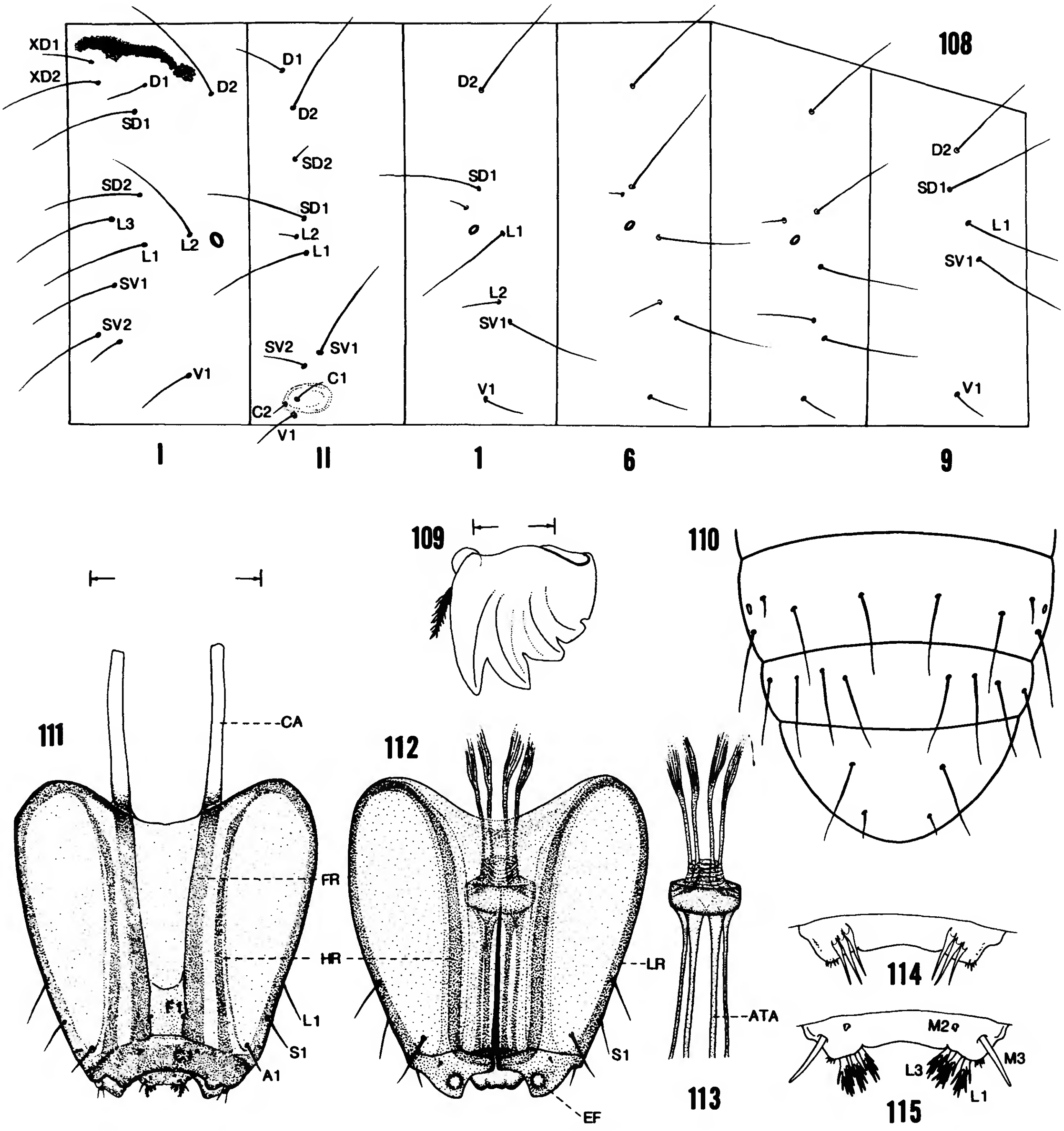
FIGURES 90–95.—Last instar larva of *Notiopostega atrata*, new species: 90, dorsal view of head (0.3 mm); 91, ventral view of head (0.3 mm); 92, dorsal detail of fronto-clypeal area (136 µm); 93, detail of labral setae (23.1 µm); 94, ventral view of head (200 µm); 95, ventral detail of mouthparts (50 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 90.)



FIGURES 96–101.—Last instar larva of *Notiopostega atrata*, new species: 96, lateral view of head (0.3 mm); 97, anterolateral view of head (200 μm); 98, lateral view of mouthparts (75 μm); 99, dorsolateral view of stemma and antenna (41 μm); 100, lateral view of mandibular seta (23.1 μm); 101, frontal view of head (158 μm). (Scale lengths in parentheses; bar scale for all photographs = Figure 96.)



FIGURES 102–107.—Last instar larva of *Notiopostega atrata*, new species: 102, ventral view of head and prothorax (0.5 mm); 103, sternum of prothorax (250 µm); 104, microtrichia, midventral detail of Figure 103 (30 µm); 105, prothoracic spiracle (38 µm); 106, ambulatory calli on venter of T2 and 3 (0.4 mm); 107, lateral view of Figure 106 (0.33 mm). (Scales lengths in parentheses; bar scale for all photographs = Figure 102.)



FIGURES 108–115.—*Notiopostega atrata*, new species, chaetotaxy of last larval instar: 108, lateral diagram of prothorax, mesothorax, and abdominal segments 1, 6, 8, and 9; 109, left mandible (0.5 mm); 110, dorsal view of abdominal segments 8–10; 111, dorsal view of head (0.5 mm); 112, ventral view of head; 113, tentorium; 114, ventral view of labrum; 115, dorsal view of labrum. (Scale lengths in parentheses.)

thinner scaling; cilia contrastingly darker, similar to forewing color. Venter of thorax slightly paler, more gray and lustrous. All legs uniformly grayish fuscous, without banding, somewhat paler and more gray ventrally.

Abdomen: Uniformly dark grayish fuscous dorsally; gray to pale gray ventrally.

Male Genitalia: As described for genus and illustrated in Figures 274, 275. Valva broadly truncate at apex distad to pedicel of cucullus. Aedoeagus with rudimentary cornuti, usually only 1-2 short spines present.

Female Genitalia: As described for genus and illustrated in Figures 306, 307.

LARVA (Figures 89-115).—As described for genus.

PUPA (Figures 63-67).—As described for genus.

COCOON (Figure 68).—Length: 5.5-6.5 mm; width: 3.6-4.5 mm; thickness: 1.5-2.0 mm; an oval, flat case; surface relatively smooth, constructed entirely of densely woven, brownish silk. Pupa rarely extruded from slit aperature that extends around approximately half the circumference of case.

ETYMOLOGY.—The specific name is derived from the Latin *atratus* (dressed in black), in reference to the characteristic dark vestiture of this species.

HOLOTYPE.—Female; Valdivia, Valdivia Prov., Chile; 28 Aug 1973, R.S. Cameron, type no. 100678 (USNM).

PARATYPES.—CHILE: Same data as holotype: 4♂, 4♀, 22 Aug-19 Sep 1973 (USNM); 1♂, 19 Sep 1973 (MHNS). Valdivia Prov: Fundo San Sabastian: 9 larvae, 12 Mar 1974, P. Carey (USNM); 5 pupae, 24 Apr 1973, P. Carey (USNM).

HOST.—Fagaceae: *Nothofagus dombeyi* (Mirbel) Oersted (Carey et al., 1978).

FLIGHT PERIOD.—Late August to early October; univoltine.

DISTRIBUTION.—Known only from the coastal hills of Valdivia Province, Chile. Most, if not all, of the type series was collected at Fundo San Sabastian, 30 km south of the city of Valdivia.

DISCUSSION.—Being the only uniformly dark colored species of Opostegidae, this species is truly unique and easily recognizable. The nearly black vestiture of the diurnal adult moth is an adaptation associated with its late winter to early spring emergence period, that commences whenever the daily ambient temperature approaches 18°C (Carey, ms; Carey et al., 1978).

The life history of this species, which is regarded as a significant pest of an important lumber tree, coigue (*Nothofagus dombeyi*), in the Valdivian forest of Chile, has been thoroughly investigated by Carey (ms) and Carey et al. (1978). One of the first references to the larval biology was by Knigge and Bonnemann (1969), who mistook *N. atrata* for a species of Agromyzidae (Spencer, 1981). These authors state that the larvae partly destroy the cambium and initiate the formation of callus rays of a characteristic appearance. The resulting rays, together with the excrements from the larvae, are responsible for the reddish brown color of the pith flecks, which substantially diminish the commercial veneer quality of the wood. The seasonal occurrence of the principal stages is summarized in Figure 70 (from Carey et al., 1978). Adults first appear during the last week of August and continue to fly until the first week in October. Commencing in early September, females deposit elongate eggs on the undersides of *Nothofagus* leaves. Carey described the newly deposited eggs as whitish in color, becoming yellowish as the embryo develops. They average 0.545 mm in width and 1.104 mm in length. The egg is covered with a protective, transparent secretion from the rectal glands of the female. Approximately 90% of the oviposition sites examined by Carey were located in the upper third of the tree crown (Figure 71) and most often on the terminal, or youngest branches. The oviposition site is almost always located near the leaf base with the developing larva oriented toward the pedicel. Rarely are more than one egg laid per leaf.

Larval eclosion occurs from 28 to 36 days after oviposition. Leaving the egg, the larva bores into the leaf and from there through the petiole into the supporting branch, eventually reaching the main trunk. There it continues to mine the cambium layer, creating a sinuate, "zig-zag" trail down the trunk (Figure 72). Young trees damaged in this manner demonstrate a similar sinuate pattern externally visible on the bark due to a cortical response to larval damage. The mines are the longest of any known bark or stem miner, totaling approximately seven meters with a maximum width of 2.4 mm (Carey ms:15). At times they may extend all the way down the trunk to the roots.

Carey reports six larval instars with most of the feeding performed by the first five instars from October until March. Sometime during February through early March the larva turns 180° in the mine, ascends the trunk a short distance where it constructs a small aestivation chamber in which the fifth instar molts. The final, sixth instar differs from the earlier instars in possessing more distinct body segmentation and in having longer body setae. It rests, essentially immobile, for about two weeks inside the chamber. Between mid March and early April the larva leaves the chamber, descending in the old mine and apparently feeding somewhat as it goes, to a point about 35 mm below the aestivating chamber. There it bores through the bark and drops to the ground where it pupates in a tough silken cocoon (Figure 68) amongst the leaf-litter above the soil. Overwintering (April-September) occurs in the pupal stage with the first adults starting to appear during the last week of August.

Eosopostega, new genus

TYPE SPECIES.—*Eosopostega issikii*, new species.

ADULT.—Small white moths with lanceolate wings; antennal scape greatly enlarged; male with sclerotized aedoeagus; length of forewing: 3.8 mm.

Head: Vestiture of vertex rough, consisting of piliform scales with bidentate apices; posterior to vertex scales broad, smooth, and arranged in irregular rows; lower frons naked except for scattered rows of microtrichia. Cranial vertex evenly rounded. Antennae approximately 0.8 the length of forewing, 54 segmented; scape greatly enlarged with greatest width 1.5× the vertical diameter of eye; scales broad and flat over scape and densely arranged in about 12 rows; sensilla ascoidea with 6–8 branches. Eye large, interocular index 1.2, eye index 0.6. Maxillary palpus elongate, more than twice the length of haustellum and about 2× the length of labial palpus; ratio of segments from base approximately 0.3:0.2:0.6:1.6:1.0. Haustellum short, about 0.75 the length of maxillary palpus. Labial palpus moderately long, slightly exceeding length of haustellum.

Thorax: Forewing lanceolate; greatest width 0.23 that of length; apex acute; microtrichia absent except over ventral base; venation similar to *Opostega,* with only unbranched vestiges of Sc, R, M, CuA and A present; anal fold appearing in lieu of CuP. Hindwing lanceolate, greatest width 0.16 that of length; 10 pseudofrenular setae present; venation similar to *Opostega,* with only Sc, Rs, M, Cu, and A present. Metathoracic furcal apophysis not examined. Proleg with tibia 0.7 the length of tarsal segments. Midleg with tibial spurs of unequal lengths, one member of pair 0.6 the length of other. Hindleg with two pairs of unequal spurs, the basal pair located well below basal third of tibia, with one spur 0.5 the length of other; apical spurs shorter and more similar in length, the shorter spur nearly 0.7 the length of other; longest spur of basal pair exceeding length of first tarsomere. Dorsum of midtibia, hindtibia, and first tarsomere of hindleg densely covered with long, spinose setae.

Abdomen: Six functional spiracles present; A7 absent in male.

Male Genitalia: Uncus moderately developed into a terminal subacute lobe. Tegumen a moderately broad, dorsal ring. Vincullum moderately broad; anterior margin deeply excavated, with a pair of short, relatively slender anterior lobes at lateral angles. Gnathos extending caudally to base of uncus, approximately quadrate in form with a pair small acute apices at posteriolateral margins. Valva with internal apophysis slender and fused to costa; basal half of valva extremely broad, with a partially divided saccular lobe, which is normally folded in repose. Cucullus pedunculate, arising on a slender subapical stalk; distal margin bearing a densely spined pectinifer. Juxta absent. Aedoeagus well sclerotized, elongate, and equipped with stout coruti.

ETYMOLOGY.—The generic name originates from the Greek *eos* (dawn, east) prefixed to the generic stem *Opostega,* in reference to the extreme eastern palearctic distribution of this taxon. It is feminine in gender.

DISCUSSION.—The distinctive morphology of the male genitalia of the single included species has necessitated its recognition as a separate genus. *Eosopostega* shares with *Notiopostega, Opostegoides,* and *Paralopostega* the possession of an aedoeagus. It differs from all other opostegid genera in possessing a single, subacute uncus. The female is presently unknown.

Eosopostega issikii, new species

FIGURES 4, 5, 26, 51, 57, 251, 276–278

ADULT (Figure 251).—Length of forewing: male, 3.8 mm. Small, mostly white moths with faint fuscous markings on forewing at costa and apex. Aedoeagus preserved in male.

Head: As described for genus. Uniformly silvery white. Antenna 54-segmented; scape silvery white; flagellum pale cream.

Thorax: Silvery white. Forewing silvery white with a faint, somewhat oblique fuscous spot on distal two-thirds of costa; cilia with a single faint, pale fuscous stria extending from costa to apex where it expands and darkens slightly to form a small apical black spot; venter white to cream. Hindwings slightly darker, more cream colored. Forelegs cream white, suffused dorsally with light brown from femur to apex of tarsus. Mid- and hindlegs uniformly silvery white.

Abdomen: Uniformly silvery white.

Male Genitalia: As described for genus and illustrated in Figures 276-278. Pectinifer with 35 spines arranged in single row. Aedoeagus with three stout, acute spines arising from wall of aedoeagus and terminating at apex.

Female, larva, and pupa unknown.

ETYMOLOGY.—The species is named in honor of the late Prof. Syuti Issiki, an eminent Japanese microlepidopterist and teacher who collected the holotype shortly before his death.

HOLOTYPE.—Male; Ito, Izu Peninsula, Tskai Pref., Honshu, Japan; 29 Jun 1974, S. Issiki, type no. 100679 (USNM).

PARATYPE.—JAPAN: Kyusyu: Kagoshima-ken: 1♂, 3 Jun 1956, T. Oku (EIHU).

HOST.—Unknown.

FLIGHT PERIOD.—June; univoltine.

DISTRIBUTION.—This species has been collected at low elevations from only two localities, from the Izu Peninsula in southcentral Honshu and from Kagoshima the southwestern tip of Kyushu.

Opostegoides Kozlov

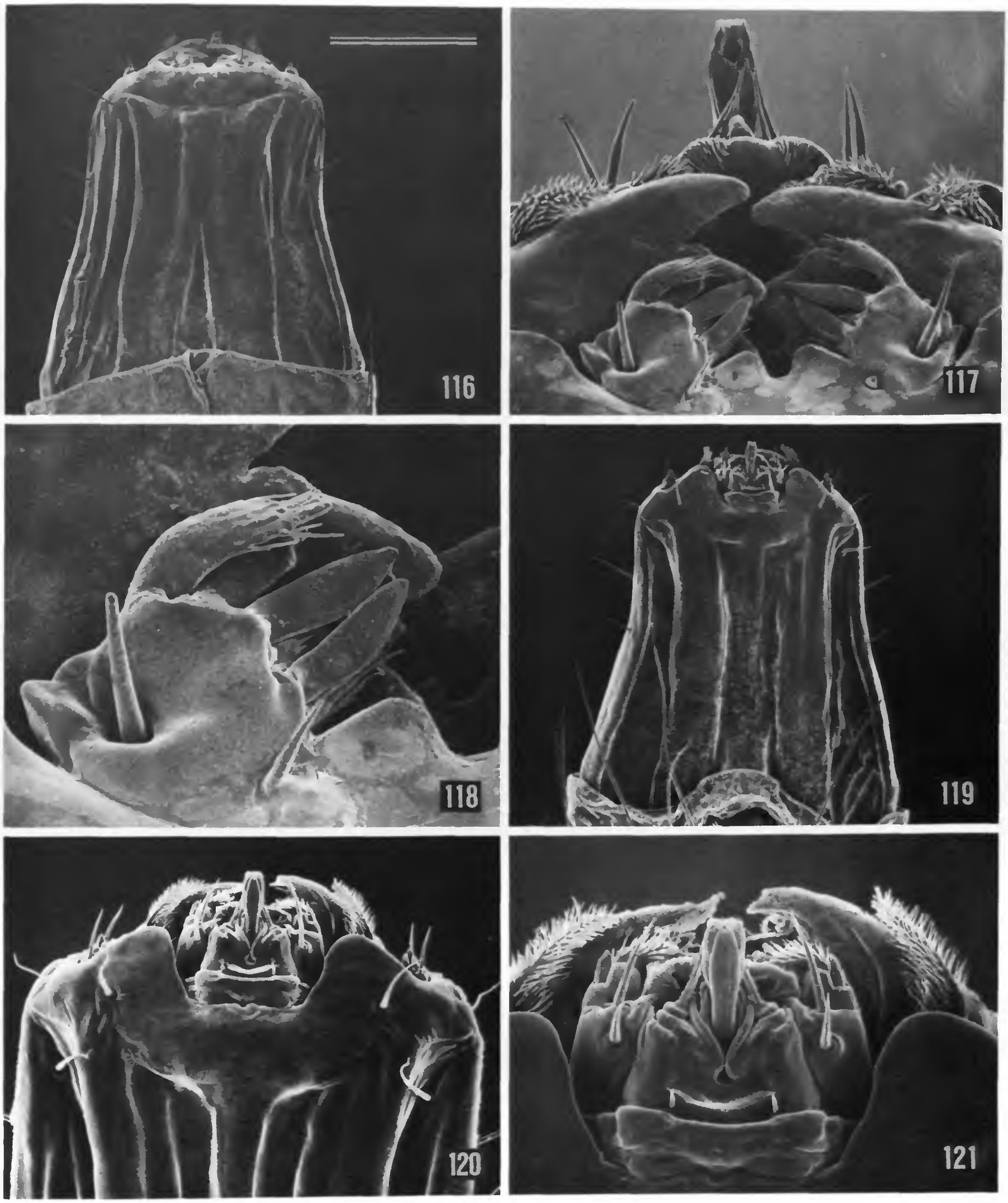
FIGURES 6, 7, 27, 34–36, 52, 58, 69, 116–161, 252–256, 279–285, 308–311

Opostegoides Kozlov, 1985:54.

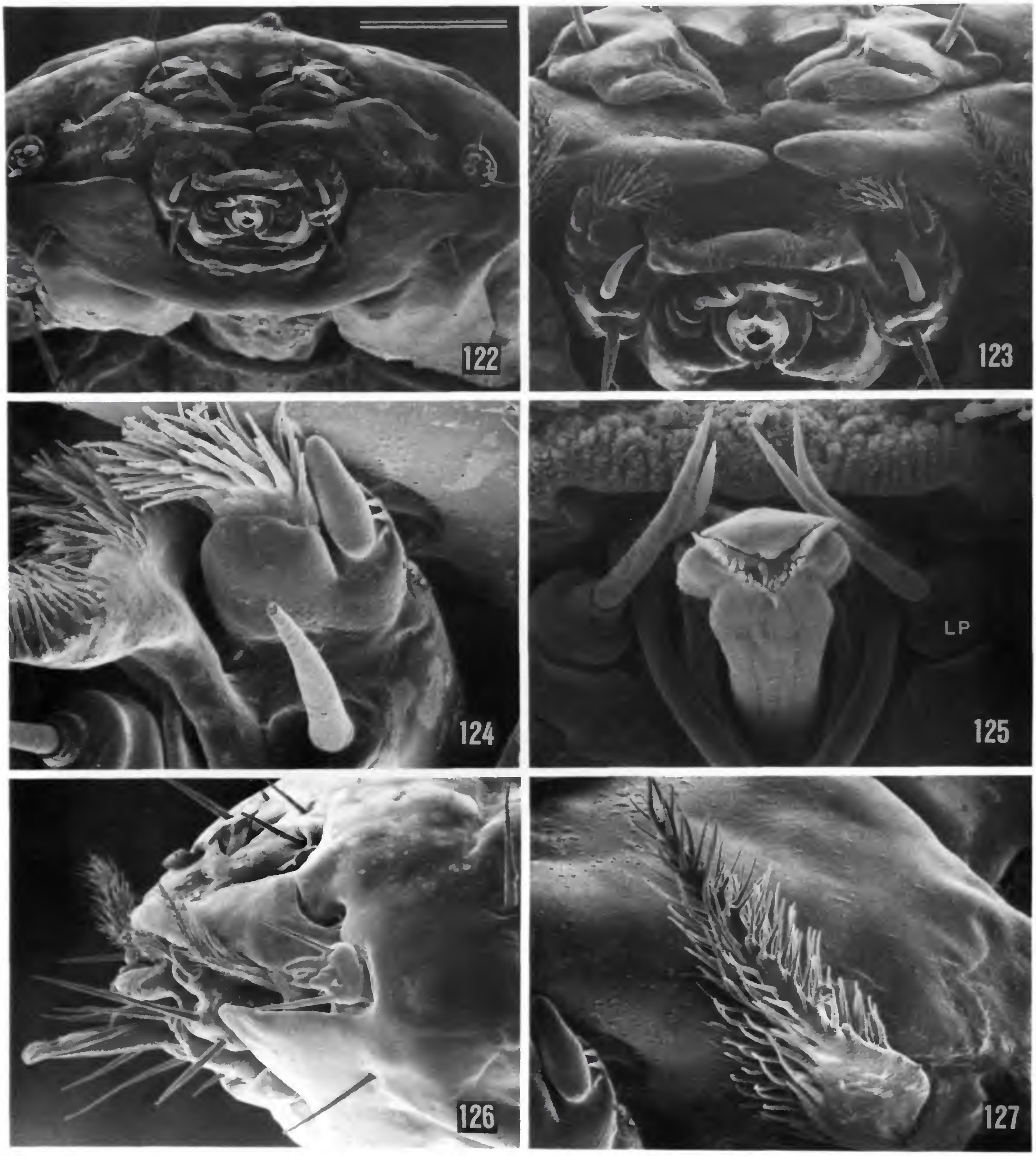
TYPE SPECIES.—*Opostega minodensis* Kuroko, 1982, by original designation.

ADULT.—Small, mostly whitish moths with lanceolate wings; antennal scape greatly enlarged; male with sclerotized aedoeagus; metafurcal apophyses free; length of forewing: 3.4-5.2 mm.

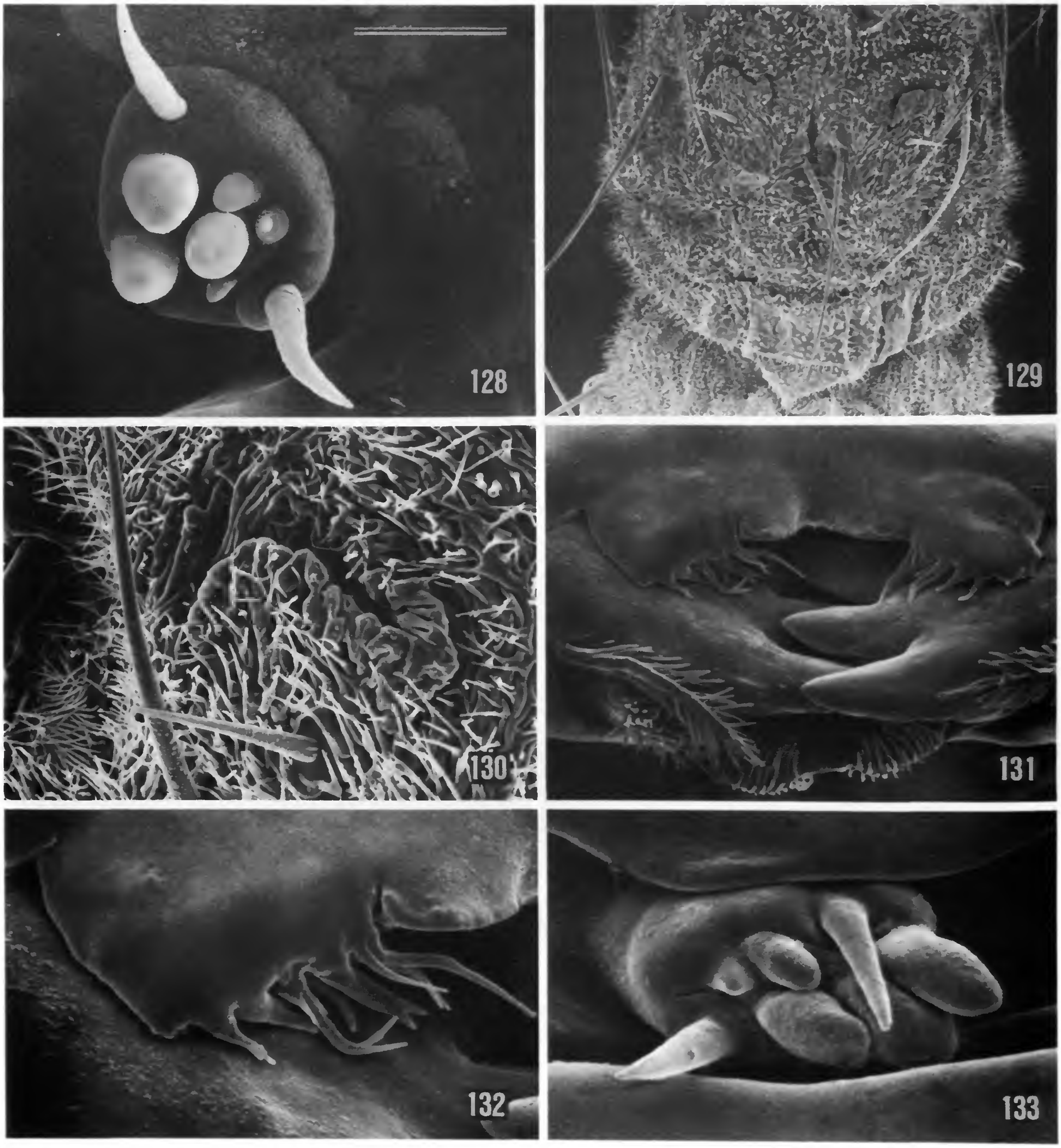
Head: Vestiture rough over most of frons and vertex, consisting of relatively short, erect, piliform scales with minutely bidentate apices; occiput posterior to vertex smooth,



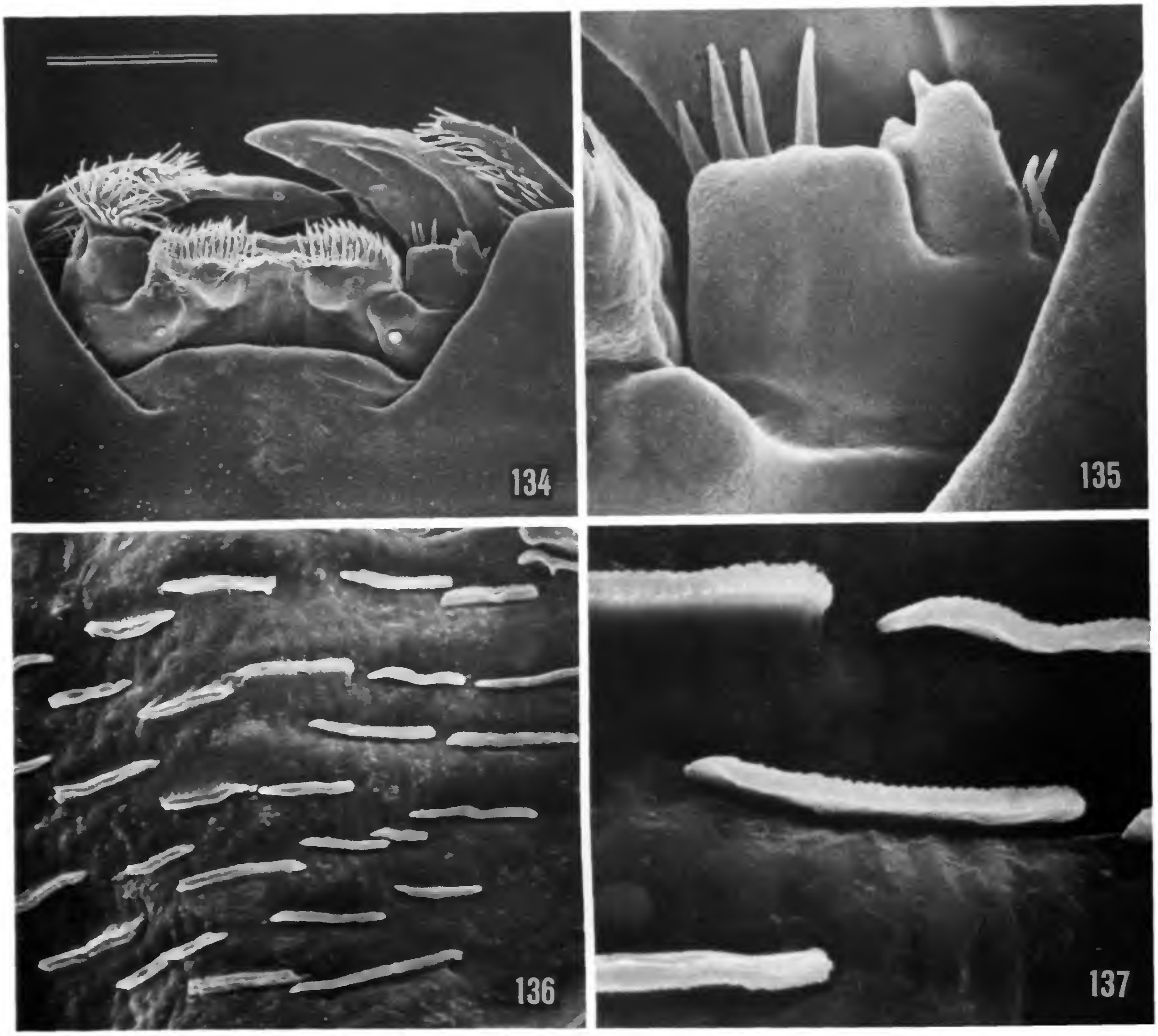
FIGURES 116–121.—*Opostegoides minodensis* (Kuroko), last larval instar: 116, dorsal view of head (231 µm); 117, detail of mouthparts, dorsal view (50 µm); 118, left lobe of labrum, detail of Figure 117 (23.1 µm); 119, ventral view of head (231 µm); 120, detail of Figure 119 (120 µm); 121, ventral view of mouthparts (60 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 116.)



FIGURES 122–127.—*Opostegoides minodensis* (Kuroko), last larval instar: 122, anterior view of head (86 µm); 123, anterior view of mouthparts, detail of Figure 122 (43 µm); 124, maxilla (15 µm); 125, spinneret and labial palpi (15 µm); 126, lateral view of head (60 µm); 127, mandibular seta (17.6 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 122.)



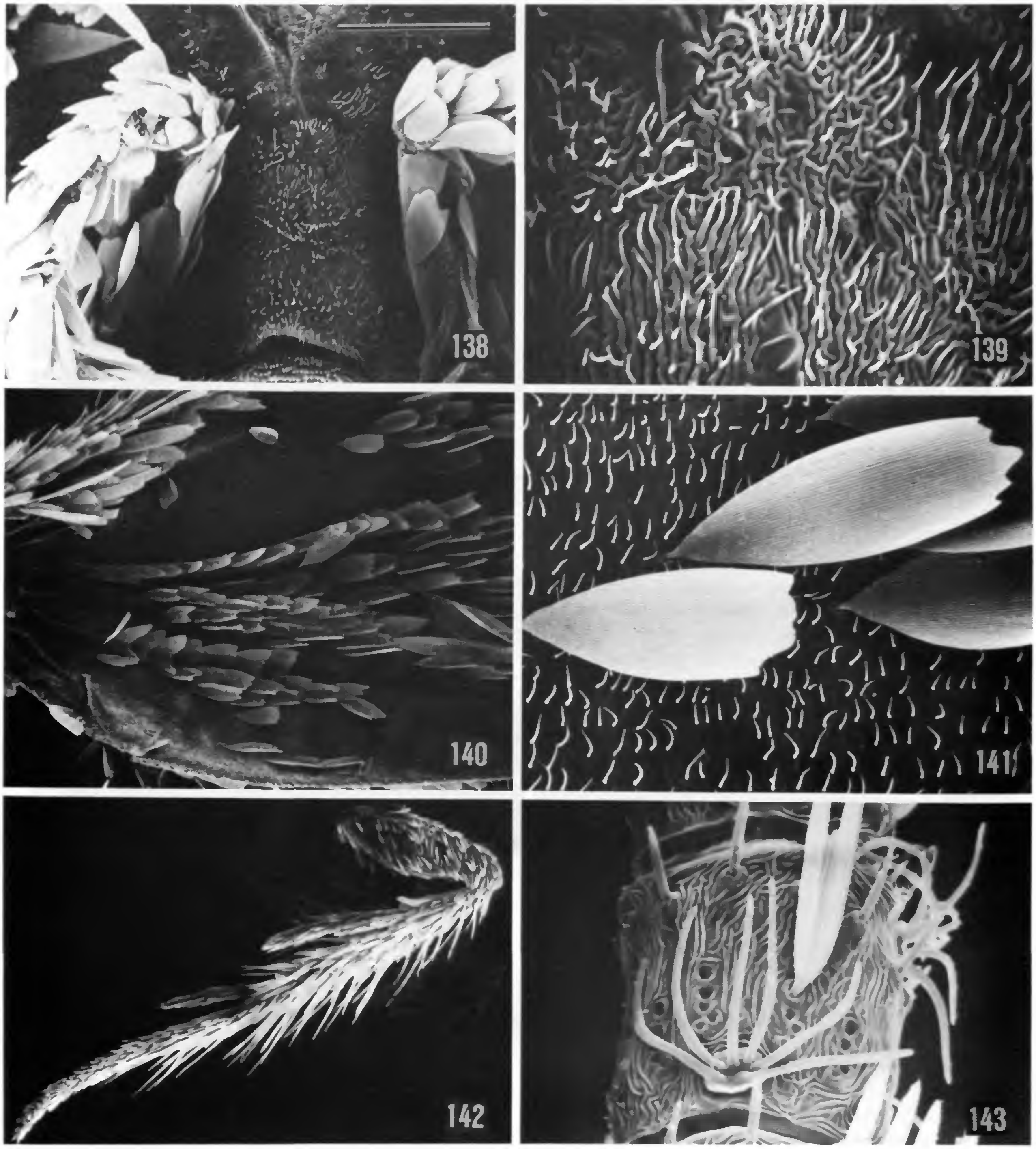
FIGURES 128–133.—*Opostegoides minodensis* (Kuroko), last larval instar: 128, antenna (13.6 μm); 129, sternum of mesothorax (150 μm); 130, detail of ambulatory callus, Figure 129 (38 μm). Pre-ultimate larval instar: 131, dorsal view of mouthparts (20 μm); 132, detail of right lobe of labrum (8.6 μm); 133, antenna (5 μm). (Scale lengths in parentheses; bar scale for all photographs = Figure 128.)



FIGURES 134–137.—*Opostegoides minodensis* (Kuroko), pre-ultimate larval instar: 134, ventral view of mouthparts (23.1 μm); 135, maxilla (5 μm); 136, sternum of mesothorax showing ridge spines (8.6 μm); 137, detail of Figure 136 (2.7 μm). (Scale lengths in parentheses; bar scale for all photographs = Figure 134.)

covered with broad flat scales densely arranged in four compact rows. Lower frons naked except for a scattering of microtrichia (Figure 138). Antenna approximately 0.8–0.9 the length of forewing, 46–56 segmented; scape greatly enlarged with greatest wiidth approximately 1.1× vertical diameter of eye; scales broad and smooth over scape and densely arranged in 7 relatively uniform, compound rows; sensilla ascoidea with 6–8 branches. Eye large, interocular index approximately 1.0, eye index 0.7. Maxillary palpus elongate, approximately 0.4 the length of labial palpus; ratio of segments from base approximately 0.2:0.2:0.6:1.4:1.0; basal segment smooth, without any lobe. Haustellum reduced, about 0.32 the length of maxillary palpus. Labial palpus moderately short, approximately equaling length of haustellum.

Thorax: Forewing lanceolate; greatest width about 0.25 that of length; apex acute; microtrichia absent over all wing surfaces except ventral base of forewing; venation similar to *Opostega*, with only unbranched vestiges of Sc, R, M, CuA, and A present; anal fold appearing in lieu of CuP. Hindwing lanceolate, greatest width approximately 0.16 that of length;



FIGURES 138–143.—*Opostegoides scioterma* (Meyrick): 138, lower frontal region of head (60 μm); 139, detail of frontal microtrichia in Figure 138 (15 μm); 140, ventral base of forewing (231 μm); 141, microtrichia in subcostal area in Figure 140 (38 μm); 142, hindleg showing spinose setae (0.71 mm); 143, sensillae of antennal segment (25 μm). (Scale lengths in parentheses; bar scale for all photographs = Figure 138.)
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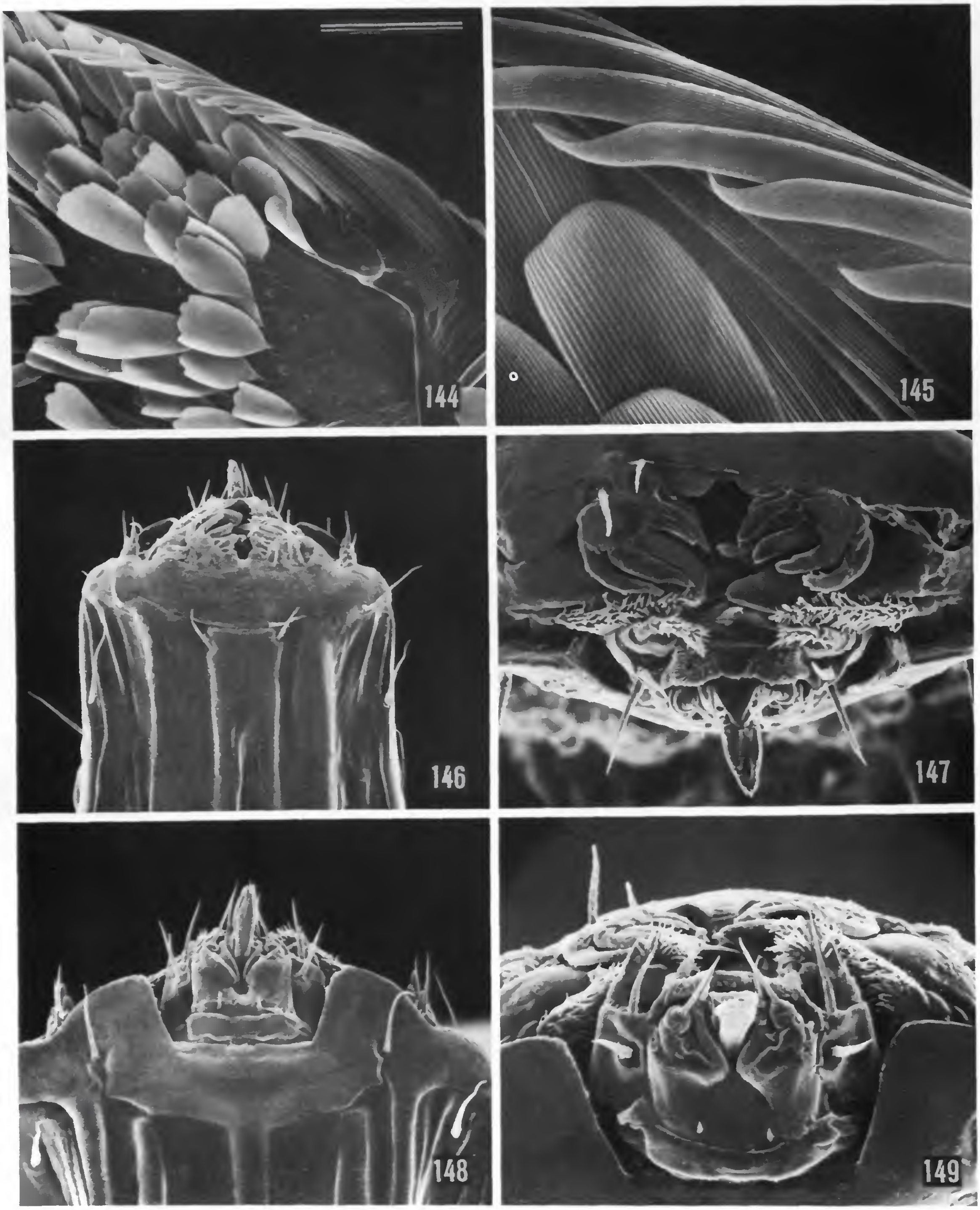
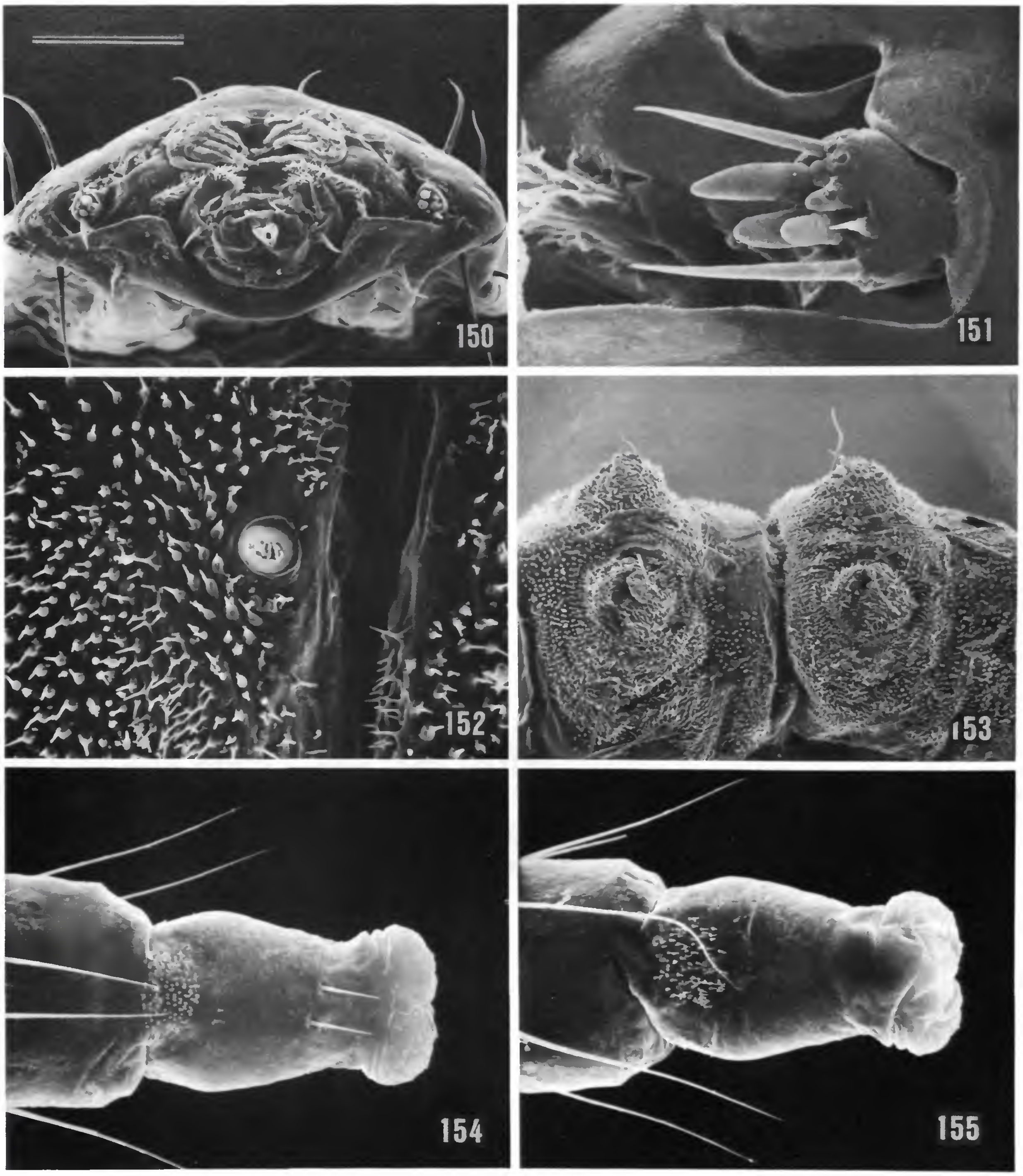
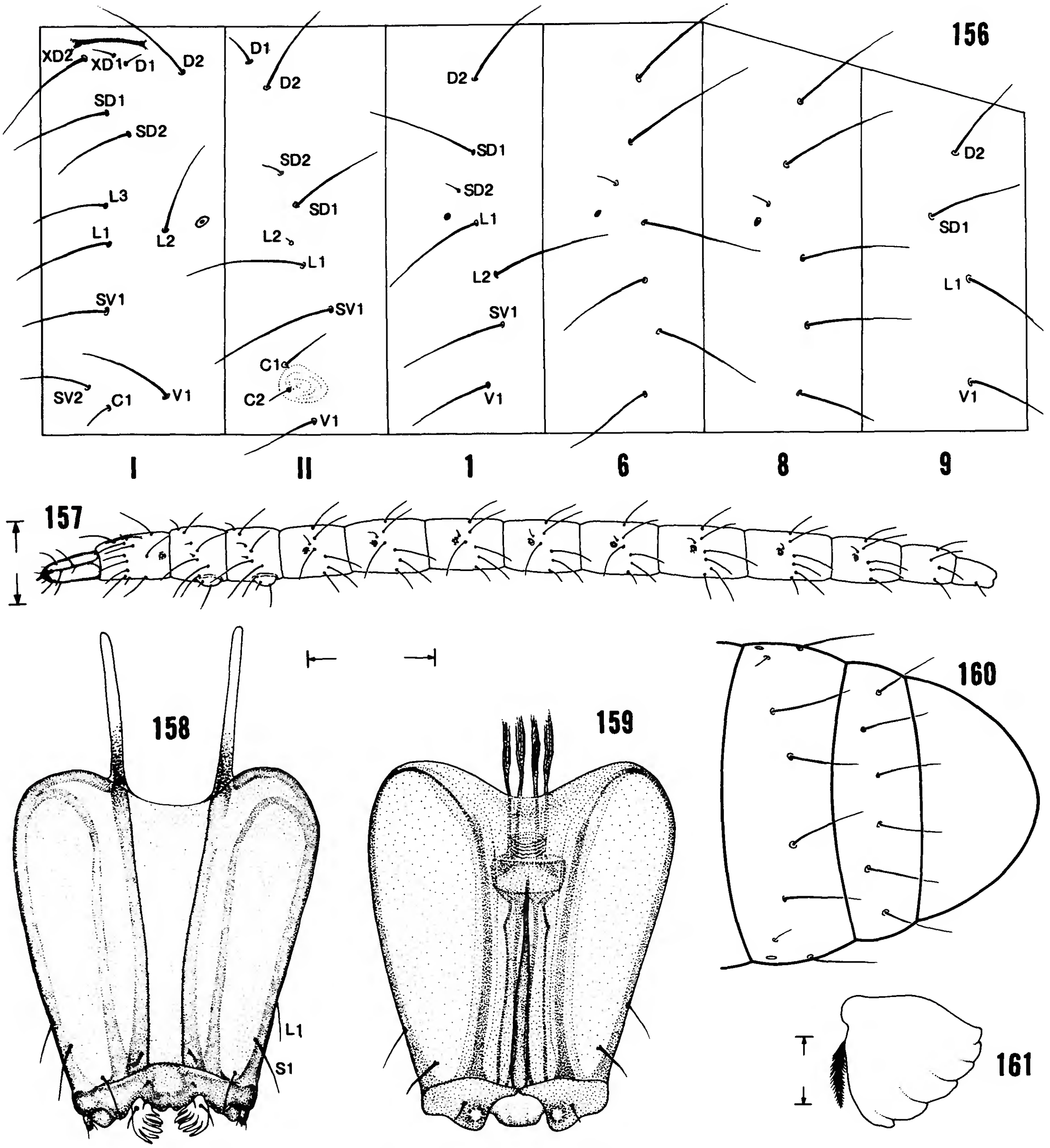


FIGURES 144–149.—*Opostegoides scioterma* (Meyrick): 144, pseudofrenular setae of hindwing (120 μm); 145, apices of pseudofrenular setae (23.1 μm). Last instar larva: 146, dorsal view of head (150 μm); 147, anterodorsal view of mouthparts (60 μm); 148, ventral view of head (94 μm); 149, anteroventral view of mouthparts (50 μm). (Scale lengths in parentheses; bar scale for all photographs = Figure 144.)



FIGURES 150–155.—*Opostegoides scioterma* (Meyrick), last instar larva: 150, anterior view of head (100 μm); 151, antenna (23.1 μm); 152, prothoracic spiracle (48 μm); 153, ambulatory calli on venter of T2 and 3 (250 μm); 154, ventral view of A9 and 10 (200 μm); 155, dorsal view of A9 and 10 (200 μm). (Scale lengths in parentheses; bar scale for all photographs = Figures 150.)



Figures 156–161.—*Opostegoides scioterma* (Meyrick), chaetotaxy of last instar larva: 156, lateral diagram of prothorax, mesothorax, and abdominal segments 1, 6, 8, and 9; 157, lateral view of larva (1 mm); 158, dorsal view of head (0.2 mm); 159, ventral view of head, including tentorium; 160, dorsal view of abdominal segments 8–10; 161, right mandible (0.05 mm). (Scale lengths in parentheses.)

approximately 10 pseudofrenular setae present; venation similar to *Opostega,* with only Sc, Rs, M, Cu, and A present. Metathoracic furca with apophyses moderately developed, terminating in acute knobs, free and not connected to secondary furcal arms. Proleg with tibia about 0.7 the length of tarsal segments. Midleg with apical spurs of very dissimilar lengths, one approximately 0.6 the length of other. Hindleg with two pairs of unequal spurs one member of each pair about 0.6–0.7 the length of other; basal pair situated at basal two-fifths; longest spurs about 0.75 the length of first tarsomere; hindtibia densely covered with long spinose setae, as is dorsum of first and sometimes second tarsomere.

Abdomen: Six functional spiracles present; spiracles of A7 and 8 absent.

Male Genitalia: Uncus nearly indistinct, a low, slightly setigerous and nearly truncate ridge fused to tegumen. Tegumen a narrow dorsal ring. Vinculum short in length but broad, deeply concave. Gnathos reduced to a thin arch. Valva with internal apophysis reduced and fused to costa. Cucullus pedunculate, arising near apex of valva; distal margin bearing a densely spined pectinifer consisting of 16–24 spines. Juxta often a lightly sclerotized plate, fused to vinculum. Aedoeagus present, elongate, 1.3–1.8× the length of valva; cornuti absent.

Female Genitalia: Anal papillae absent. Posterior apophysis short, stout; anterior apophysis absent. Anus and oviporus with separate external openings. Dorsum of vestibulum sclerotized to form a broad plate, which is fused laterally to apices of apophyses. Corpus bursae highly variable, usually without accessory bursa; spicules either absent or present, if latter then arranged in either a sinuate row or concentrated zone. Spermathecal papilla moderately developed, sometimes poorly defined; ductus spermatheca variable, usually with afferent and efferent canals continuously intertwined, but mostly separated in *O. malaysiensis.*

LARVA (Figures 146–161).—Length of mature larva 20–25 mm; maximum diameter 2 mm (in alcohol).

Head: Maximum width 0.5–0.72 mm. Color white (in alcohol) with three pairs of reddish brown longitudinal lines corresponding to the internal ridges. Antenna with three moderately large sensilla basiconica, often of different lengths, and three minute sensilla basiconica, likewise of varying sizes, and two elongate sensilla chaetica of equal lengths. Seta F1 moderately long; C1 extremely reduced in *O. minodensis,* absent in *O. scioterma.* Labrum highly modified, divided into two separate lobes, each bearing a pair of setae (M2 and 3) and a series of about six digitate lobes from outer margin in mature larva; apex of some lobes further subdivided; dorsal lobes probably represent La 1-3 and 3 epipharyngeal setae; labrum of pre-ultimate instars (Figures 131, 132) without M2-3 and with more slender, numerous marginal lobes. Mandible with 5-6 cusps. Maxilla of pre-ultimate instars less spinose than last instar; setae of stipes reduced or absent. Labium more developed in last instar, with well-developed spinneret, labial palpus, and labial seta; labium of pre-ultimate instars greatly reduced, without spinneret, labial palpus, and labial seta; operculum and opening to labial gland not observed.

Thorax: Prothorax with XD1 closely approximate to D1 and arising posterior to XD2. SV2 absent on meso- and metathorax. A pair of ventral ambulatory callosities on T2–3 in last instar but absent in pre-ultimate instars; latter with minute ridge-like spines on T2–3 (Figures 136, 137) and on A1–8.

Abdomen: L2 elongate; length equal to longest seta of segment. Ninth segment with four pairs of primary setae; SV1 absent. Dorsum of A10 devoid of setae. All body setae extremely long in last instar, greatly reduced in pre-ultimate instars.

PUPA.—Not examined.

COCOON (Figure 69).—Length 3.1–3.5 mm; width 1.8–2.0 mm; thickness 1.0–1.2 mm. An elongate flattened case; surface smooth, constructed entirely of densely woven, light brownish silk.

DISCUSSION.—In addition to the four species originally included in *Opostegoides* by Kozlov (1985), I also recognize the southern European *Opostegoides menthinella* (Mann), new combination, as congeneric as well as the Australian *Opostegoides gephyraea* (Meyrick), new combination. The generic placement of the latter is somewhat tentative and is primarily based on the female genitalia. In particular, the absence of anal papillae and the presence of a similar, well-defined vestibulum and stout apophyses seem to indicate greatest affinities to *Opostegoides.* The male genitalia of most species are very similar but distinct. In most instances these relatively minor differences are correlated with differences in wing pattern.

This genus agrees with *Notiopostega, Eosopostega,* and *Paralopostega* in the retention of an aedoeagus. The relative homogenous male genitalia exhibit several synapomorphies that easily distinguish the group. Most obvious among these are the concave anterior margin of the vinculum, reduced gnathos, juxta broad at base and fused to vinculum, and elongate pedicel of the cucullar lobe (pectinifer). The female genitalia have been less studied and poorly illustrated in previous reports, but they appear to be characterized by the absence of anal papillae, presence of a broad, sclerotized, roof-like dorsal wall over the vestibulum and stout apophyses.

The larvae of only two members of this genus have been studied (*minodensis* and *scioterma*). Little, if any, differences have been observed between these two species, which suggests a general conservatism among species within genera. From *Notiopostega,* the larva of *Opostegoides* can be easily destinguished by the more specialized, divided labrum and generally more reduced chaetotaxy over the body (e.g., the absence of dorsal setae on A10). *Opostegoides* differs from the Hawaiian *Paralopostega* in the possession of more generalized antennal sensilla, by the presence of L1, in the absence of an operculum over the labial gland aperture, and possibly by the absence of the aperture itself in pre-ultimate instars.

Opostegoides malaysiensis, new species

FIGURES 253, 279, 280, 309

ADULT (Figure 253).—Length of forewing: male, 2.7 mm; female, 3.0 mm. Small silvery white moths with an oblique golden brown subapical facia extending to black apical spot.

Head: Vestiture silvery white. Scape silvery white with a narrow suffusion of fuscous along anterior margin; flagellum 42–47 segmented, cream, becoming darker over apical third. Maxillary palpus cream to buff. Labial palpus cream with fuscous vestiture laterally.

Thorax: Silvery white. Forewing silvery white dorsally with a faint brown spot along hindmargin near basal third and a golden brown fascia, margined externally and internally by a thin band of dark brown, extending obliquely from subapex of costa to a small black apical spot; apical cilia beyond fascia light brown to white; venter of forewing dull white to cream with faint fuscous shading midway near costal margin. Hindwing white dorsally and ventrally. Forelegs shiny white with heavy suffusion of fuscous dorsally. Mid- and hindlegs shiny white, becoming more cream over tarsi.

Abdomen: Dull white to pale buff dorsally, shiny white ventrally.

Male Genitalia (Figures 279, 280): Uncus bearing only four setae; lateral pair the largest. Excavation of anterior margin of vinculum 0.4 the length of entire genital capsule. Base of valva 0.66 the total length of valva; pectinifer well developed, with 20–22 elongate spines that nearly cover cucullar lobe. Aedoeagus with a large, internal, sclerotized rod, which broadens posteriorly.

Female Genitalia (Figure 309): Vestibulum nearly as broad as eighth segment, lightly sclerotized both dorsally and ventrally, angulate at its lateral margins then abruptly narrowing to short, relatively slender ductus bursae. Corpus bursae elongate, with a short but enlarged lateral (accessory) lobe; a lightly sclerotized, bidigitate plate partially encircling corpus bursae at level of junction of lateral lobe; numerous, minute papillose spines projecting externally from plate. Spermatheca highly modified; slender, sclerotized efferent canal arising from distinct papilla near caudal end of ductus bursae, then extending anteriorly along wall of corpus bursae into the larger primary lobe of corpus where it spirals along the inner wall of the bursa constricting the walls as it proceeds; afferent canal originates as an elongate sac at level of sclerotized zone, and passes anteriorly in a typical convoluted manner through the center of primary lobe of corpus; both afferent and efferent canals then exit anterior end of corpus bursae in normal juxtaposition. A spermathecal vesicle and utriculus was not observed; most likely these were broken off during dissection.

Larva and pupa unknown.

ETYMOLOGY.—The species name is derived from the country of origin (Malaysia) plus the Latin suffix *-ensis* (denoting place, locality).

HOLOTYPE.—Male; Berinchang, Cameron Highlands, (West) Malaysia; 29 Aug 1986, T. Kumata (FRIM).

PARATYPE.—MALAYSIA: Same locality as holotype: ♀, 31 Aug 1986, T. Kumata (ELHU).

HOST.—Unknown.

FLIGHT PERIOD.—Late August; univoltine.

DISTRIBUTION.—Known only from the type locality in western Malaysia.

DISCUSSION.—The discovery of this Malaysian species is of some significance in that the genus *Opostegoides* was previously known only from the holarctic region. *Opostegoides gephyrea* (Meyrick) is also believed to represent this genus in Australia. The forewing markings, particularly the subapical, golden brown fascia, should distinguish *O. malaysiensis* from the other members of *Opostegoides*. Unfortunately, the fascia is not as evident in the male holotype because of its somewhat more rubbed condition. However, because the male genitalia conclusively demonstrates the generic affinities of the species, the male was selected over the female as the holotype. Although the male genitalia closely resembles the other species in this genus, the female genitalia appear so highly modified that they may be unique not only for the family but for the entire Lepidoptera as well. The most remarkable feature of the female is the enclosure of the ductus spermatheca for most of its length within the corpus bursae. Possibly similar modifications are present in other female *Opostegoides*, but the few illustrations published to date are too incomplete for comparison.

Paralopostega, new genus

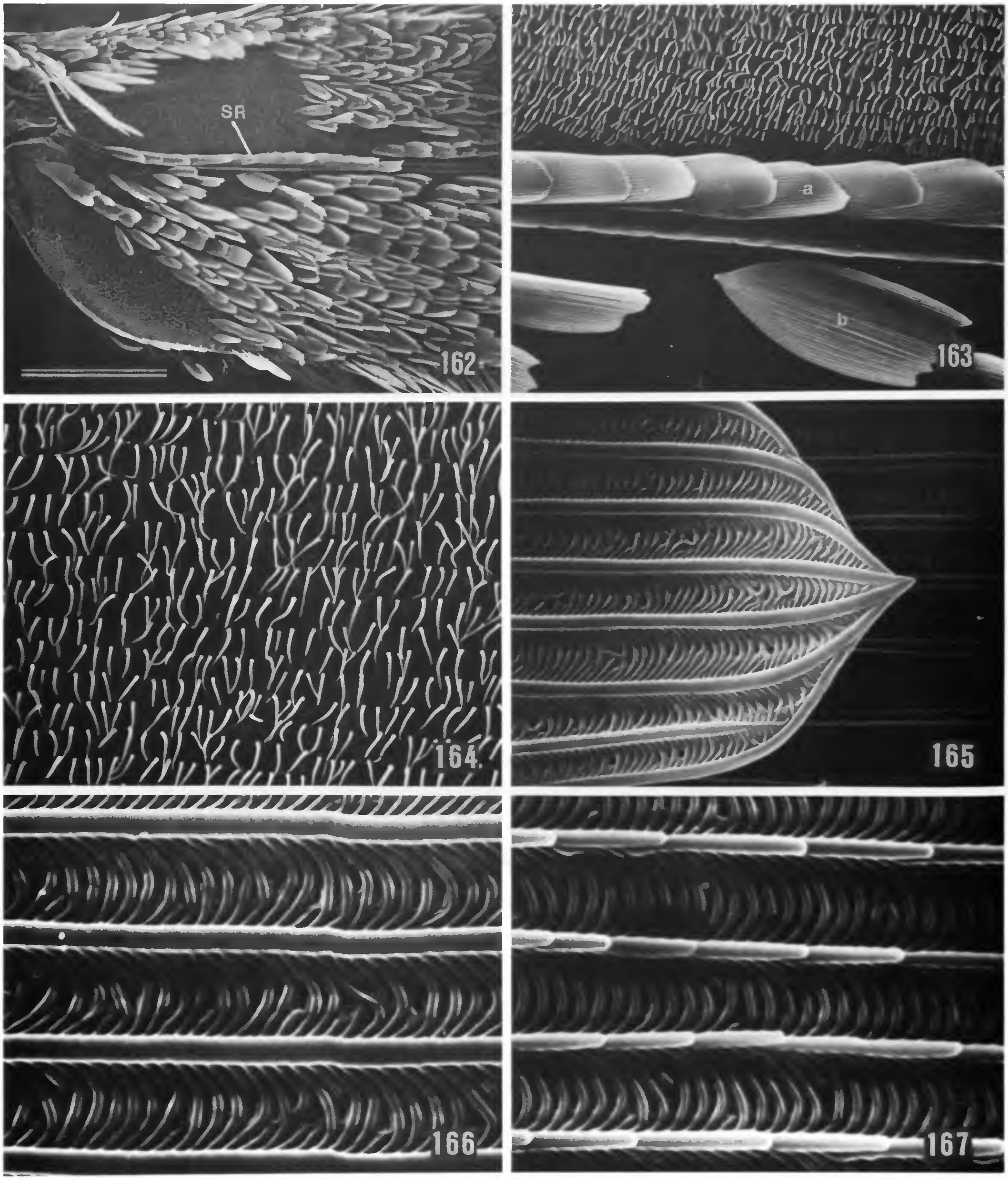
FIGURES 8, 9, 28, 37–39, 53, 59, 162–191, 257–260, 286–288, 312, 313

TYPE SPECIES.—*Opostega callosa* Swezey, 1921.

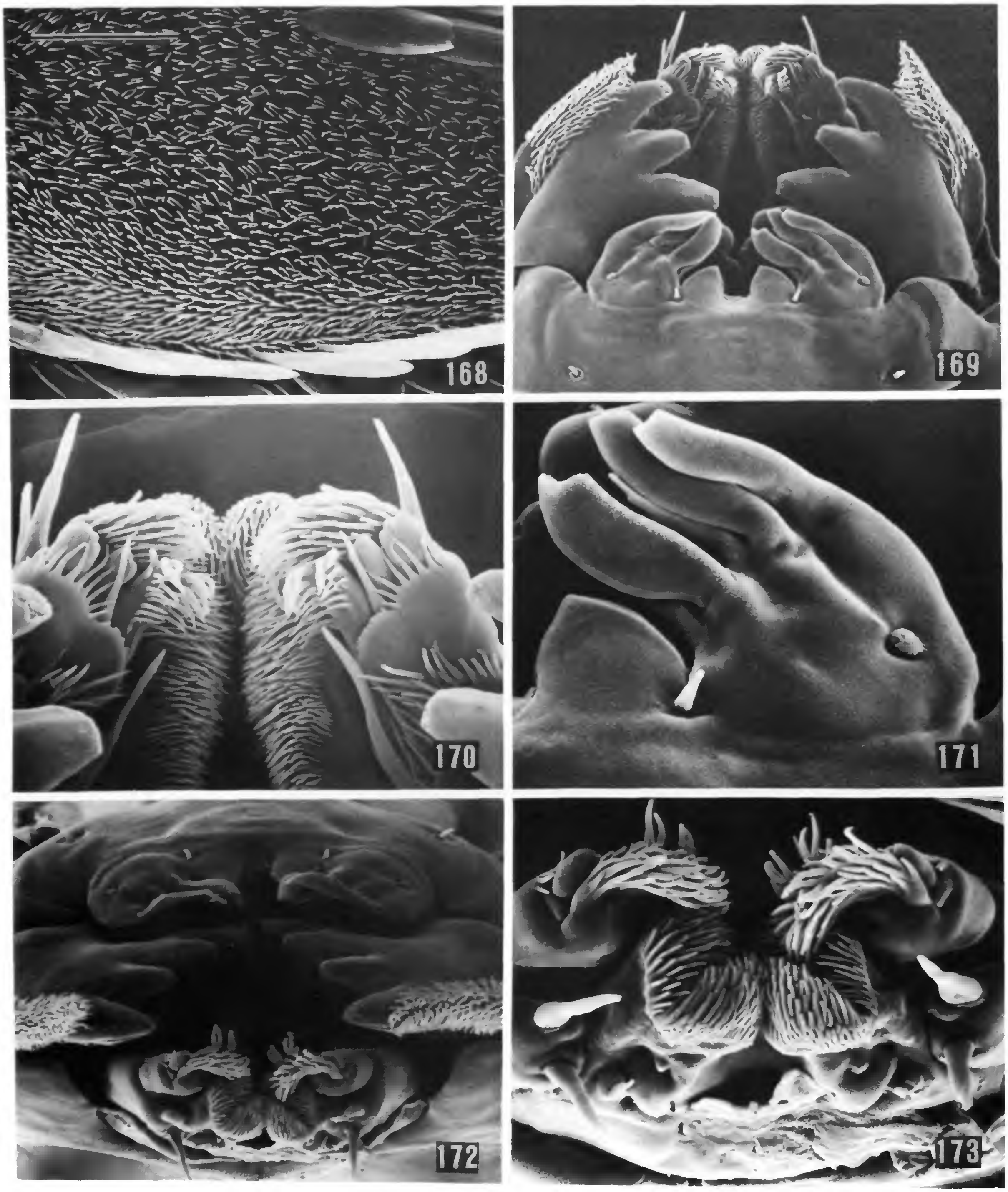
ADULT.—Small white to dusky moths with lanceolate wings; antennal scape greatly enlarged; male with sclerotized, reduced aedoeagus; metafurcal apopyhses free; length of forewing: 2.75–5 mm.

Head: Vestiture of vertex rough, consisting of piliform scales with either simple or minutely bidendate apices; posterior to vertex scales broad, smooth, densely arranged in 3–4 rows; lower frons naked except for scattered microtrichia. Cranial vertex evenly rounded. Antenna approximately 0.8–1.0 the length of forewing, 52–75 segmented; scape greatly enlarged, greatest width about 1.2× the vertical eye diameter; scales broad and flat over scape and densely arranged in approximately 11–12 somewhat irregular rows. Eye large; interocular index approximately 1.2; eye index 0.7. Maxillary palpus elongate, exceeding length of haustellum and about 1.5× length of labial palpus; ratio of segments from base approximately 0.2:0.2:0.5:1.3:1.0. Haustellum reduced, about 1.6× the length of maxillary palpus. Labial palpus reduced, approximately 0.8 the length of haustellum.

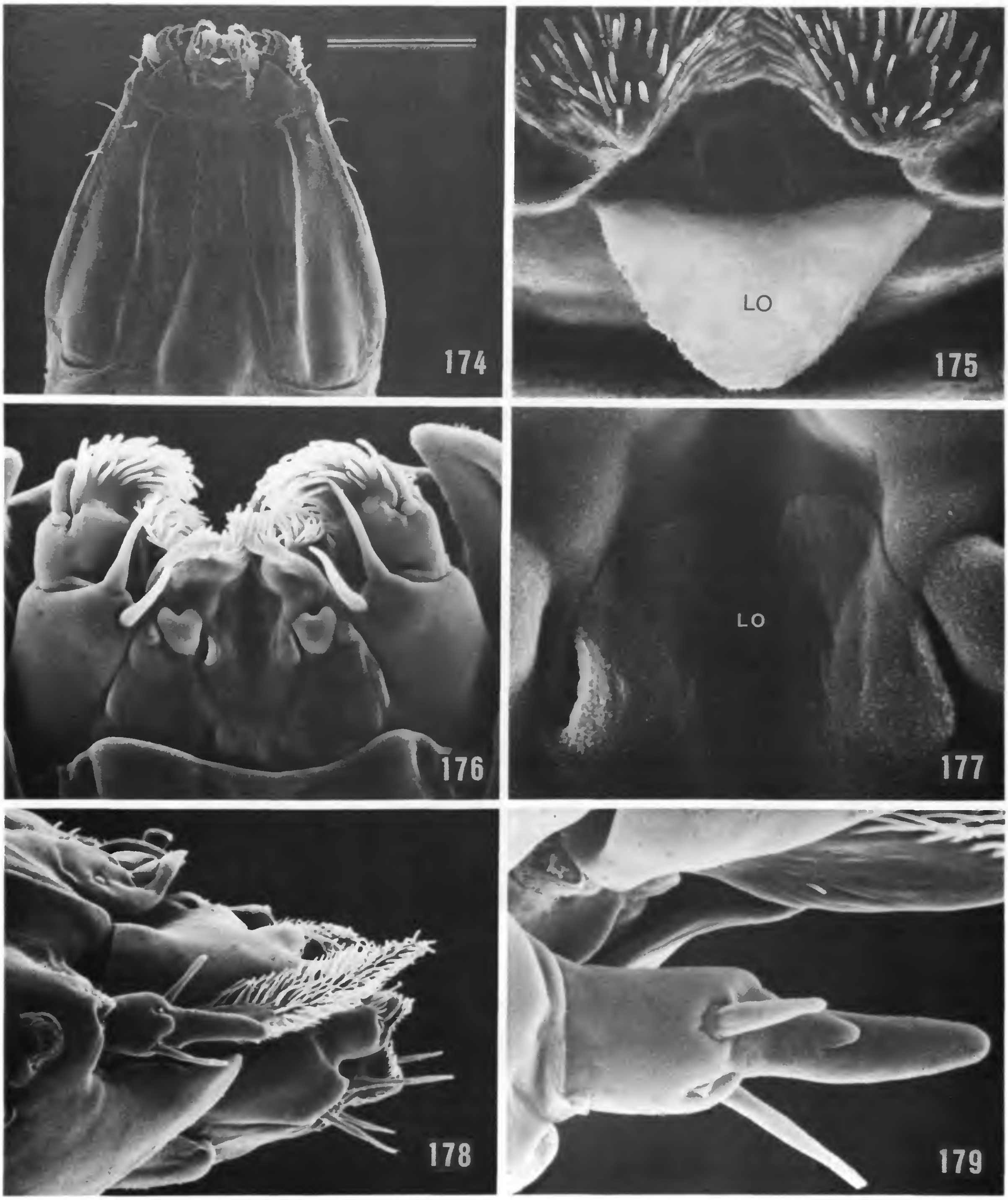
Thorax: Forewing lanceolate; greatest width 0.26 that of length; apex acute; microtrichia absent except over ventral



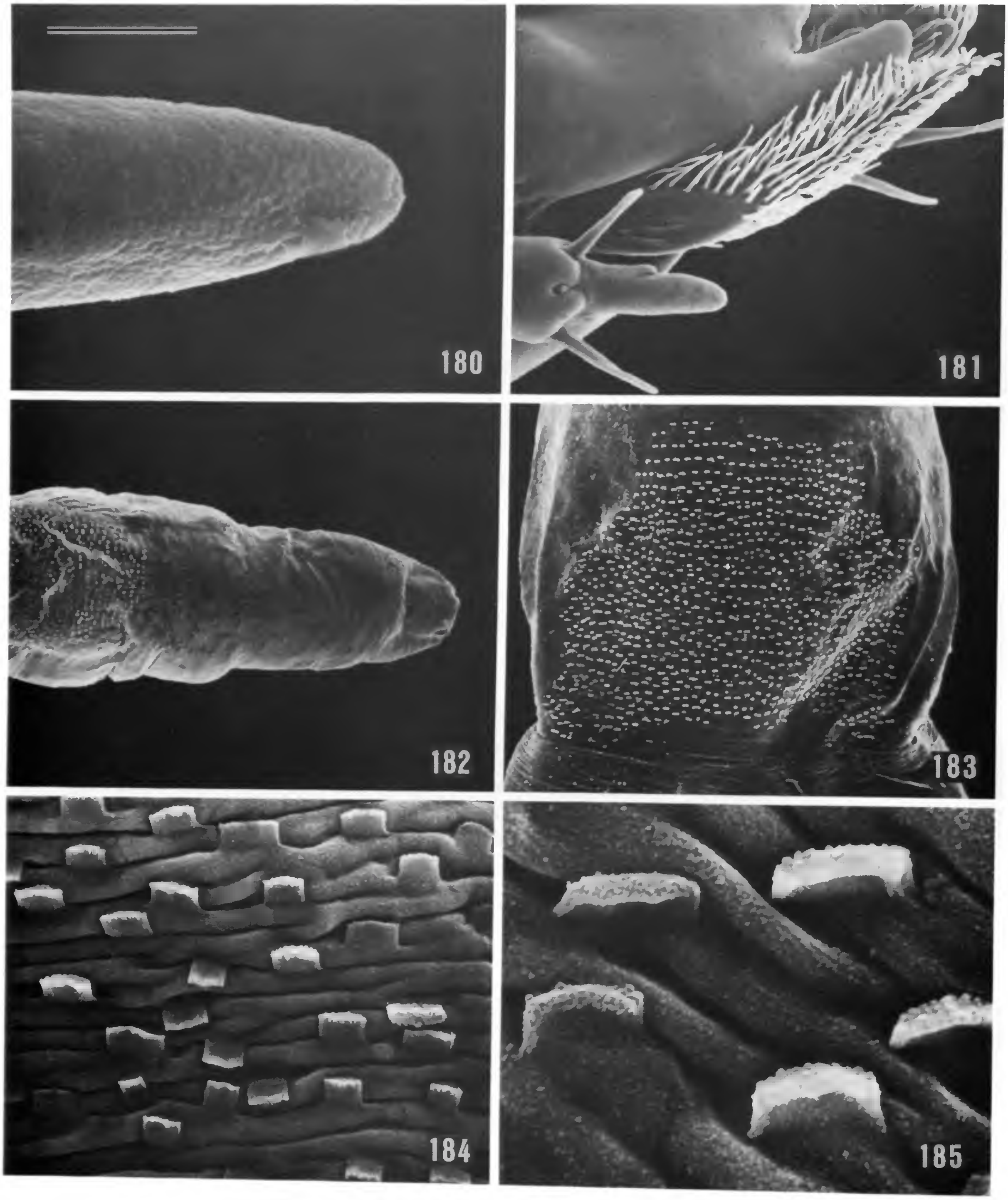
FIGURES 162–167.—*Paralopostega callosa* (Swezey): 162, ventral basal half of forewing (0.27 mm); 163, subdorsal retinaculum composed of row of stiff scales along venter of medial vein (50 µm); 164, dense concentration of microtrichia on venter of forewing subcostal area (Figure 162) (25 µm); 165, apex of retinacular scale (Figure 163, a) (3 µm); 166, detail of Figure 165 showing absence of scutes (1.5 µm); 167, detail of typical wing scale (Figure 163, b) showing scutes (1.5 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 162.)



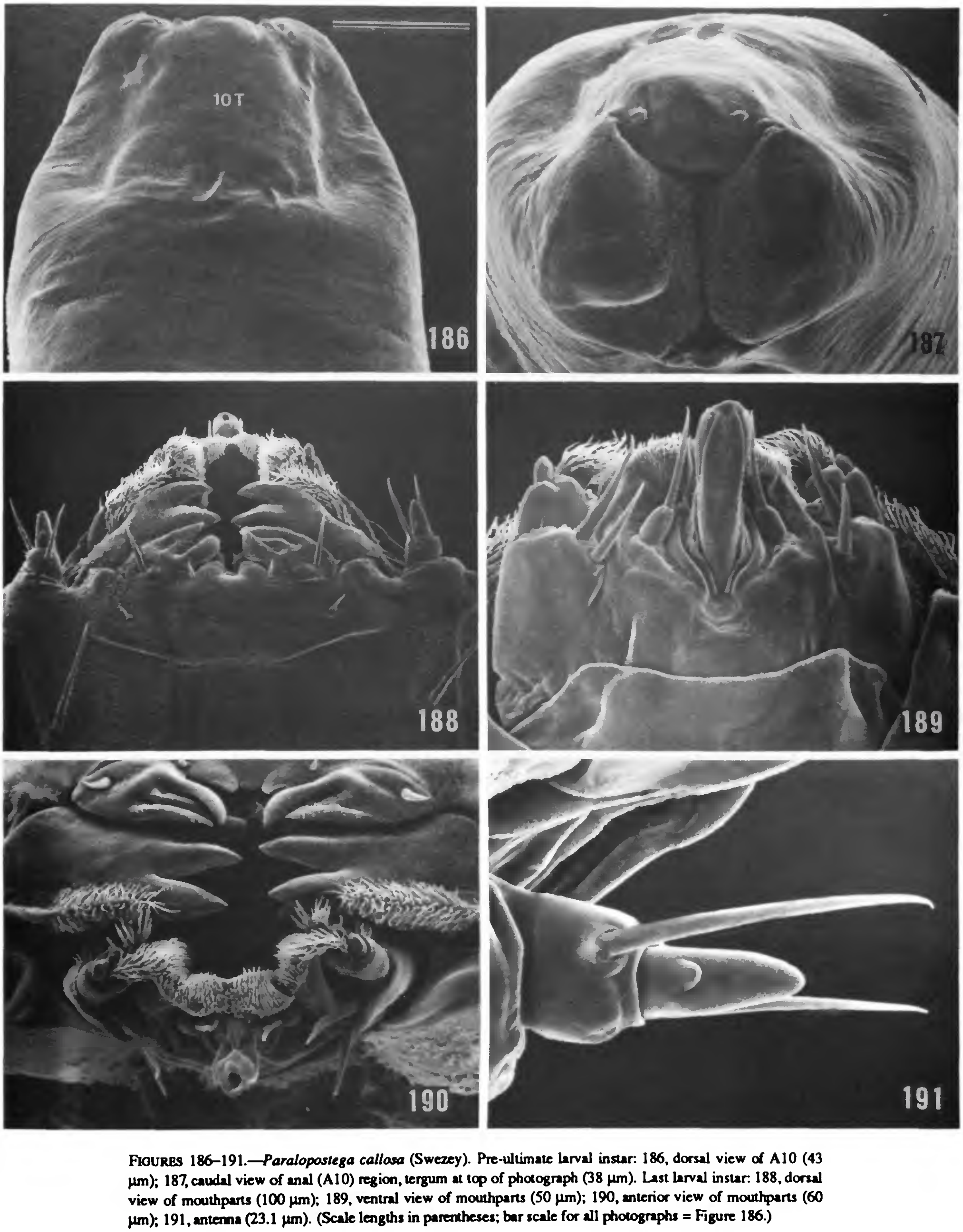
FIGURES 168–173.—*Paralopostega callosa* (Swezey): 168, detail of microtrichia in anal area of ventral forewing (Figure 162) (60 μm). Pre-ultimate larval instar: 169, dorsal view of mouthparts (50 μm); 170, detail of Figure 169 (20 μm); 171, labrum, right lobe (15 μm); 172, anterior view of mouthparts (43 μm); 173, detail of Figure 172 (20 μm). (Scale lengths in parentheses; bar scale for all photographs = Figure 168.)



FIGURES 174–179.—*Paralopostega callosa* (Swezey), pre-ultimate larval instar: 174, ventral view of head (150 µm); 175, labial gland aperture with operculum open (8.6 µm); 176, ventral view of mouthparts (17.6 µm); 177, labial operculum in closed condition (4.3 µm); 178, lateral view of anterior end of head (38 µm); 179, antenna (15 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 174.)



FIGURES 180–185.—*Paralopostega callosa* (Swezey), pre-ultimate larval instar: 180, large apical sensillum of antenna (of Figure 179) (3.8 μm); 181, mandibular seta and antenna (25 μm); 182, dorsal view of abdominal segments 8–10 (136 μm); 183, eighth abdominal tergum (75 μm); 184, detail of Figure 183 (7.5 μm); 185, detail of ridge spines in Figure 184 (2.7 μm). (Scale lengths in parentheses; bar scale for all photographs = Figure 180.)



FIGURES 186–191.—*Paralopostega callosa* (Swezey). Pre-ultimate larval instar: 186, dorsal view of A10 (43 µm); 187, caudal view of anal (A10) region, tergum at top of photograph (38 µm). Last larval instar: 188, dorsal view of mouthparts (100 µm); 189, ventral view of mouthparts (50 µm); 190, anterior view of mouthparts (60 µm); 191, antenna (23.1 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 186.)

base; venation similar to *Opostega,* with only unbranched vestiges of Sc, R, M, CuA, and A present; anal fold present in lieu of CuP. Hindwing lanceolate, greatest width 0.16 that of length; 7-8 pseudofrenular setae present; venation similar to *Opostega,* with only Sc, Rs, M, Cu, and A present. Metathoracic furcal apophysis free, extending caudally and laterally well short of secondary arm of metafurcasternum. Proleg with tibia approximately 0.7 the length of tarsal segments. Midleg with tibial spurs of unequal lengths, one member of pair about 0.6 the length of other. Hindleg with two pairs of unequal spurs, the basal pair situated near basal third of tibia with one spur about 0.5 the length of other; apical spurs shorter and more similar in length, the shorter member about 0.6 the length of other; longest spur of basal pair slightly longer than first tarsomere; hindtibia densely covered with long spinose setae.

Abdomen: Six functional spiracles present; spiracles of A7 and 8 absent.

Male Genitalia: Uncus reduced to a pair of widely separated, setigerous lobes. Tegumen a narrow dorsal ring. Vinculum a narrow, evenly rounded ventral ring. Gnathos moderately well developed, broadly rounded to sub-truncate. Valva with prominent apophysis continuous with base of costa; cucullar lobe elliptical in shape and borne on a relatively slender, short pedicel; pectinifer consisting of 27-31 blunt spines arranged in a single row. Juxta relatively broad, triangular, tapering anteriorly to vinculum, with caudal margin the broadest and slightly emarginate. Aedoeagus present, relatively short with rounded apex, and closely associated with juxta.

Female Genitalia: Anal papillae present, consisting of a pair of small setigerous tubercules arising from dorsum of T8. Posterior apophysis elongate, slender; anterior apophysis vestigial, short, lightly sclerotized and terminating at base of anal papilla. Anus and oviporus with separate external openings. Vestibulum only slightly widened with relatively thin walls. Ductus bursae with scattered spicules. Corpus bursae moderately enlarged, without spicules.

LARVA (Figures 169-191).—Length of largest larva 8 mm; maximum diameter 0.6 mm (in alcohol). Development undergoing slight hypermetamorphosis with body setae greatly reduced in length in all instars except last; tubular spinneret not formed until last instar.

Head: Maximum width 0.6 mm. Color white (in alcohol) with three pairs of dark reddish brown longitudinal lines corresponding to the internal ridges. Antenna with a single, large, apical basiconic sensillum, possessing a small flattened lateral lobe near base; apex of antenna also bears two elongate sensilla chaetica of equal lengths that may surpass apex of basiconic sensillum; an extremely short, nearly obsolate sensillum chaeticum arises between bases of two elongate sensilla. Labrum reduced and highly modified (Figure 170) closely resembling that of *Opostegoides;* labrum divided at middle, with two normal seta (M2 and M3), with the most lateral (M3) approximately 4× the length of M2; apical margin bearing a series of digitate lobes probably consisting of the three lateral setae (L1-3) underlayed by three elongate and more slender epipharyngeal setae. Mandible with 4-5 cusps and one, densely spined mandibular seta. Distal region of hypopharynx more densely spined than in *Notiopostega* or *Opostegoides.* Development of labium hypermetamorphic; last instar with typical, tubular spinneret (Figure 189) and well-developed labial palpus with elongate seta; pre-ultimate instars lacking spinneret and labial palpus but with relatively large, simple aperture to labial gland, which is closed by a triangular operculum (Figures 175, 177). Setae S1 and A1 present, L1 absent.

Thorax and Abdomen: Setae greatly reduced in pre-ultimate instars; body practically naked in some instars except for rectangular patches of minute, broadly truncate spines (Figures 183-185) on venter of T1-3 and A1-8. Body setae greatly elongated in last instar.

PUPA.—Length 2.1 mm, not examined but illustrated by Zimmerman (1978:246).

ETYMOLOGY.—The generic name is derived from the Greek *paralos* (near the sea) prefixed to the generic stem *Opostega,* in reference to the oceanic distribution of this group. It is feminine in gender.

DISCUSSION.—This genus is proposed for the six Hawaiian species treated by Zimmerman (1978) and included in the synoptic catalog of this paper (p. 72). As mentioned by Zimmerman, the status of some of these names is questionable because their genitalia appear indistinguishable. Their larval mines, however, as figured by Swezey (1921) and later Zimmerman (1978), appear quite distinct. The genus is characterized largely by the male genitalia, particularly by the presence of a reduced aedoeagus, nearly truncate gnathos, large, broad juxta, and extension the of valva far beyond the base of the cucullar lobe. The genus is also unique in being the only Opostegidae known to possess leafmining larvae through all larval instars. This behavior, however, is likely to be encountered in other genera eventually. All six Hawaiian species are restricted as leafminers to *Pelea,* a genus of approximately 75 species of Pacific and mostly Hawaiian Rutaceae.

The genitalia of *Paralopostega* and *Opostega* are similar in some features. The anterior apophyses of the ovipositor is relatively distinct in *Opostega* but are barely evident in *Paralopostega.* In the male genitalia, the only structure that closely agrees is the juxta, with a similar appearance that may be due to convergence.

Both Swezey and Zimmerman discuss the difficulty in collecting and rearing *Paralopostega* in Hawaii. The type series of all six described species totals only 10 specimens, and only a few additional adults have been collected since these names were proposed in 1907 and 1921. Specimens have been collected on Kauai, Oahu, Molokai, and Maui. Of the described species, only *Paralopostega callosa* is represented by a male. Largely for this reason and also because all three syntypes were reared from very distinct leafmines, I have selected this species as type for the genus.

The larvae of *Paralopostega* are also distinctive, particularly with regard to antennal morphology. The antenna of this genus possesses one large, apical basiconic sensillum (which Heinrich refers to as the third antennal segment) instead of three or four small sensilla as in *Notiopostega* and *Opostegoides.* Heinrich (1918) was the first to illustrate a *Paralopostega* larva, and his observations were fairly accurate considering the instruments available to him at the time. His depictions of the labrum (Heinrich, 1918, fig. 1) and spinneret (Heinrich, 1918, fig. 4) vary with mine, however, and appear wrong. For example, it is clear that Heinrich's illustration (fig. 4) of a Hawaiian opostegid larva is not of a mature (i.e., final instar) specimen. The absence of labial palpi, fully developed spinneret, and large labial setae (laterad to spinneret) indicate it to be a pre-ultimate stage. Because immature opostegid larvae are not known to possess a tubular spinneret, Heinrich's description of a greatly reduced one is believed incorrect and his illustration apparently is of a non-existent structure.

Opostega Zeller

FIGURES 10, 11, 29, 40–42, 54, 60, 192–205, 261–264, 292–296, 314–316

Opostega Zeller, 1839:214; 1848:279.—Clemens, 1862:131.—Herrich-Schäffer, 1853:60.—Stainton, 1854:288.—Meyrick, 1881:174; 1893:605; 1928b:806.—Spuler, 1910:428.—Walsingham, 1914:349.—Fletcher, 1929:154.—Pierce and Metcalfe, 1935:87.—Pelham-Clinton, 1976:269.—Zimmerman, 1978:233.—Kozlov, 1985:49.

TYPE SPECIES.—*Elachista salaciella* Treitschke, by Walsingham, 1914:349.

ADULT.—Small, predominantly white moths with lanceolate wings; antennal scape greatly enlarged; male with aedoeagus absent; metafurcal apophyses free; length of forewing 3.1–8.0 mm.

Head: Vestiture of vertex rough, consisting of piliform scales with minutely bidentate apices; posterior to vertex scales broad, smooth, densely arranged in irregular rows; lower frons naked except for scattered rows of microtrichia (Figure 192). Cranial vertex evenly rounded. Antenna approximately 0.8 the length of forewing, 65–70 segmented; scape greatly enlarged, greatest width 1.4× the vertical eye diameter; scales broad and flat over scape and densely arranged in about 9–10 irregular rows; sensilla ascoidea usually with 7–10 branches. Eye large, interocular index approximately 0.9; eye index 0.7. Maxillary palpus relatively short, less than haustellum in length, and about 1.5× length of labial palpus; ratio of segments from base approximately 1.2:019:1.7:2.3:1.0. Haustellum moderately long, about 1.5× length of maxillary palpus. Labial palpus reduced, less than 0.5 the length of haustellum.

Thorax: Forewing lanceolate; greatest width about 0.23 that of length, apex acute; microtrichia absent on all surfaces except for ventral base of forewing; venation extremely reduced with only unbranched vestiges of Sc, R, M, CuA, and A present; anal fold appearing in lieu of CuP. Hindwing lanceolate, greatest width about 0.14 that length; approximately 13 pseudo-frenular setae present; venation extremely reduced with only SC, RS, M, Cu, and A present. Metathoracic furcal apophysis free, extending caudally and laterally almost to secondary arm of metafurcasternum. Proleg with tibia approximately 0.6 the length of tarsal segments. Midleg with tibial spurs of unequal lengths, one member of pair about 0.6 the length of other. Hindleg with two pairs of unequal spurs, the basal pair situated slightly basad to middle, with one spur about 0.6 the length of other; apical spurs shorter and more similar in length; the shorter member about 0.7 the length of other; longest spur of basal pair exceeding length of first tarsomere; hindtibia densely covered with long spinose setae.

Abdomen: Six functional spiracles present; spiracles of A7 and 8 absent.

Male Genitalia: Uncus reduced to a pair of widely separated, setigerous lobes. Tegumen a narrow dorsal ring. Vinculum a narrow, evenly rounded, ventral ring. Gnathos present, consisting of a well-developed, plate-like sclerite usually bearing an acute, median process from caudal margin. Valva with apophysis well developed and fused to base of costal margin. Cucullar lobe elliptical in shape and borne on a relatively stout pedicel arising near distal third of valva; pectinifer with 28–40 blunt spines arranged in a single row. Juxta in the form of a relatively broad, flat plate with the caudal margin broadly rounded, subacute, or biolobed. Aedoeagus absent, although ejaculatory duct usually well developed, elongate.

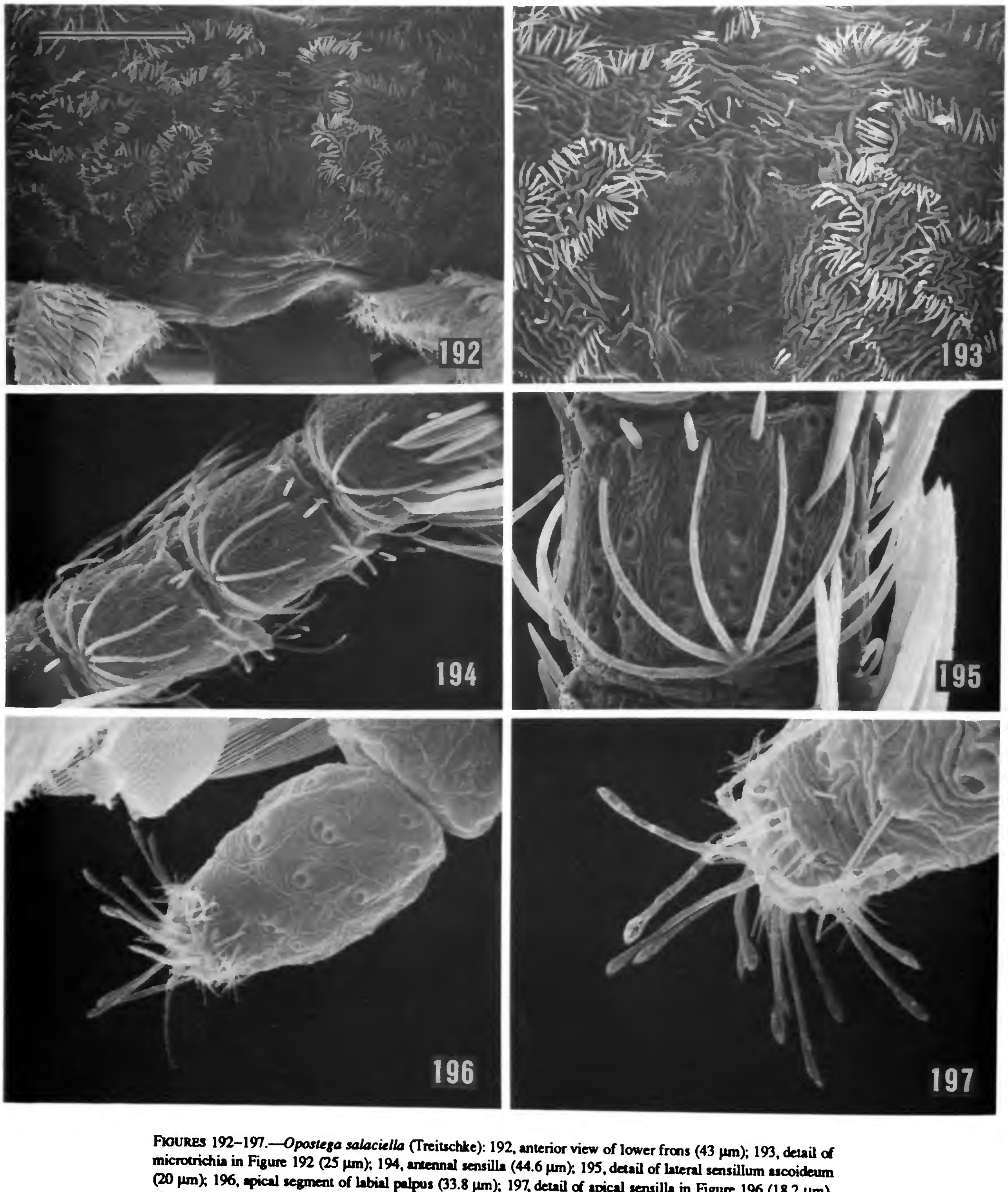
Female Genitalia: Anal papillae present, consisting of a pair of nearly contiguous, setose, dorsal lobes arising from T8. Posterior apophysis elongate, slender; anterior apophysis short and stout. Anus and oviporous with separate external openings. Walls of vestibulum slightly thickened. Corpus bursae greatly enlarged, without spicules. External duct of ductus spermatheca enlarged.

LARVA.—"Light green in color" (Sorhagen, 1886). Not examined.

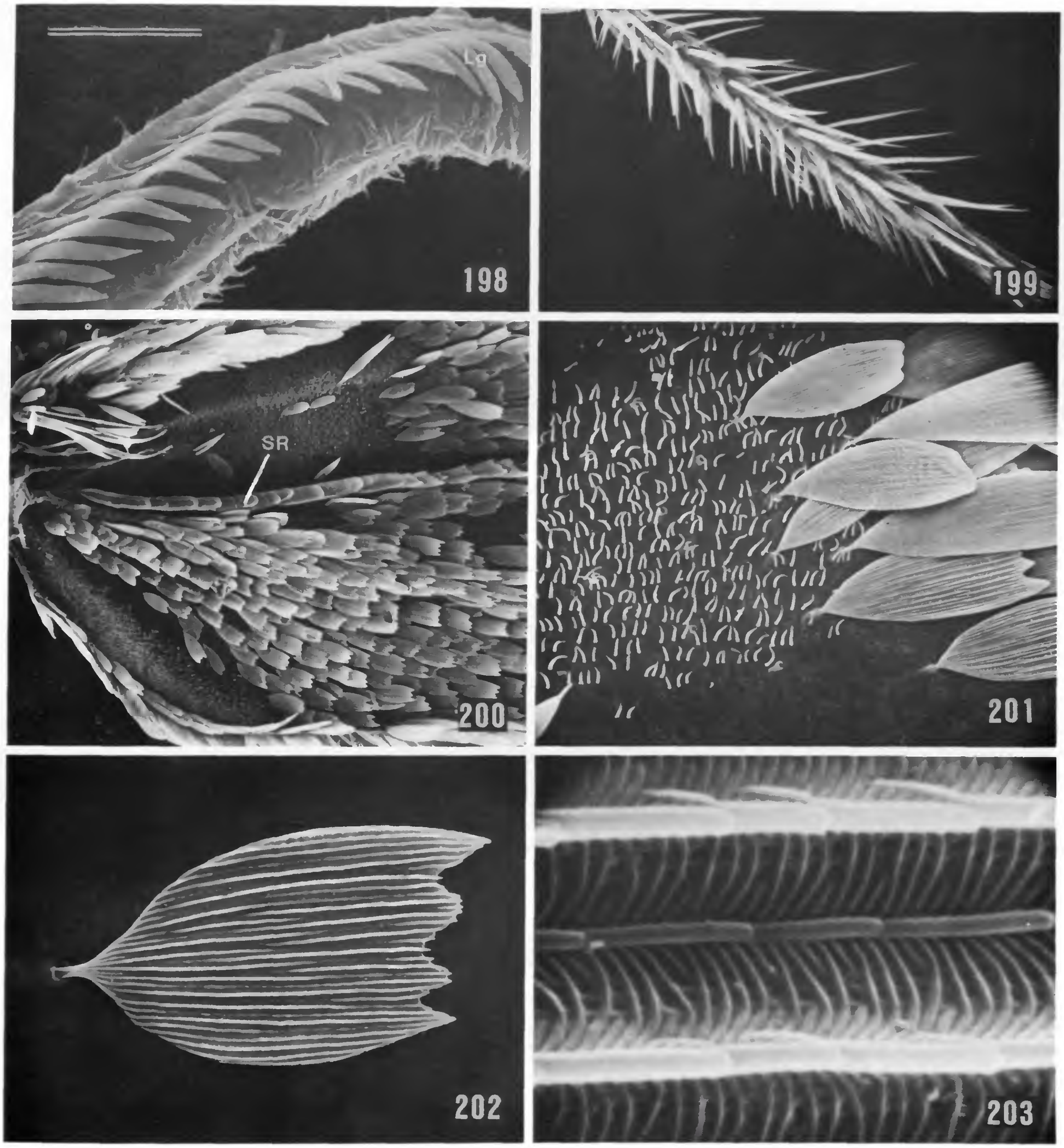
PUPA.—Unknown.

DISCUSSION.—Further study of the species now placed in *Opostega* will undoubtedly result in the restriction of the size of the group even more than indicated in this report. Presently 58 species remain in *Opostega,* although the majority have not been examined sufficiently to determine their true relationships.

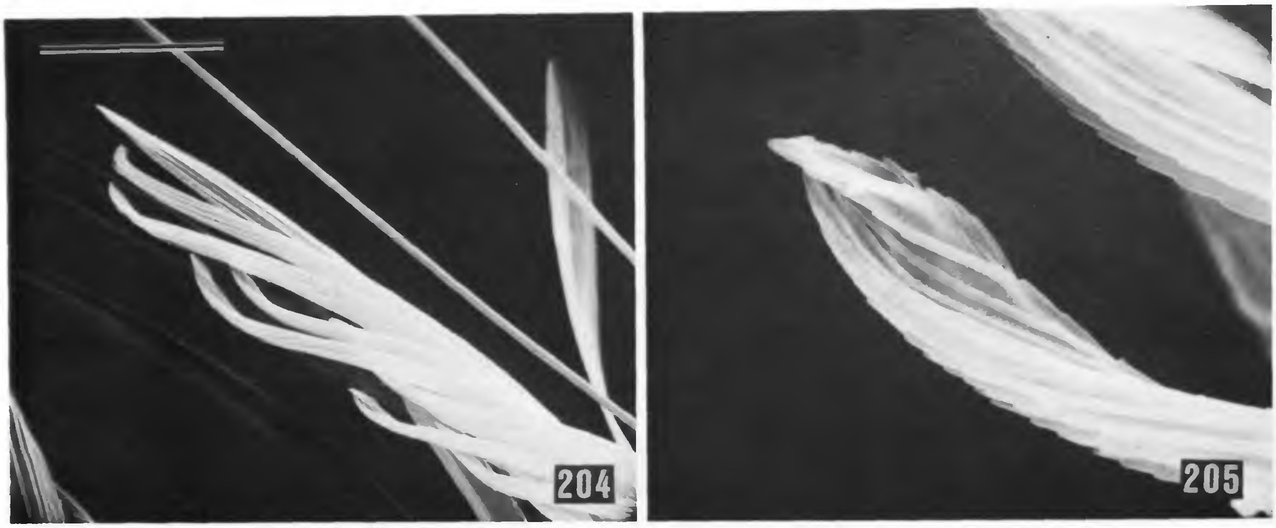
As characterized by the type species, *O. salaciella,* the genus is most allied to *Pseudopostega.* This relationship is indicated by the loss of an aedoeagus, attenuated gnathos, and by the presence of similar anal papillae. *Opostega* differs from *Pseudopostega* in having the apophysis fused to the valva and the presence of a broad, V-shaped juxta in the male, and in the presence of the anterior apophyses in the female. The metafurcal apophyses, which are fused to the secondary arms in *Pseudopostega,* are free in *Opostega,* as they are in other opostegid genera (not examined in *Eosopostega*).



FIGURES 192–197.—*Opostega salaciella* (Treitschke): 192, anterior view of lower frons (43 μm); 193, detail of microtrichia in Figure 192 (25 μm); 194, antennal sensilla (44.6 μm); 195, detail of lateral sensillum ascoideum (20 μm); 196, apical segment of labial palpus (33.8 μm); 197, detail of apical sensilla in Figure 196 (18.2 μm). (Scale lengths in parentheses; bar scale for all photographs = Figure 192.)



FIGURES 198–203.—*Opostega salaciella* (Treitschke): 198, mesal view of haustellum (120 μm); 199, spinose setae on hindtibia (0.45 mm); 200, ventral base of forewing (0.27 mm); 201, microtrichia in subcostal area of forewing (Figure 200) (60 μm); 202, broad scale from discal area of ventral forewing showing variable ridge dimorphism (24 μm); 203, detail of Figure 202 (1.5 μm). (Scale lengths in parentheses; bar scale for all photographs = Figure 198.)



FIGURES 204, 205.—*Opostega salaciella* (Treitschke): 204, pseudofrenular setae from hindwing (46 μm); 205, apex of pseudofrenular seta (6 μm). (Scale lengths in parentheses; bar scale for photographs = Figure 204.)

Opostega afghani, new species

FIGURES 261, 292

ADULT (Figure 261).—Length of forewing: male, 3.8–4.2 mm. Small, immaculate, whitish moths with light buff hindwings.

Head: Mostly dull white; piliform scales of vertex predominantly pale buff. Scape and pedicel dull white; flagellum 60–62 segmented, light brown, slightly paler, more buff ventrally. Maxillary and labial palpi dull white to buff.

Thorax: Pronotum and forewing dull white, immaculate; underside of forewing darker, buff. Hindwing slightly darker, buff to pale gray dorsally and dull white ventrally. Foreleg with coxae silvery white; remainder of leg light brown to buff dorsally, more whitish ventrally. Mid- and hindleg predominantly dull white to buff, indistinctly irrorated with white.

Abdomen: Light brown to buff dorsally, paler, more whitish ventrally.

Male Genitalia (Figure 292): Uncus reduced, almost evenly rounded, consisting of a terminal-lateral pair of setigerous pads. Gnathos well developed with a short, stout, median, acute process directed caudally. Juxta relatively narrow, candal margin evenly rounded. Valva tapering to a somewhat smoothly rounded apex slightly distad of pedunculate cucullar process; the latter bearing a broadly ellptical lobe bearing an apical pectinifer consisting of 32–34 blunt spines in a single reflexed row. Ejaculatory duct moderately long, about 2–2.5× the length of genital capsule.

Female, larva, and pupa unknown.

ETYMOLOGY.—The species name is from the Pushtu (or Afghan) term meaning a native or inhabitant of Afghanistan.

HOLOTYPE.—Male; Khurd-kabul, southeast of Kabul, Afghanistan, 1900 m; 20 May 1965, Kasy and Vartian, (NHMV).

PARATYPES.—AFGHANISTAN: Same data as holotype, 11♂, (NHMV), 2♂, (USNM). 40 km SW of Kabul, 2300 m: 1♂, 17 Jun 1965, Kasy and Vartian, (NHMV). 10 km NW of Kabul, 1900 m: 1♂, 1 Jun 1965, Kasy and Vartian (NHMV). Paghman, 30 km NW of Kabul, 2200 m: 2♂, 20–22 Jun 1957, Kasy and Vartian (NHMV); 1♂ (USNM). Paghman, 30 km NW of Kabul, 2500 m: 1♂, 12–15 Jun 1965, Kasy and Vartian (NHMV).

HOST.—Unknown.

FLIGHT PERIOD.—Middle May to middle June; univoltine.

DISTRIBUTION.—Known only from the environs of Kabul, Afghanistan, at elevations from 1900 to 2500 m.

DISCUSSION.—This species shows nearest affinities to *Opostega salaciella* and may be easily distinguished from the latter by features of the male genitalia. In *O. afghani* the caudal margin of the juxta is smoothly rounded and not attenuated as in *O. salaciella*, and the valva is more narrowed at the apex distad to the cucullar pedicel.

Pseudopostega Kozlov, new status

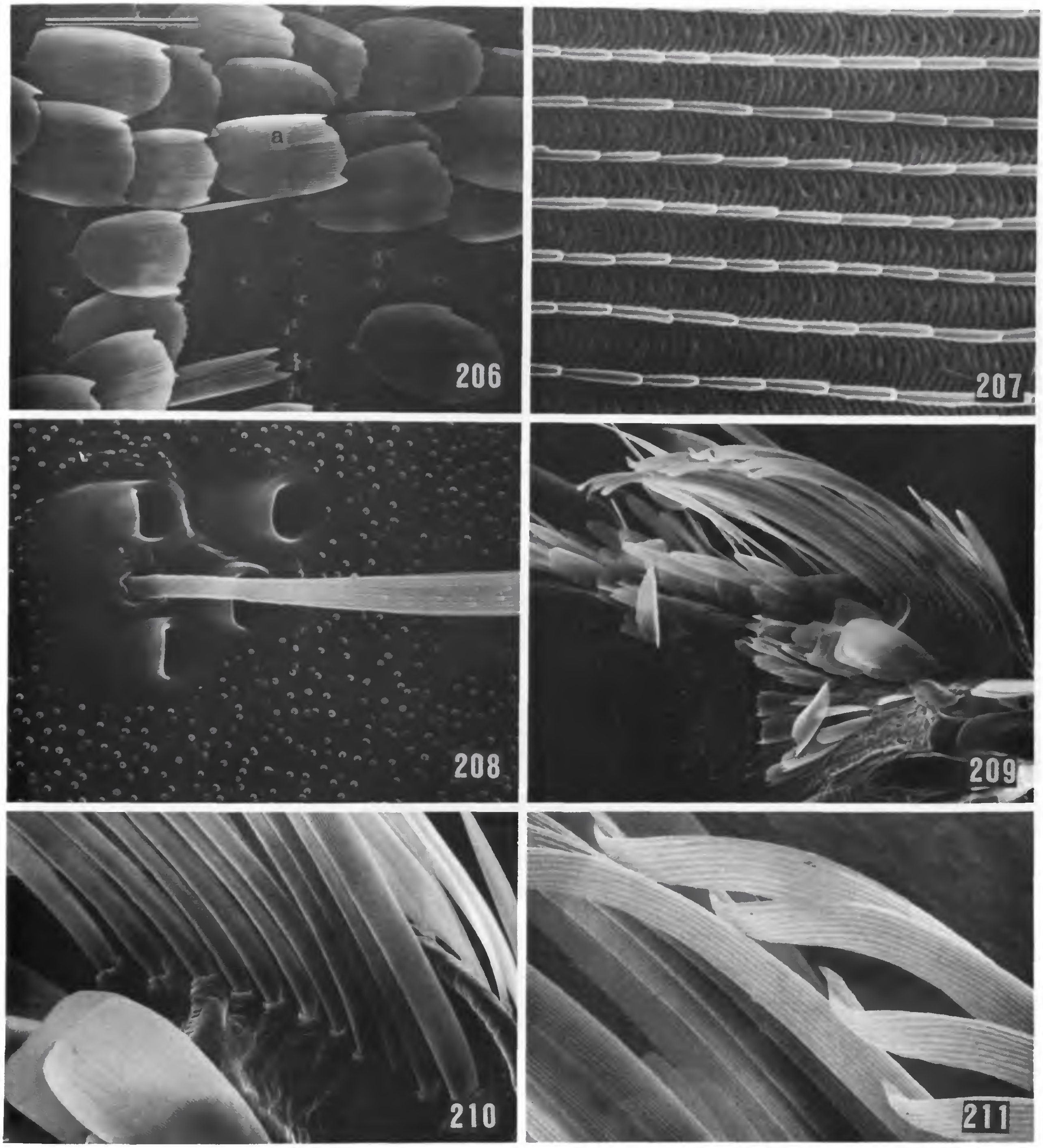
FIGURES 12–14, 30, 43–49, 55, 61, 206–249, 265–273, 297–305, 317–320

Pseudopostega Kozlov, 1985:53 [subgenus of *Opostega*].

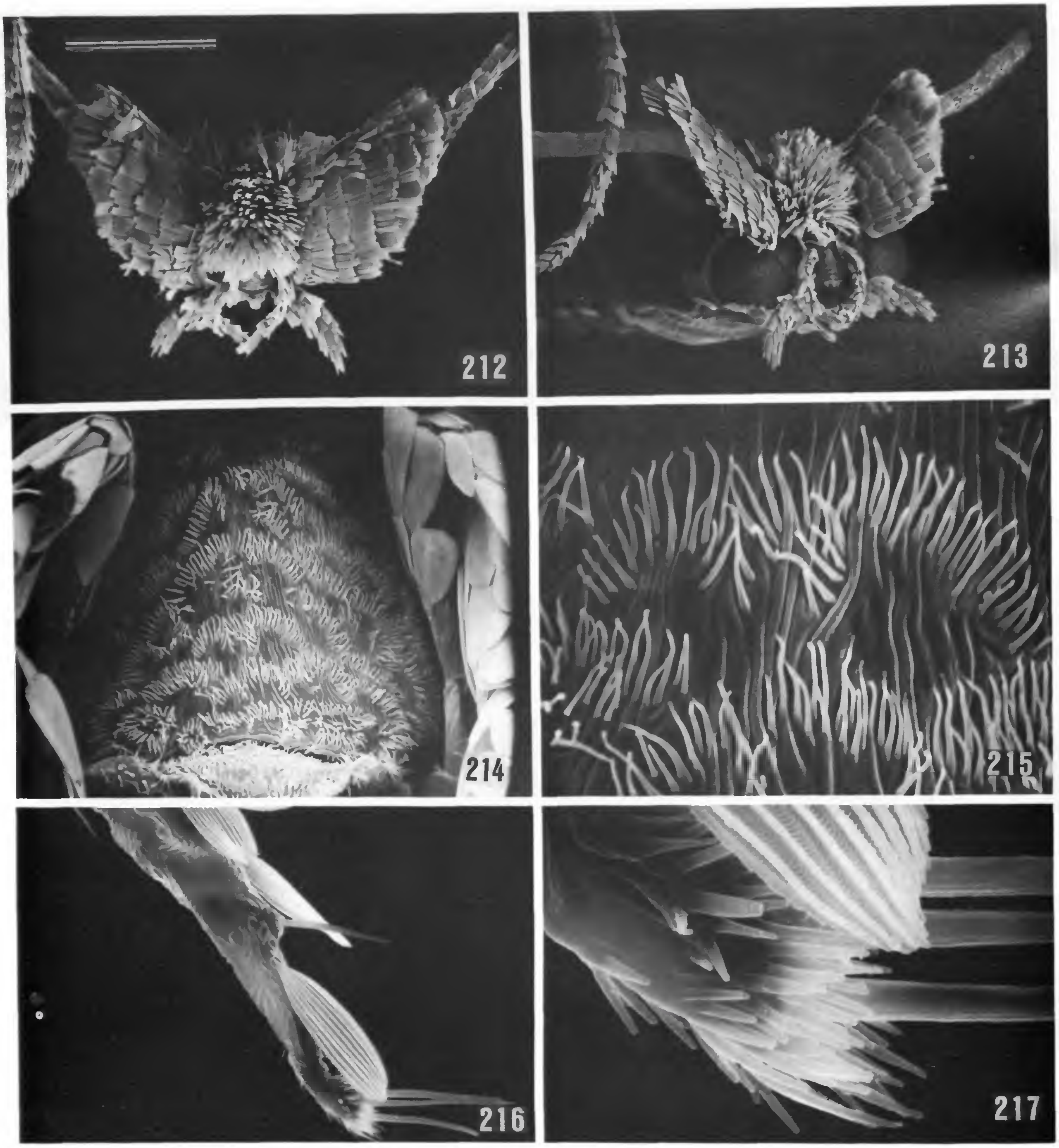
TYPE SPECIES.—*Tinea auritella* Hübner, original designation.

ADULT.—Small, predominantly white moths with lanceolate wings; antennal scape greatly enlarged; male with aedoeagus absent; metafurcal apophyses fused to secondary arms of metafurcasternum; length of forewing: 1.8–6.0 mm.

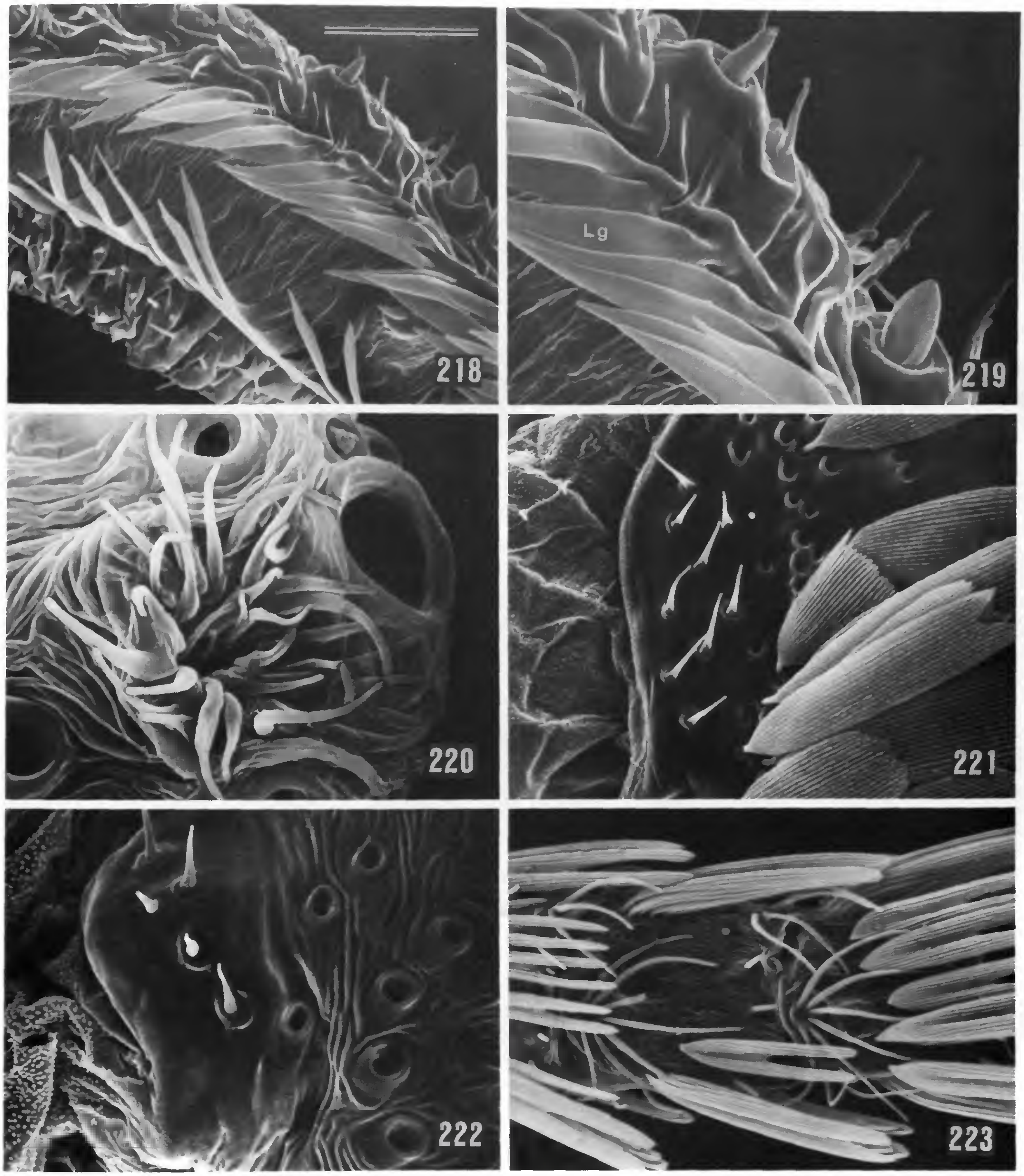
Head: Vestiture of vertex rough, consisting of slender to



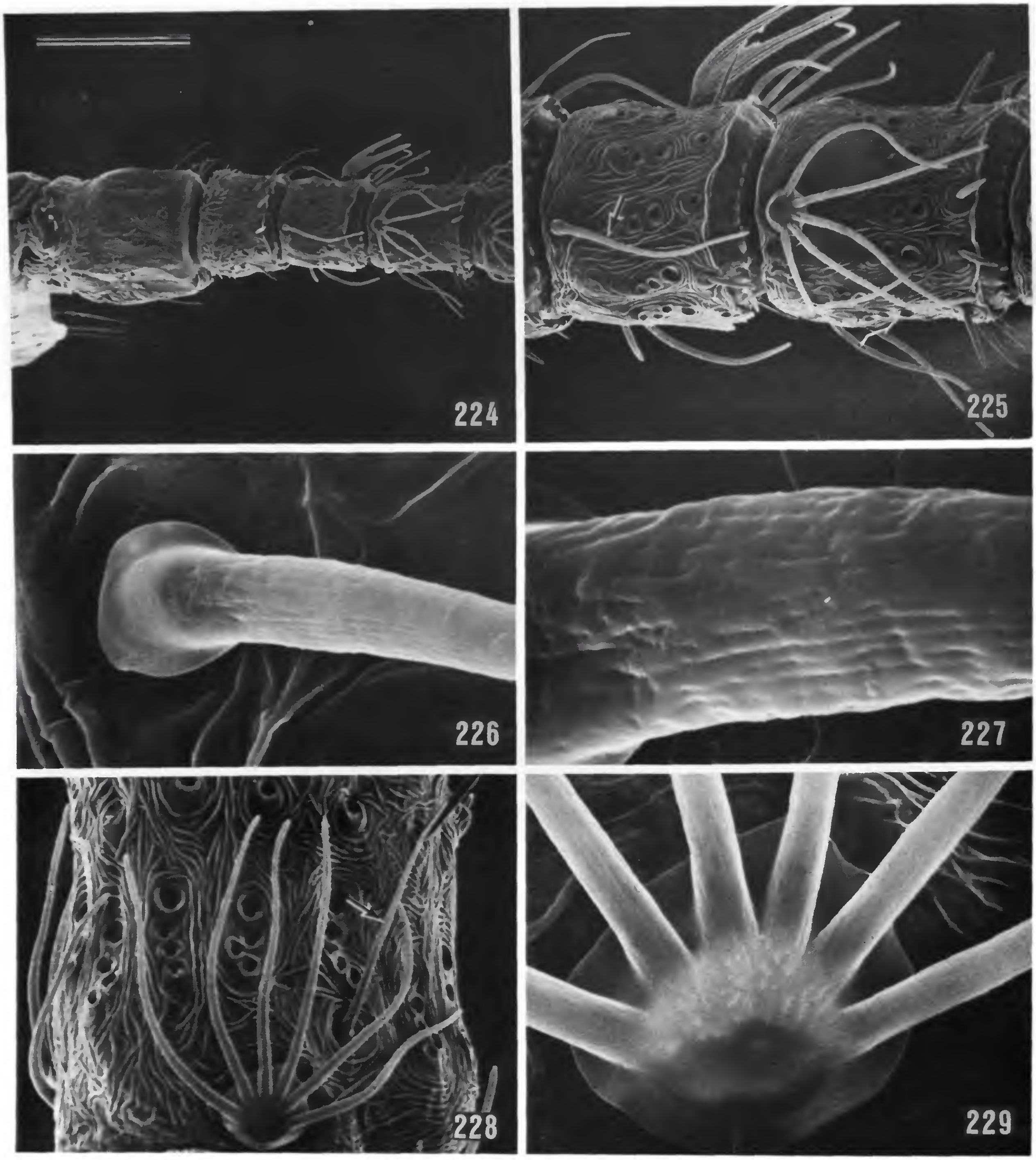
FIGURES 206–211.—*Pseudopostega auritella* (Hübner): 206, dorsal forewing scales from discal cell (60 μm); 207, detail of Figure 206, a (3 μm); 208, piliform scale and microtubercules from discal cell of dorsal forewing (7.5 μm); 209, pseudofrenular setae from hindwing (150 μm); 210, bases of pseudofrenular setae (50 μm); 211, apices of pseudofrenular setae (25 μm). (Scale lengths in parentheses; bar scale for all photographs = Figure 206.)



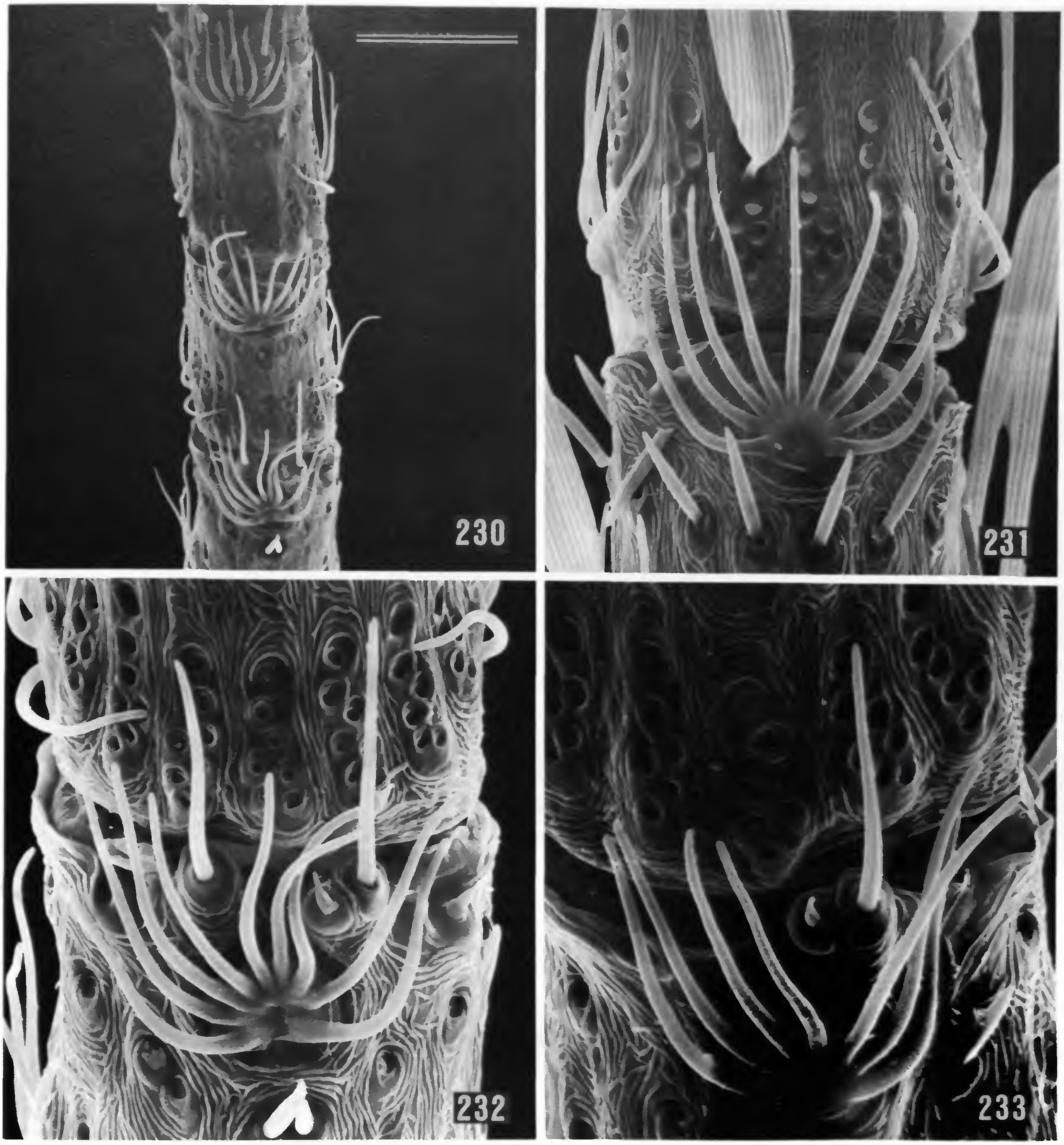
FIGURES 212–217.—*Pseudopostega bistrigulella* (Braun): 212, dorsal view of head (0.39 mm); 213, anterolateral view of head (0.39 mm); 214, anterior view of lower frontal area (60 µm); 215, detail of Figure 214 showing microtrichia (15 µm); 216, apical (fifth) segment of maxillary palpus (25 µm); 217, cluster of microtrichia at apex of maxillary palpus (4.3 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 212.)



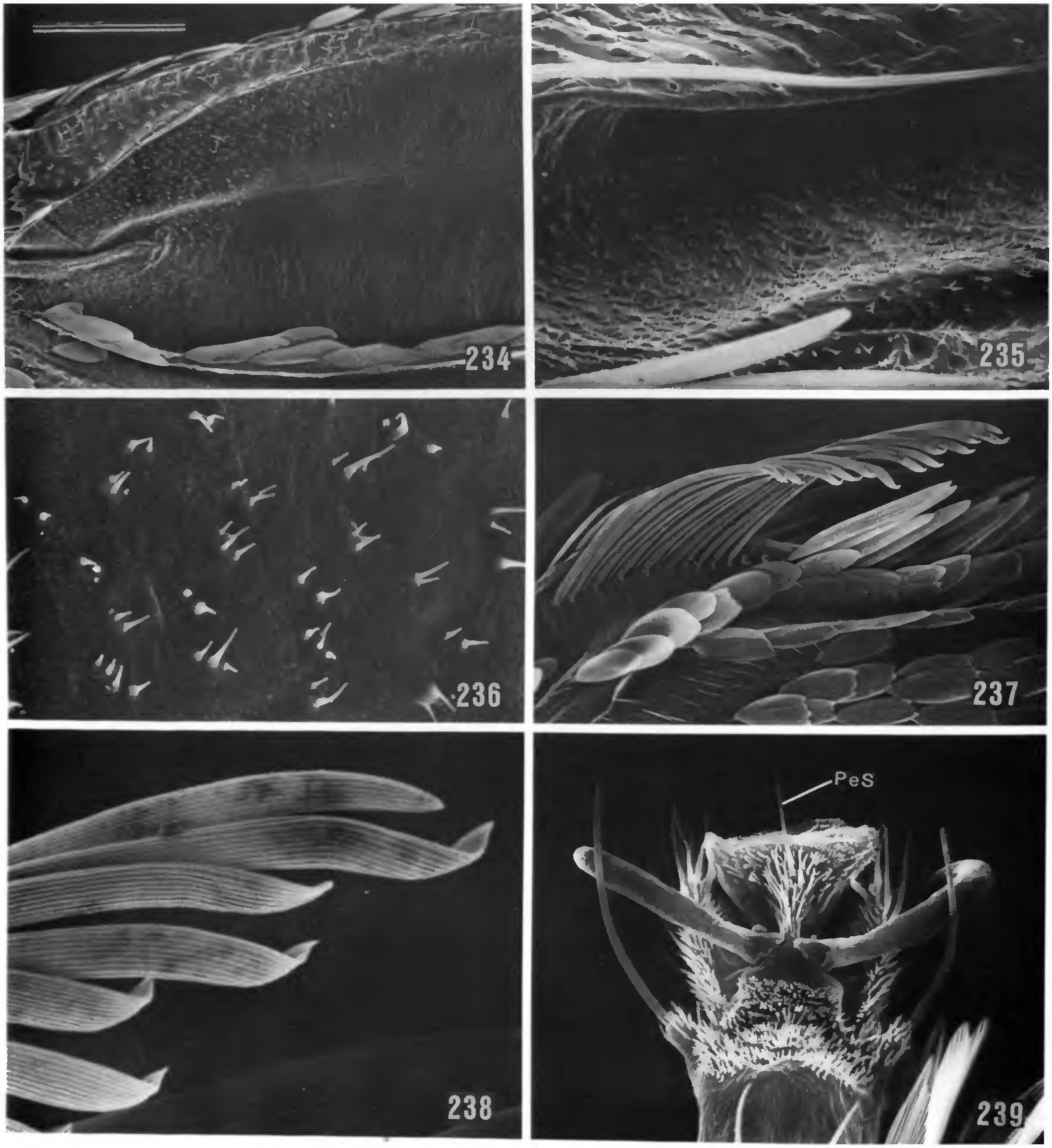
FIGURES 218–223.—*Pseudopostega bistrigulella* (Braun): 218, mesal view of haustellum (12 µm); 219, detail of Figure 218 showing legulae and sensilla (6 µm); 220, sensory pit at apex of labial palpus (4.3 µm); 221, proprioceptor setae (Böhm bristles) at dorsal base of scape (17.6 µm); 222, proprioceptor setae (Böhm bristles) at dorsal base of pedicel (see Figure 224) (12 µm); 223, antennal scale vestiture (38 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 218.)



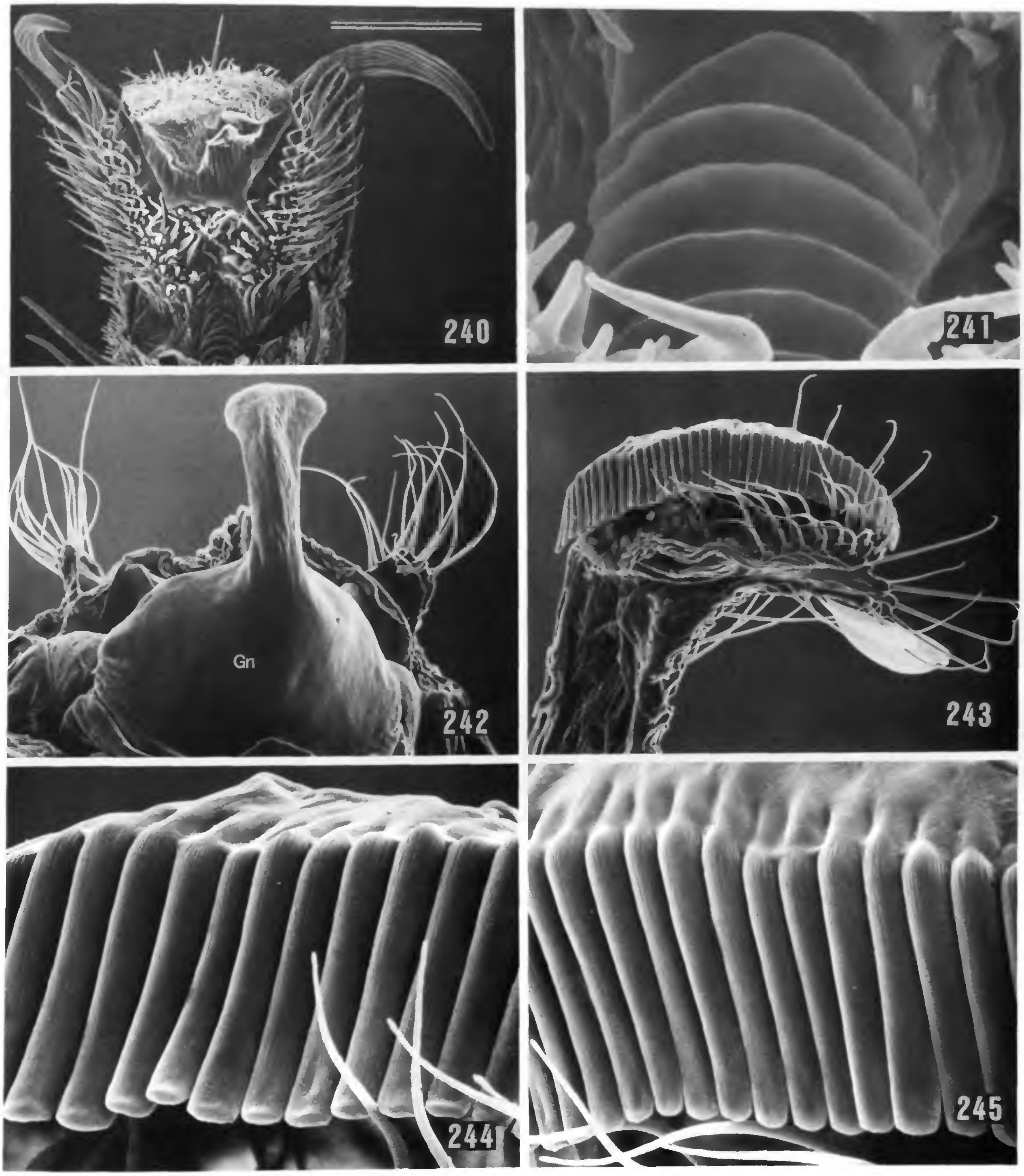
FIGURES 224–229.—*Pseudopostega bistrigulella* (Braun), antennal structure: 224, lateral view of pedicel and basal three flagellomeres (75 µm); 225, detail of Figure 224 showing flagellomeres 2 and 3, note unbranched sensillum ascoideum (arrow) on flagellomere 2 (30 µm); 226, detail of base of sensillum ascoideum in Figure 225 (3 µm); 227, surface detail of Figure 226, note pitted grooves (1.2 µm); 228, flagellomere 4 with extra, unbranched sensillum ascoideum (arrow) (15 µm); 229, detail of Figure 228 showing base of typical sensillum ascoideum (3.8 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 224.)



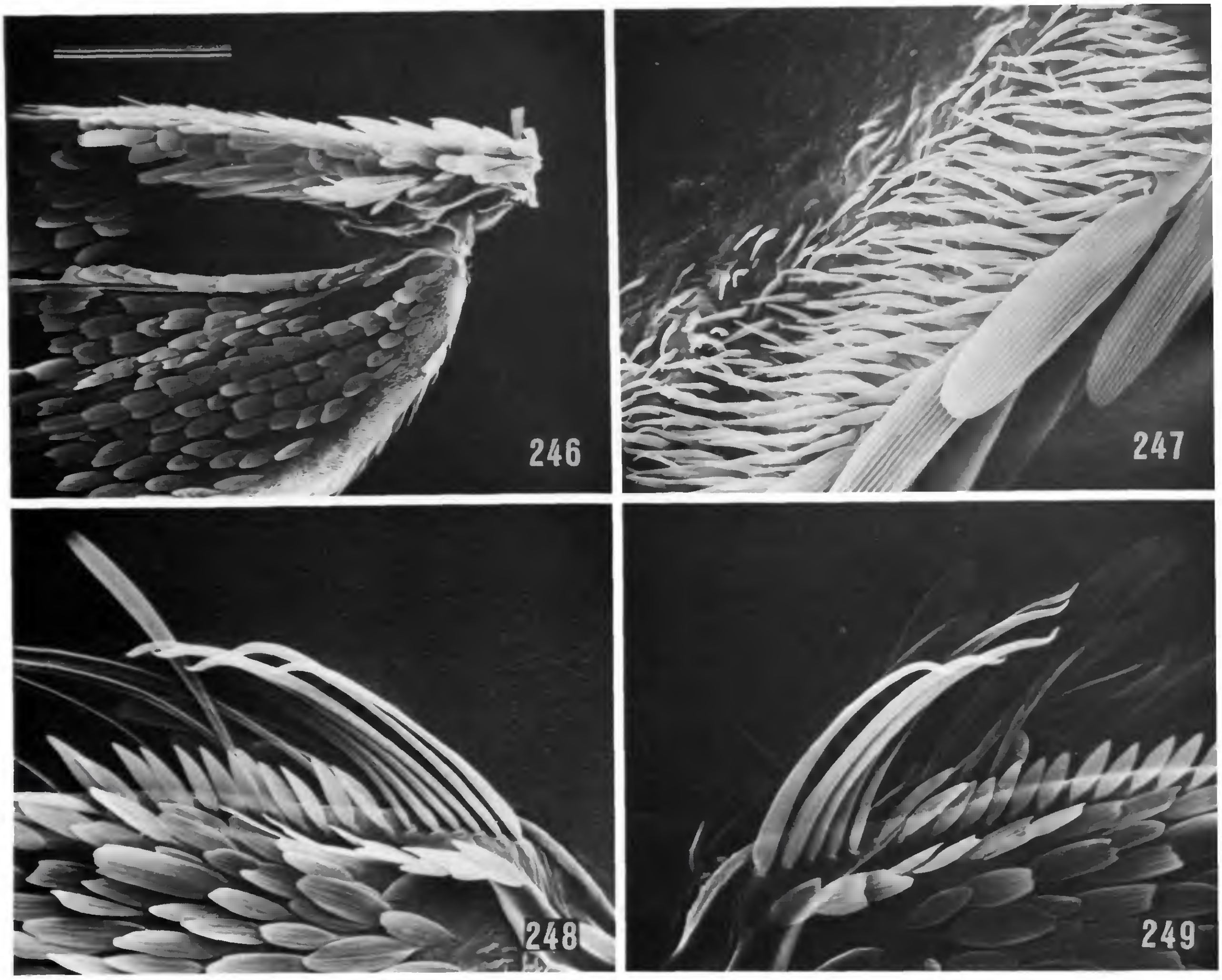
FIGURES 230–233.—*Pseudopostega bistrigulella* (Braun), variation of antennal sensilla: 230, dorsal view of flagellomeres 7–9 with sensilla ascoidea projecting distad (38 µm); 231, flagellomere 16 lacking elongate sensilla chaetica anteriorly (15 µm); 232, flagellomere 7 with 2 long and 1 short sensilla chaetica anteriorly (10 µm); 233, flagellomere 4 with 1 long and 1 short sensilla chaetica anteriorly (10 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 230.)



FIGURES 234–239.—*Pseudopostega bistrigulella* (Braun): 234, vental base of forewing showing reduction of microtrichia in subcostal area (150 µm); 235, detail of Figure 234 showing subcostal fold (43 µm); 236, subcostal microtrichia in Figure 234 (15 µm); 237, pseudofrenular setae from hindwing (150 µm); 238, apices of pseudofrenular setae (23.1 µm); 239, dorsal view of prothoracic pretarsus (23.1 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 234.)



FIGURES 240–245.—*Pseudopostega bistrigulella* (Braun): 240, ventral view of mesothoracic pretarsus (20 µm); 241, detail of unguitractor plate (3 µm); 242, ventral view of male gnathos and socii (75 µm); 243, cucullar lobe of male valva with terminal pectinifer (60 µm); 244, detail of pectinifer (12 µm); 245, detail of pectinifer base (15 µm). (Scale lengths in parentheses; bar scale for all photographs = Figure 240.)



FIGURES 246–249.—*Pseudopostega species*, Dominica: 246, ventral base of forewing (200 µm); 247, microtrichia bordering ventral anal margin of forewing (20 µm); 248, 249, lowest number of pseudofrenular setae observed in Opostegidae showing left (248, 6 setae, 94 µm) and right (249, 5 setae, 100 µm) hindwings of same species. (Scale lengths in parentheses; bar scale for all photographs = Figure 246.)

piliform scales with bidentate apices; posterior to vertex scales broad and arranged in rows; lower frons naked except for scattered rows of dense microtrichia (Figure 214). Cranial vertex evenly rounded. Antenna approximately 0.8–0.9 the length of forewing, 56–77 segmented; scape greatly enlarged, greatest width 1.0–1.15× the vertical eye diameter; scales broad and flat over scape and densely arranged in 7 relatively uniform rows; sensilla ascoidea with usually 7–9 branches. Eye large, interocular index approximately 0.8; eye index 0.8–0.9. Maxillary palpus elongate, about 1.7× the length of labial palpus; ratio of segments from base approximately 0.5:0.25:0.6:2.0:1.0. Haustellum moderately long, about 0.8 the length of maxillary palpus. Labial palpus moderately short, less than haustellum in length.

Thorax: Forewing lanceolate; greatest width about 0.2 that of length; apex acute; microtrichia absent on all surfaces except for ventral base of forewing; venation similar to *Opostega*, with only unbranched vestiges of Sc, R, M, CuA, and A present; A with only middle section faintly preserved; anal fold appearing in place of missing CuP. Hindwing lanceolate, greatest width about 0.14 that of length; 5–11 pseudofrenular setae present; venation extremely reduced, with only Sc, Rs, M, Cu and A present. Metathoracic furcal apophyses fused to secondary arms of metafurcasternum. Proleg with tibia about 0.6 the length of tarsal segments. Midleg with tibial spurs of unequal lengths, one member of pair about 0.65 the length of other.

Hindleg with two pairs of unequal spurs; the basal pair situated slightly basad to middle and with one spur about 0.6 the length of other; apical spurs shorter and more similar in length, the shorter member about 0.7–0.75 the length of other; longest spur (of basal pair) slightly exceeding first tarsomere; hindtibia densely covered with long spinose setae, as is dorsum of most of tarsal segments.

Abdomen: Six functional spiracles present; spiracles of A7 and 8 absent.

Male Genitalia: Uncus reduced, consisting of a pair of widely separated, setigerous lobes. Tegumen a narrow dorsal ring. Vinculum a narrow, ventral, often evenly rounded ring, occasionally with anterior margin slightly concave or extended. Gnathos well developed, consisting of a plate-like sclerite with a stout, median projection from caudal margin; projection either acute, spatulate, or furcate. Valva with apophysis borne on a basal sclerite separate but closely articulated to distal three-fourths of valva. Cucullar lobe bearing pectinifer usually linear-elliptical in shape and supported by a slender, sometimes curved pedicel arising near middle near apex of costal margin, pedicel sometimes extremely short with cucullar lobe nearly sessile; pectinifer with 25–59 spines arranged in a single row. Juxta absent or reduced to a slender, median process. Aedoeagus absent.

Female Genitalia: Anal papillae present, consisting of a pair of nearly contiguous, setose lobes situated dorsally and slightly anterior to caudal end of abdomen. Posterior apophysis slender, elongate; anterior apophysis absent. Alimentary canal and oviporus terminating very close together. Vestibulum completely membranous. Corpus bursae greatly enlarged to slender, often with dense array of spicules over caudal half; spicules sometimes absent. Spermathecal papilla usually evident as a small membranous lobe.

Larva and pupa unknown.

DISCUSSION.—Kozlov (1985) recognized this group as a subgenus of *Opostega* on the basis of two features of the male genitalia—the presence of a more developed, apically broader "transtilla" (actually gnathos) and the absence of a juxta. In addition to those more variable characteristics, I have further distinguished this relatively large, monophyletic group by the autapomorphic, basal subdivision of the male valvae and by the fusion of the metafurcal apophyses to the secondary arms of the metafurcasternum (Figure 49). Largely because of the paucity of specimens, it has not been possible to examine several species of "*Opostega*" for the latter character. Most likely several more species now listed in *Opostega* will eventually be transferred to *Pseudopostega*. Dissections of all nearctic species and many neotropical species suggest that nearly all New World species formerly assigned to *Opostega* should be transferred to this genus.

Synoptic Catalog of the Family Opostegidae

Notiopostega Davis, new genus. [Type species: *Notiopostega atrata* Davis, new species, by original designation.]

1. *Notiopostega atrata* Davis, new species.
   Type: Holotype, ♀; USNM.
   Type locality: CHILE: Valdivia: Valdivia.
   Collection data: 28 August 1973 (S. Cameron). Cambium miner on *Nothofagus dombeyi* (Mirbel) Oersted.

Esosopostega Davis, new genus. [Type species: *Eosopostega issikii* Davis, new species, by original designation.]

2. *Eosopostega issikii* Davis, new species.
   Type: Holotype, ♂; USNM.
   Type locality: Japan: Honshu: Tskai Pref: Izu Peninsula: Ito.
   Collection data: 29 June 1974 (S. Issiki).

Opostegoides Kozlov 1985:54. [Type species: *Opostega minodensis* Kuroko, by original designation.]

3. *Opostegoides gephyraea* (Meyrick), new combination (= *Opostega gephyraea* Meyrick, 1881:176).
   Type: Lectotype, sex? [abdomen missing] (present designation); BMNH.
   Type locality: AUSTRALIA: New South Wales: Sydney.
   Collection data: Number of ♂, ♀ syntypes not stated, October; "taken on fences in Sydney."
4. *Opostegoides malaysiensis* Davis, new species.
   Type: Holotype, ♂; FRIM.
   Type locality: Malaysia: Cameron Highlands: Berinchang.
   Collection data: 29 August 1986 (T. Kumata).
5. *Opostegoides menthinella* (Mann), new combination (= *Opostega menthinella* Mann, 1855:568).
   Type: Lectotype, ♂; NHMV.
   Type locality: FRANCE: Corsica: "im Thale nach San Antonio."
   Collection data: Originally 20 syntypes, July; flying around *Mentha*.
6. *Opostegoides minodensis* (Kuroko) (= *Opostega minodensis* Kuroko, 1982:50, 448, pl. 1:15, pl. 262:3, 4).
   Type: Holotype ♀; UOP.
   Type locality: JAPAN: Honshu: Nagano Pref., Chino-shi, Minodoguchi.
   Collection data: 21 July 1972 (H. Kuroko). Cambium miner on *Betula platyphylla* var. *japonica* (Miquel) Hara.
7. *Opostegoides omelkoi* Kozlov, 1985:57.
   Type: Holotype, ♂; ZIL.
   Type locality: USSR: Primorsk Territory: Ussuri Region: Gornotaezhnoe.
   Collection data: 1 August 1983 (M.V. Kozlov).
8. *Opostegoides scioterma* (Meyrick) (= *Opostega scioterma* Meyrick, 1920:358).
   nonstrigella (Grossenbacher) (= *Opostega nonstrigella* Grossenbacher, 1910:60) [misidentification].
   Type: Holotype, ♀; BMNH.
   Type locality: CANADA: Ontario: Toronto.
   Collection data: June (Parish). Cambium miner on *Ribes grossularia* L., *Ribes nigrum* L., and *Ribes satirum* Syme.
9. *Opostegoides sinevi* Kozlov, 1985:55.
   Type: Holotype, ♂; ZIL.
   Type locality: USSR: Primorsk Territory: Ussuri Region: Gornotaezhnoe.
   Collection data: 24 May 1983 (S.IU. Sinev).

Paralopostega Davis, new genus. [Type species: *Opostega callosa* Swezey, by original designation.]

10. *Paralopostega callosa* (Swezey), new combination (= *Opostega callosa* Swezey, 1921:532).
    Type: Lectotype, ♂ (by Zimmerman as holotype, 1978:239); BPBM.
    Type locality: UNITED STATES: Hawaii: Oahu: Waialae Nui.
    Collection data: Originally 3 syntypes, 16 February 1919 (Swezey). Leafminer on *Pelea lydgatei* Hillebrand, *Pelea rotundifolia* A. Gray, and *Pelea* species.
11. *Paralopostega dives* (Walsingham), new combination (= *Opostega dives* Walsingham, 1907:711, pl. 25:13).
    Type: Holotype, ♀ [not ♂]; BMNH.
    Type locality: UNITED STATES: Hawaii: Kauai: Halemanu.
    Collection data: May 1895. Leafminer on *Pelea* species.
12. *Paralopostega filiforma* (Swezey), new combination (= *Opostega filiforma* Swezey, 1921:534).
    Type: Holotype, ♀; BPBM.
    Type locality: UNITED STATES: Hawaii: Oahu: Mt. Kaala, Waianae Mts.
    Collection data: 26 September 1920 (Swezey). Leafminer on *Pelea clusiaefolia* A. Gray, *Pelea elliptica* Hillebrand, and *Pelea sapotaefolia* H. Mann.
13. *Paralopostega maculata* (Walsingham), new combination (= *Opostega maculata* Walsingham, 1907:711, pl. 25:12).
    Type: Holotype, ♂; BMNH.
    Type locality: UNITED STATES: Hawaii: Molokai,

above 3000 ft.
Collection data: 30 May 1893. Leafminer on *Pelea oblongifolia* A. Gray and *Pelea rotundifolia* A. Gray.

14. *Paralopostega peleana* (Swezey), new combination (= *Opostega peleana* Swezey, 1921:534).
    Type: Holotype, ♀; BPBM.
    Type locality: UNITED STATES: Hawaii: Oahu, Mt. Olympus.
    Collection data: 12 January 1919 (Swezey). Leafminer on *Pelea rotundifolia*, A. Gray, *Pelea sandwicensis* A. Gray, and *Pelea* species.
15. *Paralopostega serpentina* (Swezey), new combination (= *Opostega serpentina* Swezey, 1921:533).
    Type: Lectotype, ♀ (by Zimmerman as holotype, 1978:237); BPBM.
    Type locality: UNITED STATES: Oahu: Mt. Olympus.
    Collection data: Originally 2 syntypes, 19 January 1919. Leafminer on *Pelea clusiaefolia* A. Gray, *Pelea elliptica* Hillebrand, *Pelea sapotaefolia* H. Mann, and *Pelea* species.

Opostega Zeller, 1839:214. [Type species: *Opostega salaciella* Treitschke, by Walsingham, 1914:349.]

16. *Opostega afghani* Davis, new species.
    Type: Holotype, ♂; NHMV.
    Type locality: Afghanistan: Khurd-Kabul.
    Collection data: 20 May 1965 (F. Kasy).
17. *Opostega amphimitra* Meyrick, 1913:328.
    Type: Lectotype, ♂ (by Vári as holotype, 1958:58, "no. 133, 20 Dec. 1910"); TMP.
    Type locality: SOUTH AFRICA: Transvaal: Barberton.
    Collection data: Originally 4 syntypes, 4 December-February (Janse).
18. *Opostega angulata* Gerasimov, 1930:45.
    Type: Lectotype, ♂ (by Kozlov, 1985:51, "5 April 1926, A.M. Gerasimov,"); ZIL.
    Type locality: UNION SOVIET SOCIALISTIC REPUBLIC: Uzbek: Kashkadar Dist., Guzar.
    Collection data: Originally 13 syntypes, 5 April, 11 June, 14 June, 5 July, 7 August.
19. *Opostega argentella* Bradley, 1957:108, pl. 2:24.
    Type: Holotype, ♂; BNMH.
    Type locality: SOLOMON ISLANDS: Rennell Island: Hutuna.
    Collection data: 8 November 1953, at light.
20. *Opostega arthrota* Meyrick, 1915b:352.
    Type: Holotype, ♀; BMNH.
    Type locality: AUSTRALIA: Queensland: Cairns.
    Collection data: October (Dodd).
21. *Opostega atypa* Turner, 1923:179.
    Type: Holotype, ♀; ANIC.
    Type locality: AUSTRALIA: Queensland: Cairns.
    Collection data: 3 July 1911 (Turner).
22. *Opostega basilissa* Meyrick, 1893:606.
    Type: Lectotype, ♀ (present designation, 14 October 1886); BMNH.
    Type locality: AUSTRALIA: Western Australia: Perth.
    Collection data: Originally 2 syntypes, October and November.
23. *Opostega bimaculatella* W. Rothschild, 1912:29.
    Type: 2 syntypes, ♂; deposition unknown.
    Type locality: ROMANIA: Flamunda.
    Collection data: June 26. According to L. Gozmány (in litt.) the type locality is located in the Deliblat sand dune semi-desert region of Romania.
24. *Opostega brithys* Turner, 1923:179.
    Type: Holotype, ♀; ANIC.
    Type locality: AUSTRALIA: Queensland: Cairns district.
    Collection data: From F.P. Dodd.
25. *Opostega chalcopepla* Walsingham, 1908:228.
    Type: Holotype, ♂; BMNH.
    Type locality: SPAIN: Andalusia: Coto, Huelva.
    Collection data: 23-24 April 1901.
26. *Opostega chalcophylla* Meyrick, 1910:229.
    Type: Lectotype, ♂ (present designation); BMNH.
    Type locality: INDIA: Assam: Kurseong, 5000 ft.
    Collection data: originally 6 syntypes, September (Annandale).
27. *Opostega chalcoplethes* Turner, 1923:178.
    Type: Holotype, ♂; ANIC.
    Type locality: AUSTRALIA: Western Australia: Perth, Swan River.
    Collection data: date unknown (Clark).
28. *Opostega chalinias* Meyrick, 1893:607.
    Type: Holotype, ♀; BMNH.
    Type locality: AUSTRALIA: Tasmania: Georges Bay.
    Collection data: January.
29. *Opostega chordacta* Meyrick, 1915b:351.
    Type: Holotype, ♂; BMNH.
    Type locality: AUSTRALIA: Queensland: Cairns.
    Collection data: November (Dodd).
30. *Opostega cirrhacma* Meyrick, 1911a:237.
    Type: Holotype, ♀; TMP.
    Type locality: SOUTH AFRICA: Transvaal: Woodbush Village.
    Collection data: December (Swierstra).
31. *Opostega costantiniella* Costantini, 1923:70.
    Type: Holotype; ♀; lost (formerly in Turati collection).
    Type locality: ITALY: Appennines
    Collection data: 12 September 1922.
32. *Opostega cretatella* Chretien, 1915:364.
    Type: Syntypes?; sex and deposition unknown.
    Type locality: ALGERIA: Biskra.
    Collection data: April.
33. *Opostega diorthota* Meyrick, 1893:607.
    Type: Holotype, ♂; BMNH.
    Type locality: AUSTRALIA: West Australia: Albany.
    Collection data: October.

34. *Opostega diplardis* Meyrick, 1921b:123.
Type: Holotype, ♀; TMP.
Type locality: SOUTH AFRICA: Transvaal: Pretoria.
Collection data: January (Swierstra).

35. *Opostega epactaea* Meyrick, 1907:985.
Type: Lectotype, ♀ (present designation, "Feb. 1906"); BMNH.
Type locality: SRI LANKA: Maskeliya.
Collection data: Originally 6 syntypes, February and March, (Cole).

36. *Opostega epistolaris* Meyrick, 1911b:108.
Type: Lectotype, ♂ (present designation "Dibidi, N. Coorg. 13 May 1907"); BMNH.
Type locality: INDIA: Mysore: Coorg, 3500 ft.
Collection data: Originally 2 syntypes, May (Newcome).

37. *Opostega frigida* Meyrick, 1906:416.
Type: Lectotype, ♂ (present designation, "February 1905"); BMNH.
Type locality: SRI LANKA: Peradeniya.
Collection data: Originally 18 syntypes, February (Green).

38. *Opostega granifera* Meyrick, 1913:327.
Type: Holotype, ♂ [not ♀]; TMP.
Type locality: SOUTH AFRICA: Transvaal: Barberton.
Collection data: December (Janse).

39. *Opostega heringella* Mariani, 1937:12.
Type: Syntypes(?), sex unknown; MSNT.
Type locality: ITALY: Sicily: Zappulla.
Collection data: "flies in Zappulla in June."

40. *Opostega horaria* Meyrick, 1921a:457.
Type: Holotype, ♀; BMNH.
Type locality: AUSTRALIA: Queensland: Cairns.
Collection data: October (Dodd).

41. *Opostega idiocoma* Meyrick, 1918:42.
Type: Lectotype, ♀ (by Vári as holotype, 1958:78); TMP.
Type locality: SOUTH AFRICA: Natal: Umkomaas.
Collection data: Originally 4 syntypes, 29 January (Janse).

42. *Opostega index* Meyrick, 1922:557.
Type: Holotype, ♀; BMNH.
Type locality: INDIA: Assam: Shillong, 5000 ft.
Collection data: July (Fletcher).

43. *Opostega kuznetzovi* Kozlov, 1985:53.
Type: Holotype, ♂; ZIL.
Type locality: USSR: Primorsk Territory: Ussuri Region: Gornotaezhnoe.
Collection data: 27 July 1983 (M.V. Kozlov).

44. *Opostega luticilia* Meyrick, 1915b:351.
Type: Holotype, ♀; BMNH.
Type locality: AUSTRALIA: Queensland: Cairns.
Collection data: October (Dodd).

45. *Opostega machaerias* Meyrick, 1907:985.
Type: Holotype, ♀; BMNH.
Type locality: SRI LANKA: Maskeliya.
Collection data: March (Pole).

46. *Opostega melitardis* Meyrick, 1918:41.
Type: Holotype, ♂ [not ♀]; TMP.
Type locality: SOUTH AFRICA: Natal: Umkomaas.
Collection data: January (Janse).

47. *Opostega monotypa* Turner, 1923:179.
Type: Holotype, ♂; ANIC.
Type locality: AUSTRALIA: Queensland: Cairns district.
Collection data: Date unknown (F.P. Dodd).

48. *Opostega myxodes* Meyrick, 1916:619.
Type: Holotype, ♂; BMNH.
Type locality: INDIA: Bihar: Pusa.
Collection data: September (Fletcher).

49. *Opostega nephelozona* Meyrick, 1915b:352.
Type: Holotype, ♂; BMNH.
Type locality: SRI LANKA: Maskeliya.
Collection data: February (Pole).

50. *Opostega nubifera* Turner, 1900:23.
Type: Holotype, ♂; ANIC.
Type locality: AUSTRALIA: Queensland: Toowoomba.
Collection data: September (Turner).

51. *Opostega orestias* Meyrick, 1880:175.
Type: Holotype, ♀; BMNH.
Type locality: AUSTRALIA: Queensland: Brisbane, in swampy bush.
Collection data: September.

52. *Opostega orophoxantha* Meyrick, 1921b:124.
Type: Holotype, ♀; TMP
Type locality: ZIMBABWE: Umtali.
Collection data: January (Janse).

53. *Opostega pelocrossa* Meyrick, 1928a:396.
Type: Holotype, ♂ [not ♀]; TMP.
Type locality: ZIMBABWE: Mazoe.
Collection data: January (Janse).

54. *Opostega pelorrhoa* Meyrick, 1915b:352.
Type: Holotype, ♀; BMNH.
Type locality: INDIA: Assam: Khasis.
Collection data: September.

55. *Opostega phaeosoma* Meyrick, 1928a:396.
Type: Holotype, ♂; TMP.
Type locality: ZIMBABWE: Mazoe.
Collection data: January (Janse).

56. *Opostega phaeospila* Turner, 1923:179.
Type: Holotype, ♂; ANIC.
Type locality: AUSTRALIA: Queensland: [Lamington] National Park, 3500 to 4000 ft.
Collection data: 1 January 1921 (Turner).

57. *Opostega praefusca* Meyrick, 1913:327.
Type: Lectotype, ♂ (by Vári as holotype, 1985:78, "no. 139, 5 December 1910"); TMP.
Type locality: SOUTH AFRICA: Transvaal: Barberton.
Collection data: Originally 2 syntypes, December, January (Janse).

58. *Opostega radiosa* Meyrick, 1913:327.

Type: Lectotype, ♂ (by Vári as holotype, 1958:78, "no. 137, 5 December 1910"); TMP.

Type locality: Originally 2 syntypes, SOUTH AFRICA: Transvaal: Barberton.

Collection data: December, March (Janse).

59. *Opostega reliquella* Zeller, 1848:282 [junior subjective synonym of *O. salaciella* (Treitschke)].

Type: 2 syntypes, ♂, ♀; deposition unknown.

Type localities: POLAND: Glogau, Reinerz.

Collection data: 1 ♀ (Glogau) 20 June, "an einem begrasten Abhange unter Espengestrauch"; 1 ♂ (Reinerz) 16 July, "auf einem freien Grasplatz."

60. *Opostega rezniki* Kozlov, 1985:51.

Type: Holotype, ♂; ZIL.

Type locality: USSR: Kazakh SSR: Alma-Ata: Sarytau-kum.

Collection data: 16 May 1981 (S.IA. Reznik).

61. *Opostega salaciella* (Treitschke) (= *Elachista salaciella* Treitschke, 1833:180).

reliquella Zeller, 1848:282 [POLAND].

saliciella Mann, 1855:569 [misspelling].

Type: Syntypes?; sex and deposition unknown.

Type locality: GERMANY.

Collection data: Unknown.

62. *Opostega scoliozona* Meyrick, 1915b:351.

Type: Holotype, ♀; BMNH.

Type locality: AUSTRALIA: Queensland: Cairns.

Collection data: October (Dodd).

63. *Opostega snelleni* Nolcken, 1882:197.

Type: Holotype, ♀; deposition unknown.

Type locality: FRANCE.

Collection data: May.

64. *Opostega spatulella* Herrich-Schäffer, 1855:360, pl. 109:810.

Type: Lectotype, ♀ (present designation); ZMHB.

Type locality: FRANCE: Chateaudun.

Collection data: Originally 2 syntypes (Guenée).

65. *Opostega spilodes* Meyrick, 1915b:351.

Type: Holotype, ♀; BMNH.

Type locality: INDIA: Mysore: Dibidi, Coorg.

Collection data: December (Newcome).

66. *Opostega stekolnikovi* Kozlov, 1985:53.

Type: Holotype, ♂; ZIL.

Type locality: USSR: Primorsk Territory: Nadezhdinskii Region: DeFriese Peninsula.

Collection data: 21 July 1980 (M.M. Omel'ko).

67. *Opostega stiriella* Meyrick, 1881:175.

Type: Lectotype ♂ (present designation, "2 October 1878"); BMNH.

Type locality: AUSTRALIA: New South Wales: Parramatta, "and in parts of the dense forest growth on the slope of the Bulli Passe."

Collection data: Number of ♂, ♀ syntypes not stated, September, October, and March.

68. *Opostega subviolacea* Meyrick, 1920:357.

Type: Holotype, ♀; BMNH.

Type locality: INDIA: Gujarat: Kharaghoda.

Collection data: August (Maxwell).

69. *Opostega symbolica* Meyrick, 1914:203.

Type: Holotype, ♂ [not ♀]; TMP.

Type locality: SOUTH AFRICA: Natal: Sarnia.

Collection data: January (Janse).

70. *Opostega tetroa* Meyrick, 1907:986.

Type: Lectotype, ♂ (present designation, "December 1904, de Mowbray"); BMNH.

Type locality: SRI LANKA: Maskeliya.

Collection data: Originally 3 syntypes, December, January (de Mowbray, Pole).

71. *Opostega tincta* Meyrick, 1918:41.

Type: Lectotype, ♂ (by Vári as holotype, 1958:78); TMP.

Type locality: SOUTH AFRICA: Natal: Umkomaas.

Collection data: Originally 2 syntypes, January (Janse).

72. *Opostega uvida* Meyrick, 1915b:352.

Type: Holotype, ♂; BMNH.

Type locality: SRI LANKA: Maskeliya.

Collection data: November (Pole).

73. *Opostega velifera* Meyrick, 1920:357.

Type: Holotype, ♀; BMNH.

Type locality: INDIA: Maharashtra: Surat.

Collection data: 24 April 1919 (Maxwell).

74. *Opostega xenodoxa* Meyrick, 1893:608.

Type: Holotype, ♀; BMNH.

Type locality: AUSTRALIA: New South Wales: Glen Innes, 3500 ft.

Collection data: December.

75. *Opostega zelopa* Meyrick, 1905:613.

Type: Holotype, ♀; BMNH.

Type locality: SRI LANKA: Pundalu-oya.

Collection data: May (Green).

Pseudopostega Kozlov, 1985:53, new status. [Type-species: *Tinea auritella* Hübner, original designation.]

76. *Pseudopostega abrupta* (Walsingham), new combination (= *Opostega abrupta* Walsingham, 1897:139).

Type: Holotype, ♂; MGAB.

Type locality: VIRGIN ISLANDS: St. Thomas.

Collection data: 19 March (Hedemann).

77. *Pseudopostega accessoriella* (Frey and Boll), new combination (= *Opostega accessoriella* Frey and Boll, 1876:216) [junior subjective synonym of *N. quadristrigella* (Chambers)].

Type: Holotype, sex and deposition unknown.

Type locality: UNITED STATES: Texas: Dallas.

Collection data: (Boll).

78. *Pseudopostega acidata* (Meyrick), new combination (= *Opostega acidata* Meyrick, 1915b:240).

Type: Lectotype, ♂ (present designation); BMNH.

Type locality: ECUADOR: Huigra, 4500 ft.

Collection data: Originally 2 syntypes, June (Parish).

79. *Pseudopostega adusta* (Walsingham), new combination (= *Opostega adusta* Walsingham, 1897:140).

Type: Holotype, ♂; MGAB.

Type locality: VIRGIN ISLANDS: St. Thomas.

Collection data: 20 March (Hedemann).

80. *Pseudopostega albogaleriella* (Clemens) (= *Opostega albogaleriella* Clemens, 1862:131).

albogalleriella (Eyer) (= *Opostega albogalleriella* Eyer, 1963:241) [misspelling].

napaeella (Clemens) (= *Opostega napaeella* Clemens, 1872:42), (UNITED STATES: Pennsylvania).

Type: Holotype, ♂; ANSP.

Type locality: UNITED STATES: Pennsylvania: ?Easton.

Collection data: 9 July (Clemens).

81. *Pseudopostega auritella* (Hübner), new combination (= *Tinea auritella* Hübner, 1813, fig. 387).

Type: Lost.

Type locality: [Europe].

Collection data: Unknown.

82. *Pseudopostega bellicosa* (Meyrick), new combination (= *Opostega bellicosa* Meyrick, 1911a:236).

Type: Holotype, ♂ [not ♀]; TMP.

Type locality: SOUTH AFRICA: Transvaal: Pretoria.

Collection data: October (Janse).

83. *Pseudopostega bistrigulella* (Braun) (= *Opostega bistrigulella* Braun, 1918:245).

Type: Lectotype, ♂ (present designation, "23 April"); ANSP.

Type locality: UNITED STATES: California: Loma Linda.

Collection data: Number of syntypes not stated, 23 April and 27 May (G.R. Pilate).

84. *Pseudopostega clastozona* (Meyrick), new combination (= *Opostega clastozona* Meyrick, 1913:327).

Type: Lectotype, ♂, (by Vári as holotype, 1958:58, "No. 135, 4 January, 1911"); TMP.

Type locality: SOUTH AFRICA: Transvaal: Barberton.

Collection data: Originally 4 syntypes, December, January (Janse).

85. *Pseudopostega congruens* (Walsingham), new combination (= *Opostega congruens* Walsingham, 1914:350, pl. 10:8).

Type: Holotype, ♀ [not ♂]; BMNH.

Type locality: MEXICO: Guerrero: Amula, 6000 ft.

Collection data: August (H.H. Smith).

86. *Pseudopostega crepusculella* (Zeller), new combination (= *Opostega crepusculella* Zeller, 1839:214).

Type: Lectotype, sex? (present designation); BMNH.

Type locality: CZECHOSLOVAKIA (Bohmen): near Zakupy (= Reichstadt).

Collection data: Number of syntypes not stated; flies in July, between 8–8:30 P.M. [i.e., crepuscular].

87. *Pseudopostega crepusculella lvovskyi* (Kozlov), new combination (= *Opostega crepusculella lvovskyi* Kozlov, 1985:54).

Type: Holotype, ♂; ZIL.

Type locality: USSR: Primorsk Region: Riazanovka, vicinity of Khasan, 15 km SW of Slavianka.

Collection data: 6 August 1983 (A.L. L'vovski).

88. *Pseudopostega cretea* (Meyrick), new combination (= *Opostega cretea* Meyrick, 1920:358).

Type: Lectotype, ♂ (present designation, "18 July"); BMNH.

Type locality: CANADA: Ontario; Lake Muskoka.

Collection data: Originally 6 syntypes, July, August (Parish).

89. *Pseudopostega elachista* (Walsingham), new combination (= *Opostega elachista* Walsingham, 1914:350, pl. 10:7).

Type: Holotype, ♀ [not ♂]; BMNH.

Type locality: MEXICO: Guerrero: Amula, 6000 ft.

Collection data: September (H.H. Smith).

90. *Pseudopostega euryntis* (Meyrick), new combination (= *Opostega euryntis* Meyrick, 1907:985).

Type: Holotype, ♀; BMNH.

Type locality: INDIA: Mysore: Dibidi, Coorg, 3500 ft.

Collection data: June (Newcome).

91. *Pseudopostega kempella* (Eyer), new combination (= *Opostega kempella* Eyer, 1967:39, figs. 1–5).

Type: Holotype, ♂; USNM.

Type locality: UNITED STATES: Florida: Monroe County; Key Largo.

Collection data: 10 October 1964 (Kemp).

92. *Pseudopostega microlepta* (Meyrick), new combination (= *Opostega microlepta* Meyrick, 1915a:239).

Type: Lectotype, ♂ (present designation, "13 February"); BMNH.

Type locality: GUYANA: Bartica.

Collection data: Originally 2 syntypes, February, June (Duran, Ecuador) (Parish).

93. *Pseudopostega monosperma* (Meyrick), new combination (= *Opostega monosperma* Meyrick, 1931:162).

Type: Holotype, ♂; NHMV.

Type locality: BRAZIL: Bahia: Rio Preto, Baquerao.

Collection data: Unknown.

94. *Pseudopostega napaeella* (Clemens), new combination (= *Opostega napaeella* Clemens, 1872:42) [junior objective synonym of *P. albogaleriella* Clemens].

Type: Holotype, ♂; ANSP.

Type locality: UNITED STATES: Pennsylvania: ?Easton.

Collection data: July (Clemens).

95. *Pseudopostega nonstrigella* (Chambers), new combination (= *Opostega nonstrigella* Chambers, 1881:296).

Type: Lectotype, sex? [abdomen missing] (present

designation, USNM 100675); USNM.
Type locality: UNITED STATES: ?Massachusetts: Amherst.
Collection data: Number of syntypes not stated; (?Goodell).

96. *Pseudopostega paromias* (Meyrick), new combination (= *Opostega paromias* Meyrick, 1915a:240).
Type: Holotype. ♀; BMNH.
Type locality: PERU: Matucana, 7780 ft.
Collection data: July (Parish).

97. *Pseudopostega perdigna* (Walsingham), new combination (= *Opostega perdigna* Walsingham, 1914:349, pl. 10:6).
Type: Holotype, ♀; BMNH.
Type locality: mexico: Guerrero: Omilteme, 8000 ft.
Collection data: July (H.H. Smith).

98. *Pseudopostega pexa* (Meyrick), new combination (= *Opostega pexa* Meyrick, 1920:358).
Type: Holotype, ♂; BMNH.
Type locality: BRAZIL: Para. [= Belém].
Collection data: July (Parish).

99. *Pseudopostega pontifex* (Meyrick), new combination (= *Opostega pontifex* Meyrick, 1915a:240).
Type: Holotype, ♂; BMNH.
Type locality: COLOMBIA: Cali, 500 ft.
Collection data: May (Parish).

100. *Pseudopostega protomochla* (Meyrick), new combination (= *Opostega protomochla* Meyrick, 1935:567).
Type: Lectotype, ♂ (present designation); BMNH.
Type locality: ARGENTINA: Alta Gracia.
Collection data: Originally 9 syntypes, February (C. Bruch).

101. *Pseudopostega pumila* (Walsingham), new combination (= *Opostega pumila* Walsingham, 1914:350, pl. 10:9.
Type: Holotype, ♂; BMNH.
Type locality: MEXICO: Tabasco: Teapa.
Collection data: March (H.H. Smith).

102. *Pseudopostega quadristrigella* (Chambers) (= *Opostega quadristrigella* Chambers, 1875:106).
accessoriella (Frey and Boll) (= *Opostega accessoriella* Frey and Boll, 1876:216) (UNITED STATES: Texas: Dallas).
Type: Holotype, sex and deposition unknown.
Type locality: UNITED STATES: Kentucky: Edmondson Co.; Camp Bee Spring.
Collection data: Early part of July.

103. *Pseudopostega sacculata* (Meyrick), new combination (= *Opostega sacculata* Meyrick, 1915a:240).
Type: Holotype, ♂; BMNH.
Type locality: ECUADOR: Huigra, 4500 ft.
Collection data: June (Parish).

104. *Pseudopostega saltatrix* (Walsingham), new combination (= *Opostega saltatrix* Walsingham, 1897:140).
Type: Holotype, ♂; BMNH.
Type locality: VIRGIN ISLANDS: St. Thomas.
Collection data: 18 March to 2 April (Gudmann).

105. *Pseudopostega trinidadensis* (Busck), new combination (= *Opostega trinidadensis* Busck, 1910:245).
Type: Lectotype, ♂ (present designation, "15 June, USNM 13385"); USNM.
Type locality: TRINIDAD.
Collection data: Number of syntypes not stated, 2♂, 1 ♀ now in USNM. 15 June (Busck), no date (Urich).

106. *Pseudopostega venticola* (Walsingham), new combination (= *Opostega venticola* Walsingham, 1897:140).
Type: Lectotype, ♂ (present designation, "8 May, Walsingham specimen number 65268"); BMNH.
Type locality: GRENADA: Balthazar, 250–300 ft., Windward side.
Collection data: Originally 4 syntypes, Haiti: Port-au-Prince, 23 May (Gudmann); Grenada: Balthazar, 5 April–8 May (H.H. Smith).

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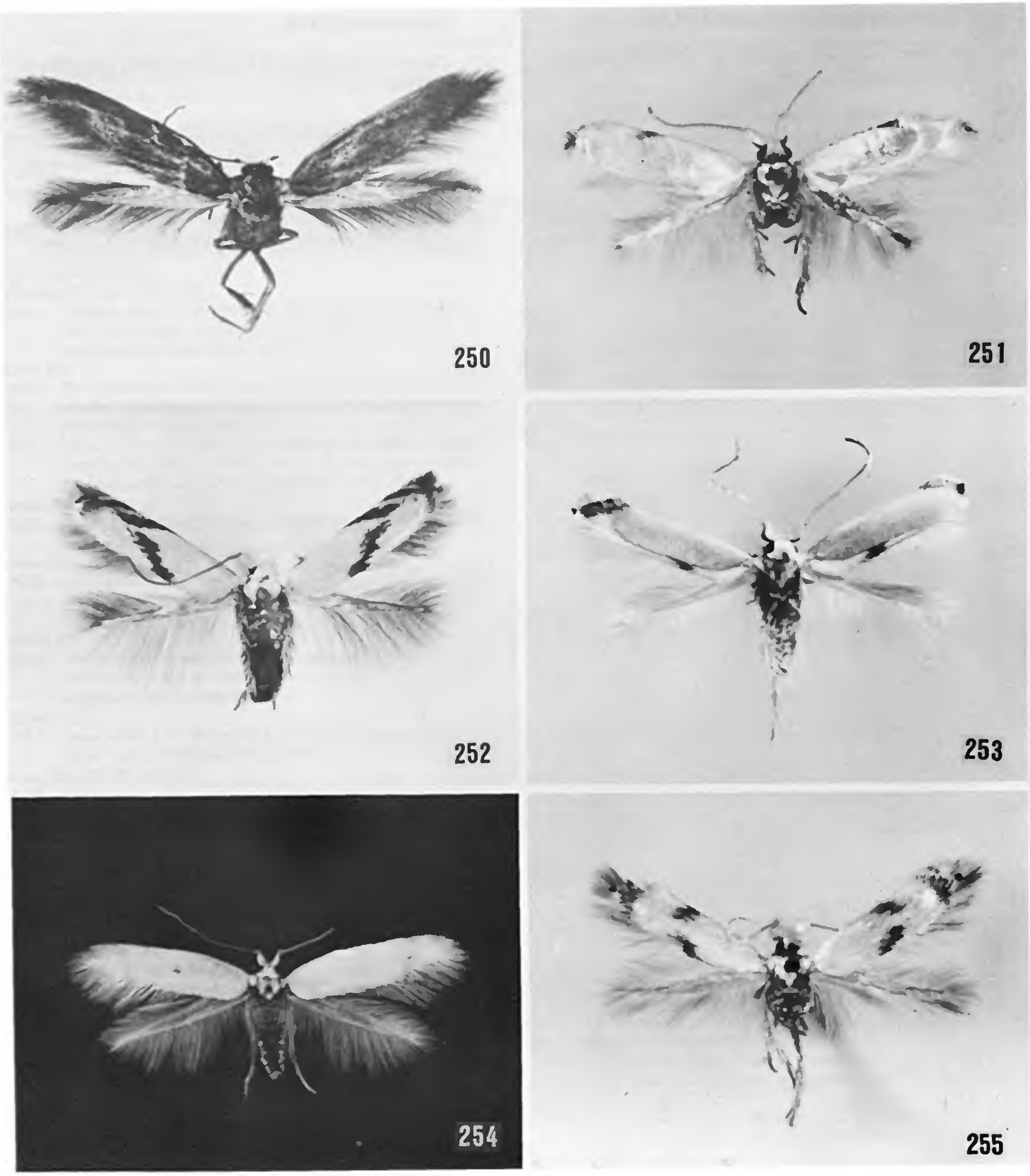

FIGURES 250–255.—Adults: 250, *Notiopostega atrata*, new species, ♀ holotype, Chile (8.3 mm); 251, *Eosopostega issikii*, new species, ♂ holotype, Japan (3.8 mm); 252, *Opostegoides gephyraea* (Meyrick), ♀, Australia (3.5 mm); 253, *Opostegoides malaysiensis*, new species, ♀ paratype, Malaysia (3 mm); 254, *Opostegoides menthinella* (Mann), ♂, Italy (5.4 mm); 255, *Opostegoides scioterma* (Meyrick), ♂, USA: Oregon (3.1 mm). (Forewing lengths in parentheses.)


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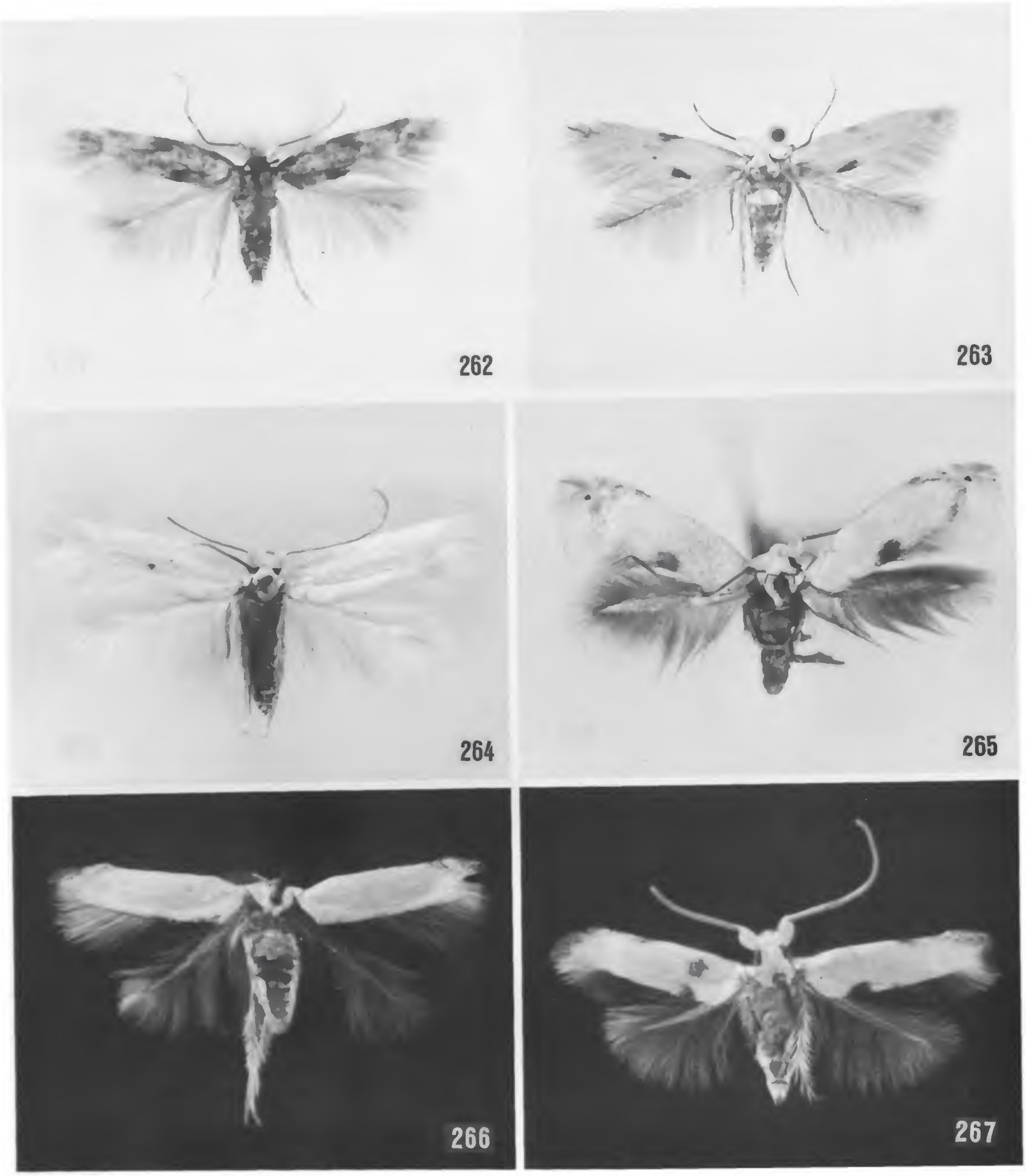
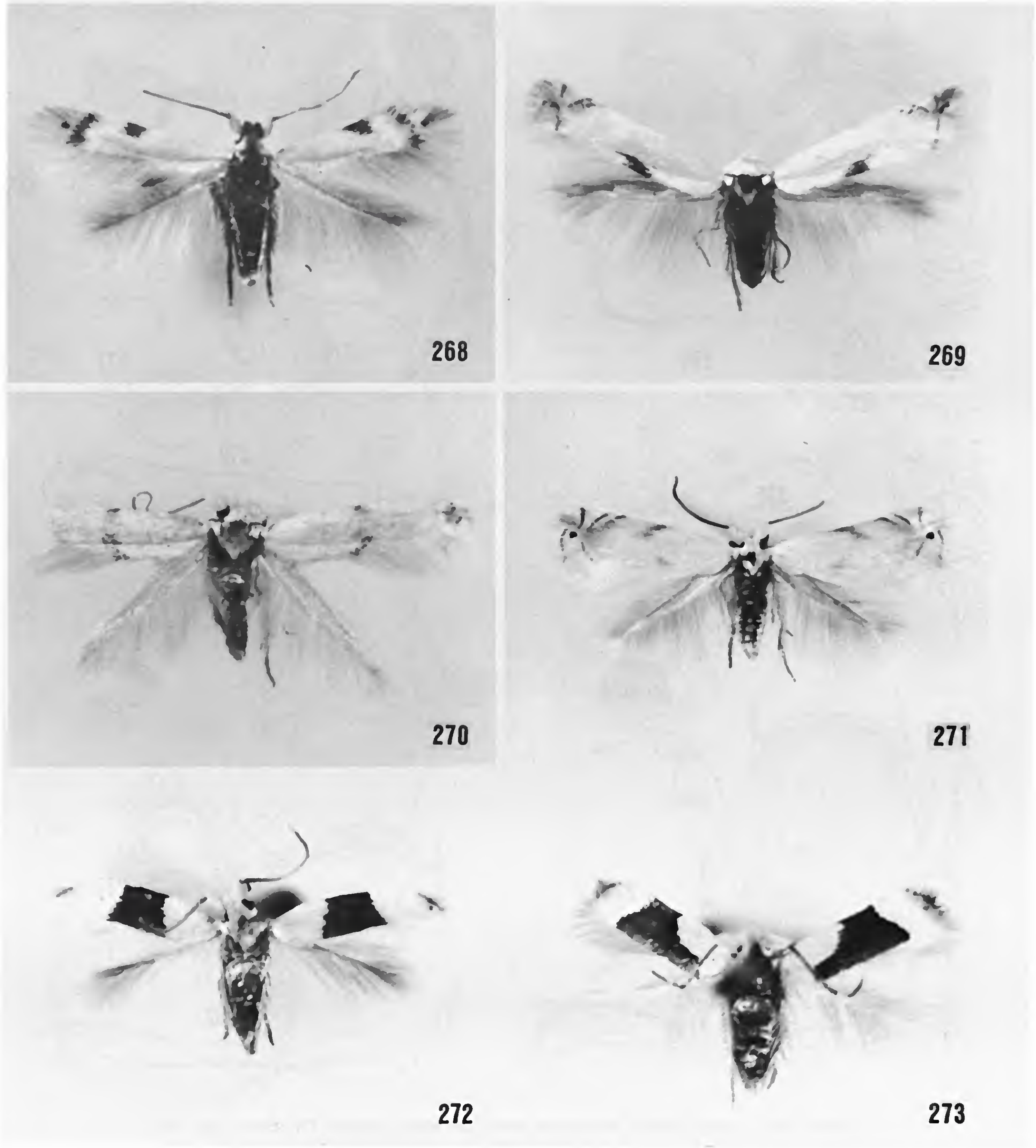
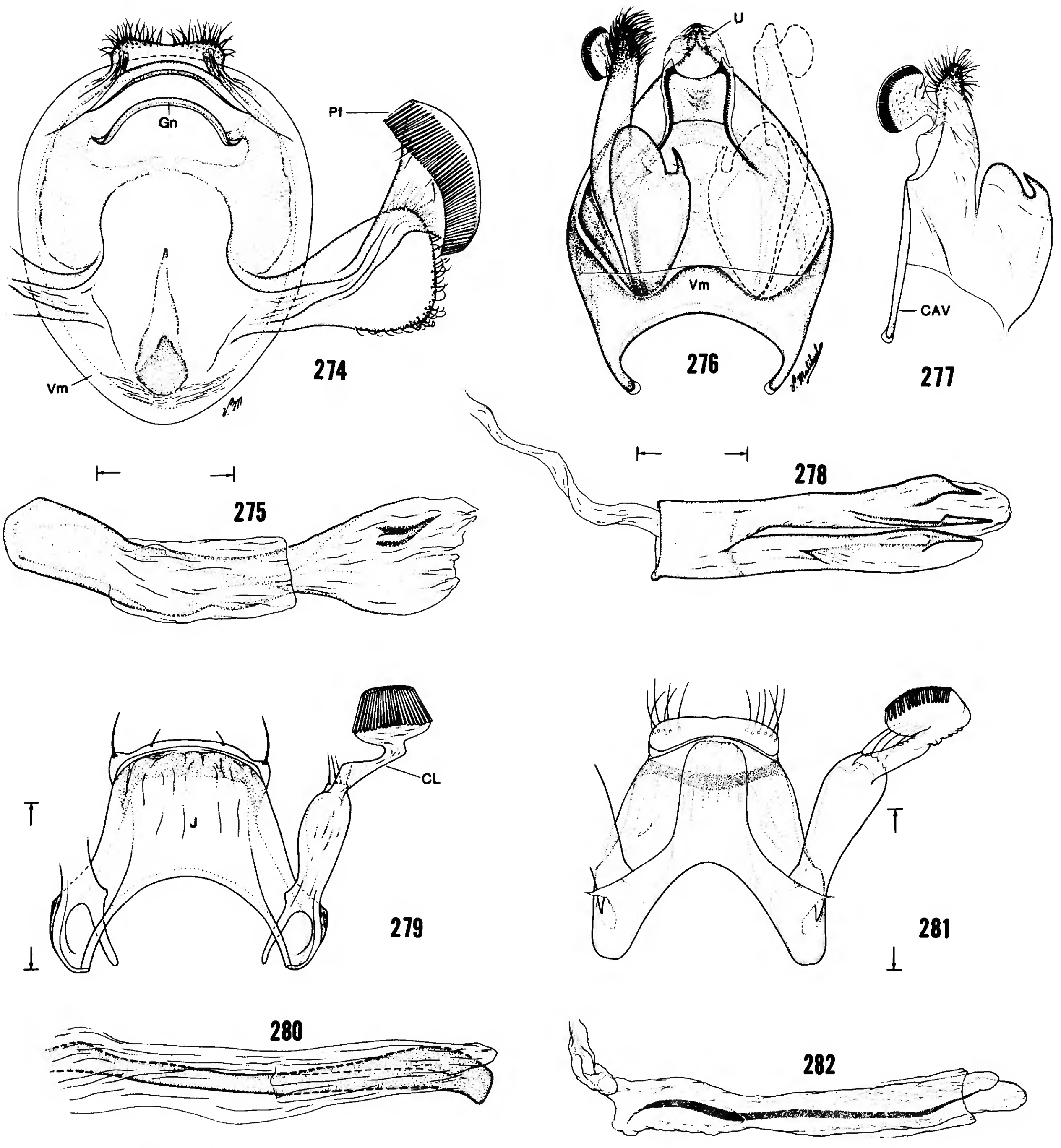
FIGURES 256–261.—Adults: 256 *Opostegoides minodensis* (Kuroko), ♀, Japan (4.7 mm); 257, *Paralopostega callosa* (Swezey), ♂ lectotype, USA: Hawaii (3.2 mm); 258, genus A, new species, ♂, Australia (5.4 mm); 259, genus A, new species, ♀, Australia (probably of Figure 258 ♂) (6.1 mm); 260, genus A, new species, ♂, Australia (5.8 mm); 261, *Opostega afghani*, new species, ♂ holotype, Afghanistan (4 mm). (Forewing lengths in parentheses.)



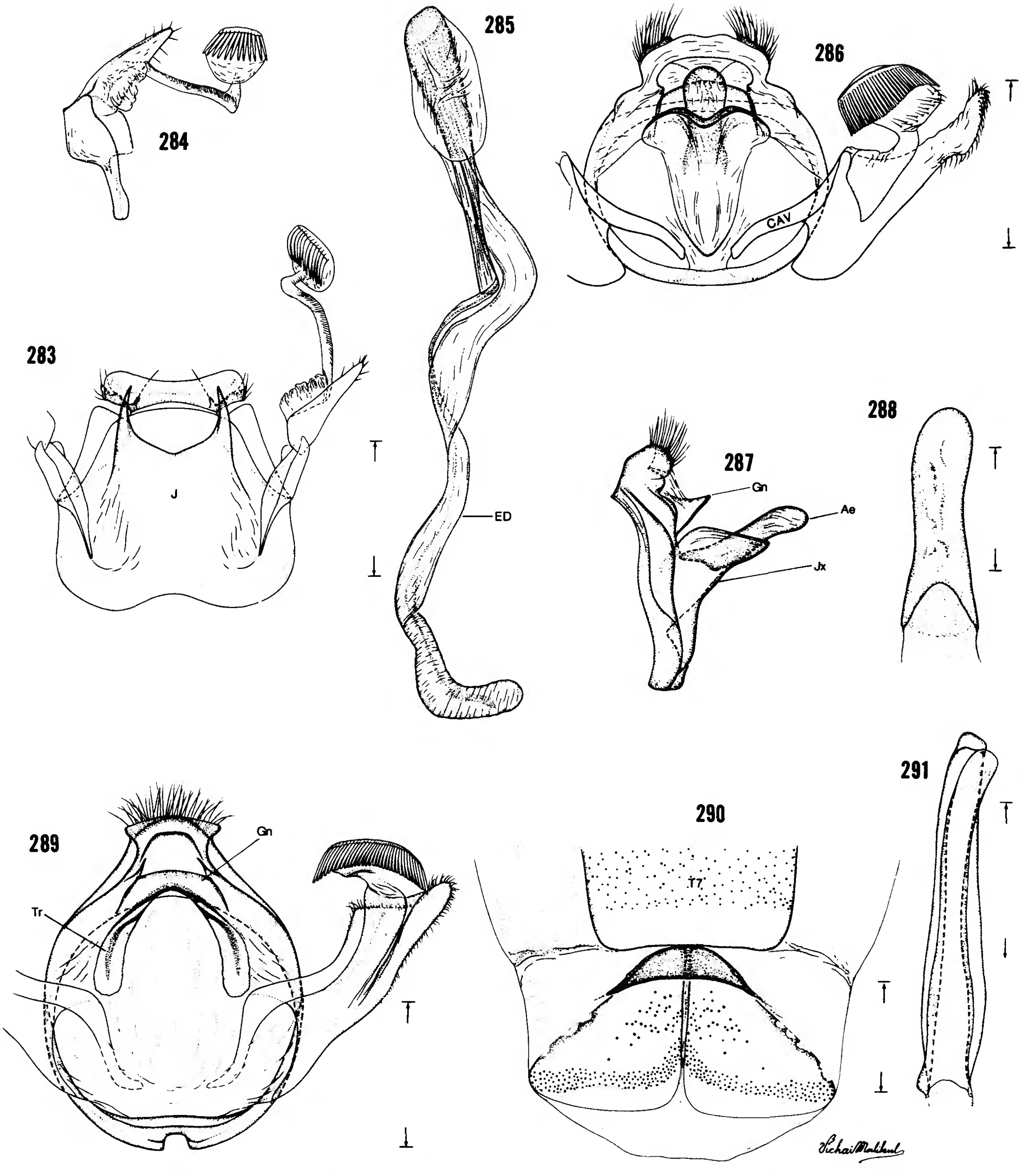
FIGURES 262–267.—Adults: 262, *Opostega spatulella* Herrich-Schäffer, "Europe" (4 mm); 263, *Opostega spatulella* Herrich-Schäffer, Lebanon (4 mm); 264, *Opostega salaciella* (Treitschke), ♂, Germany (4.8 mm); 265, *Pseudopostega auritella* (Hübner), ♂, "Europe" (5.2 mm); 266, *Pseudopostega abrupta* (Walsingham), ♂ holotype, St. Thomas (2.9 mm); 267, *Pseudopostega adusta* (Walsingham), ♂ holotype, St. Thomas (2.8 mm). (Forewing lengths in parentheses.)



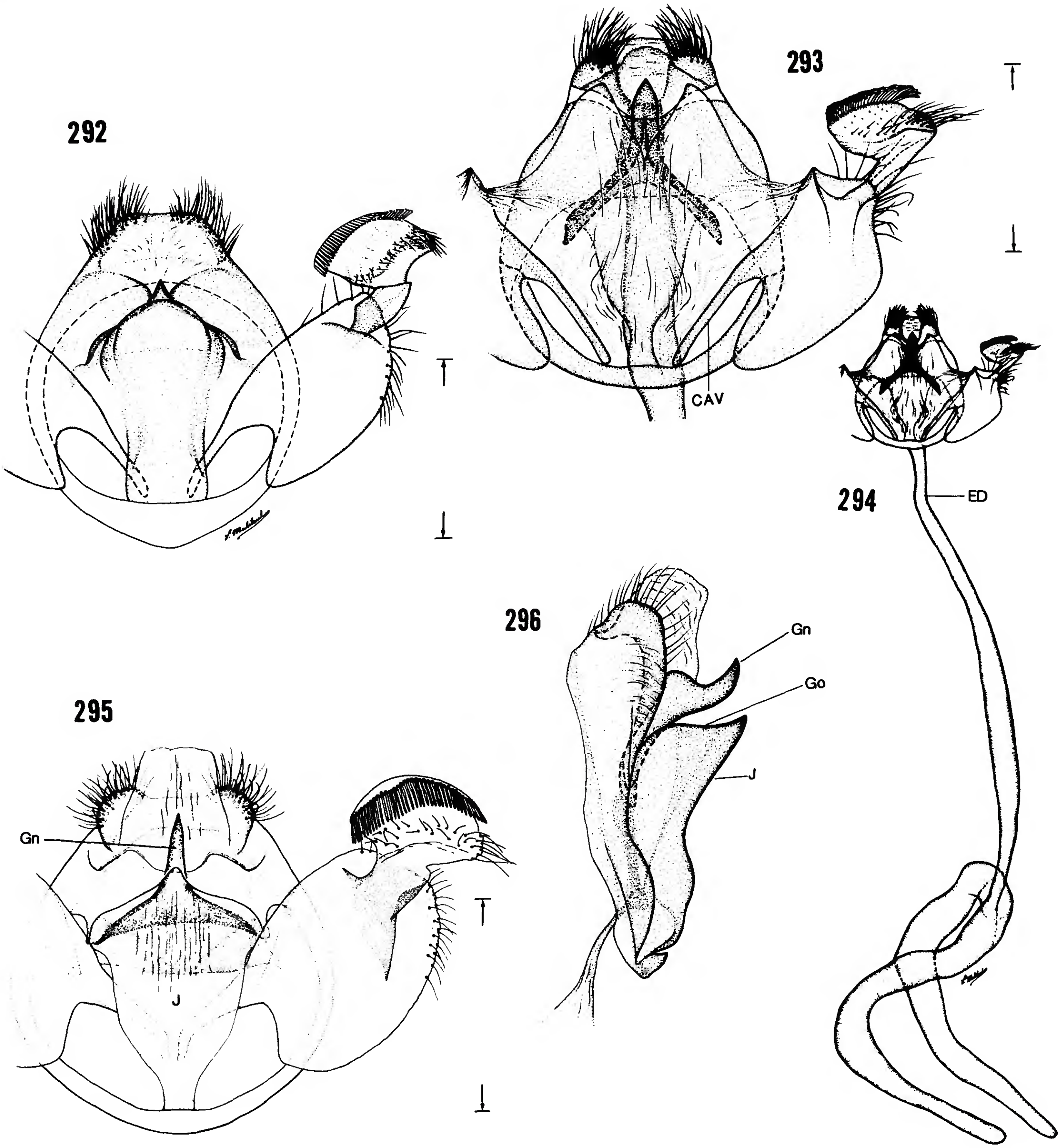
FIGURES 268–273.—Adults: 268, *Pseudopostega bellicosa* (Meyrick), ♂, South Africa (2.4 mm); 269, *Pseudopostega bistrigulella* (Braun), ♂, USA: Arizona (4.9 mm); 270, *Pseudopostega clastozoma* (Meyrick), ♂ paralectotype, South Africa (4.5 mm); 271, *Pseudopostega crepusculella* (Zeller), ♂, Greece (4.5 mm); 272, *Pseudopostega euryntis* (Meyrick), ♀, Sri Lanka (2.3 mm); 273, *Pseudopostega* species, ♂, Australia (2.1 mm). (Forewing lengths in parentheses.)



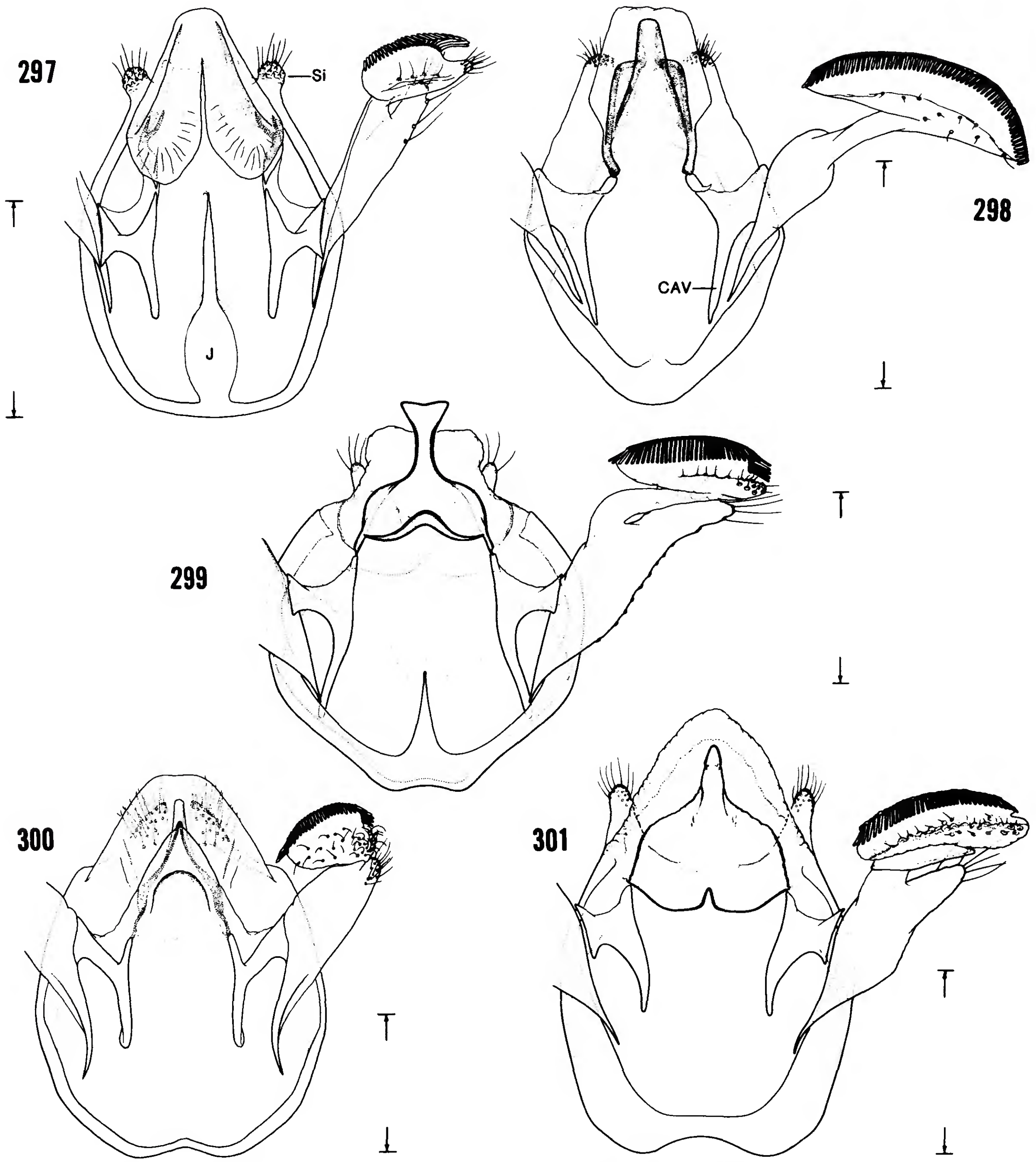
FIGURES 274–282.—Male genitalia. *Notiopostega atrata*, new species, paratype: 274, ventral view; 275, aedoeagus. *Eosopostega issikii*, new species, holotype: 276, ventral view; 277, lateral view of right valva; 278, aedoeagus. *Opostegoides malaysiensis*, new species, holotype: 279, ventral view; 280, aedoeagus. *Opostegoides scioterma* (Meyrick): 281, ventral view; 282, aedoeagus. (All scales = 0.2 mm.)



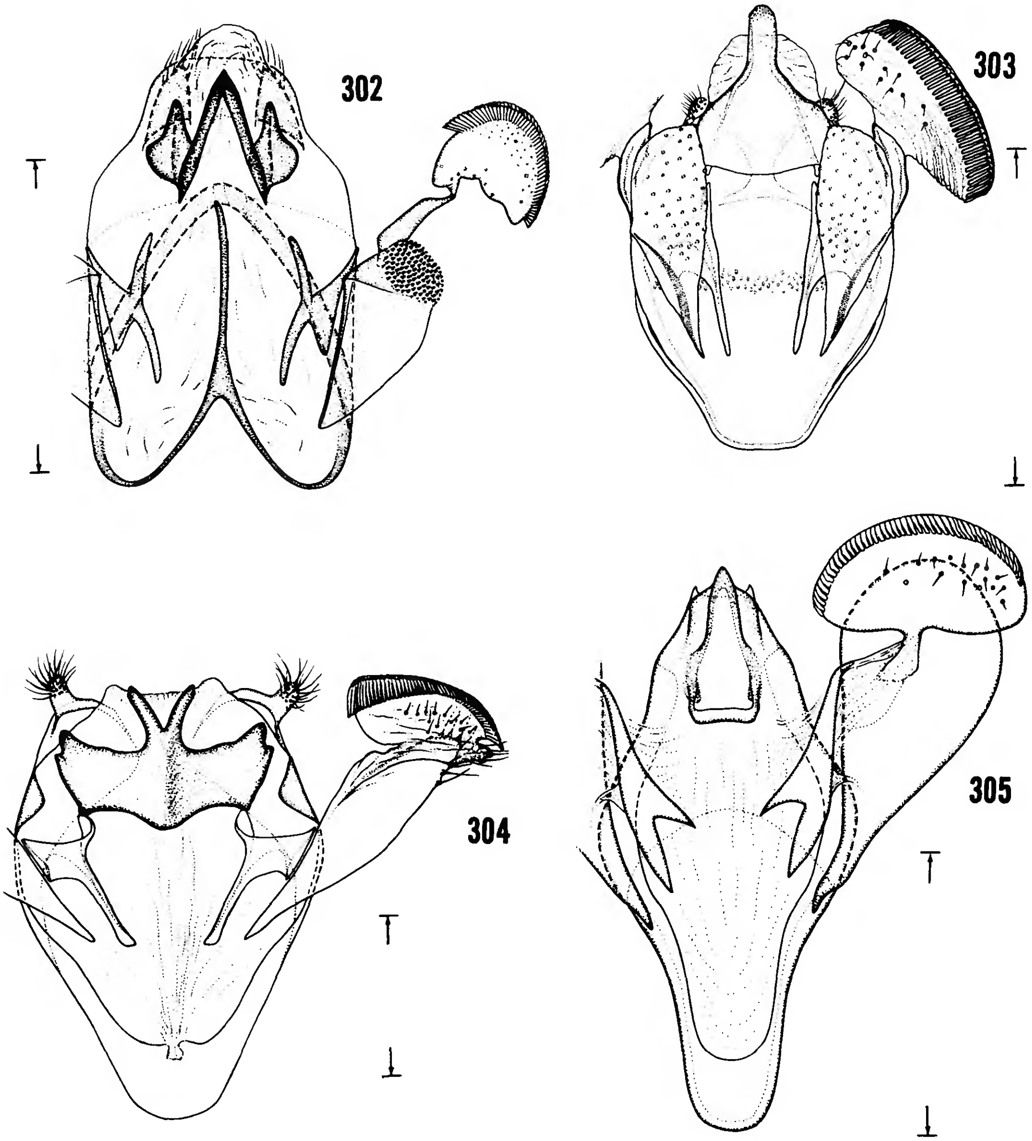
FIGURES 283–291.—Male genitalia and eighth abdominal tergite. *Opostegoides gephyraea* (Meyrick): 283, ventral view; 284, lateral view of right valva; 285, aedoeagus. *Paralopostega callosa* (Swezey), lectotype: 286, ventral view; 287, lateral view; 288, aedoeagus (scale = 0.1 mm). Genus A, new species (of Figure 258): 289, ventral view; 290, eighth abdominal tergite; 291, aedoeagus. (All scales except Figure 288 = 0.2 mm.)



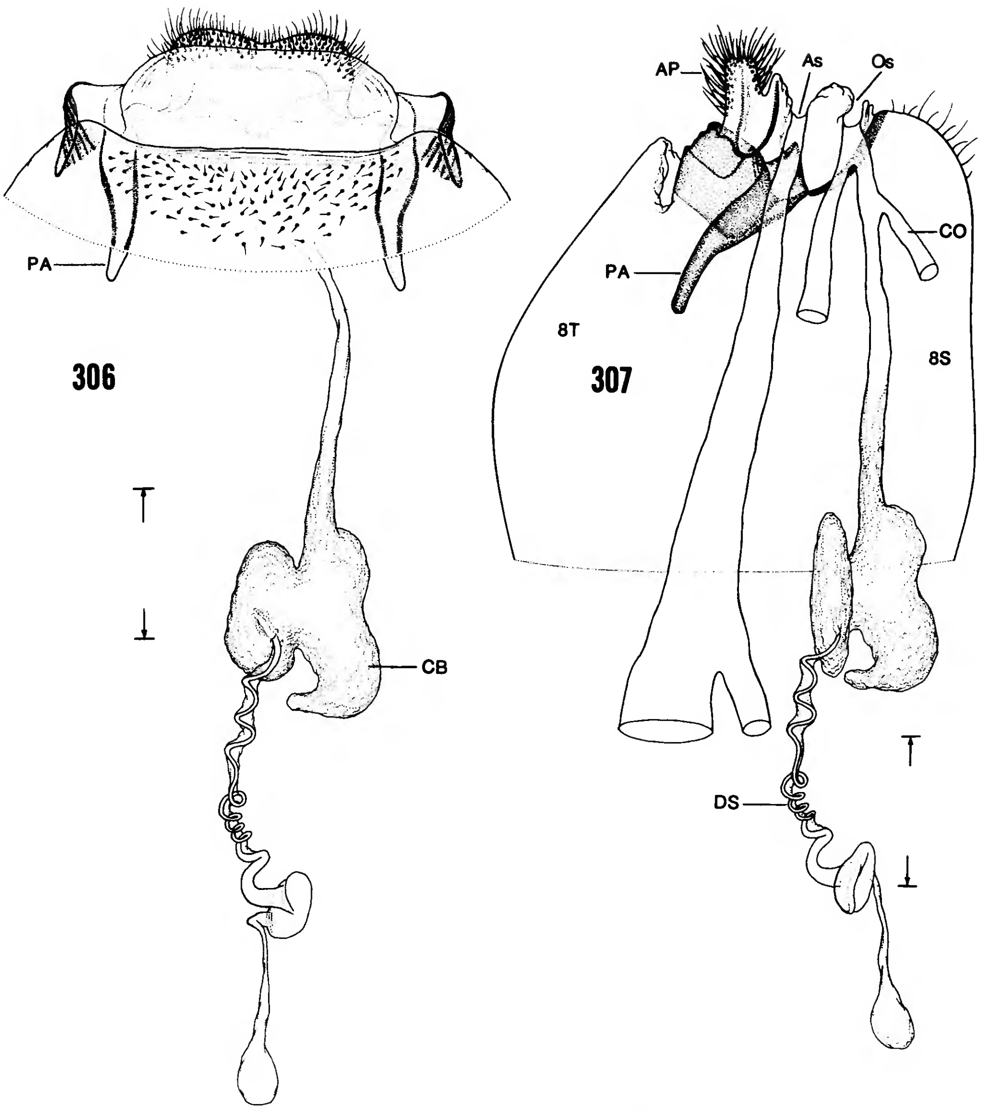
FIGURES 292–296.—Male genitalia. *Opostega afghani*, new species, paratype: 292, ventral view. *Opostega spatulella* Herrich-Schäffer: 293, ventral view; 294, ventral view with ejaculatory duct attached. *Opostega salaciella* (Treitschke): 295, ventral view, 296, lateral view. (All scales = 0.2 mm.)



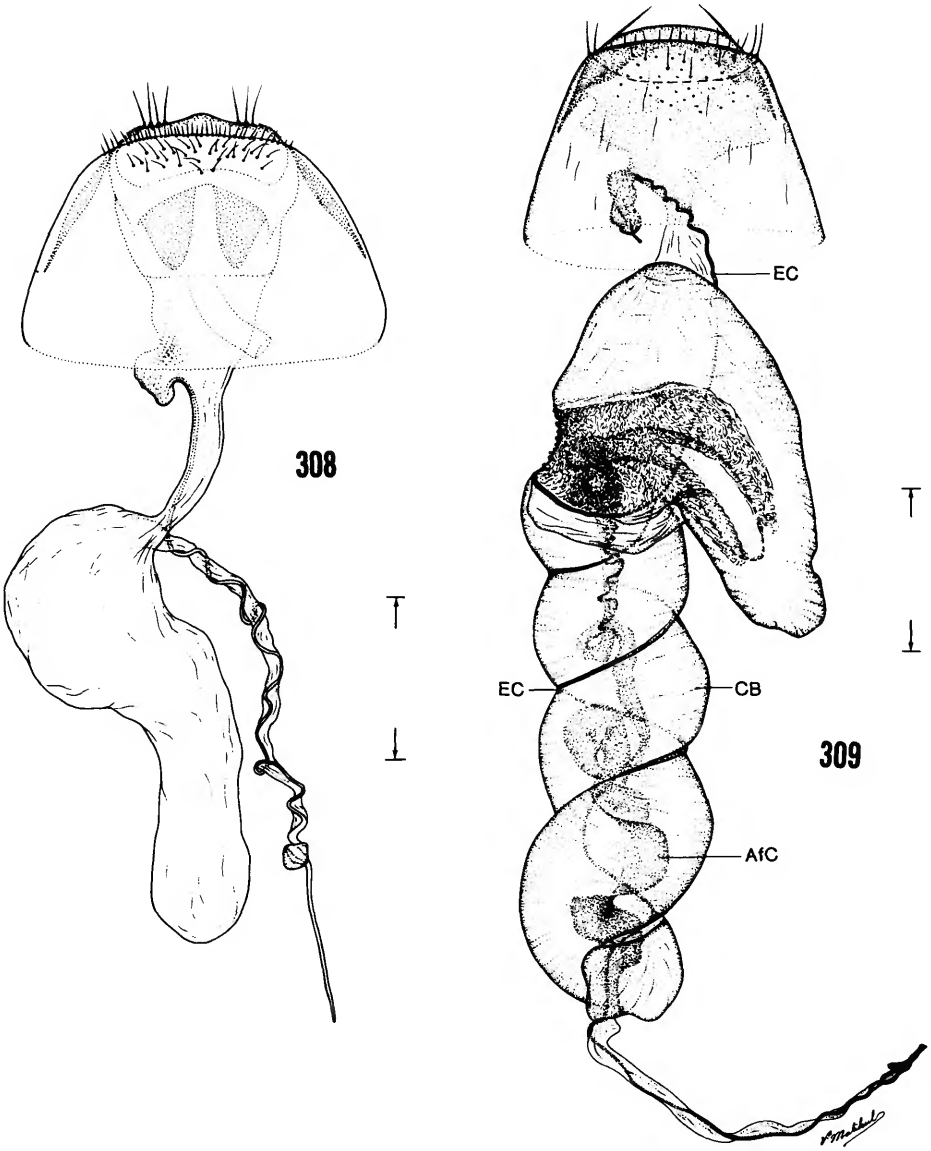
FIGURES 297–301.—Male genitalia. *Pseudopostega abrupta* (Walsingham), holotype: 297, ventral view. *Pseudopostega adusta* (Walsingham), holotype: 298, ventral view. *Pseudopostega bistrigulella* (Braun): 299, ventral view. *Pseudopostega clastozona* (Meyrick): 300, ventral view. *Pseudopostega cretea* (Meyrick): 301, ventral view. (All scales = 0.2 mm.)



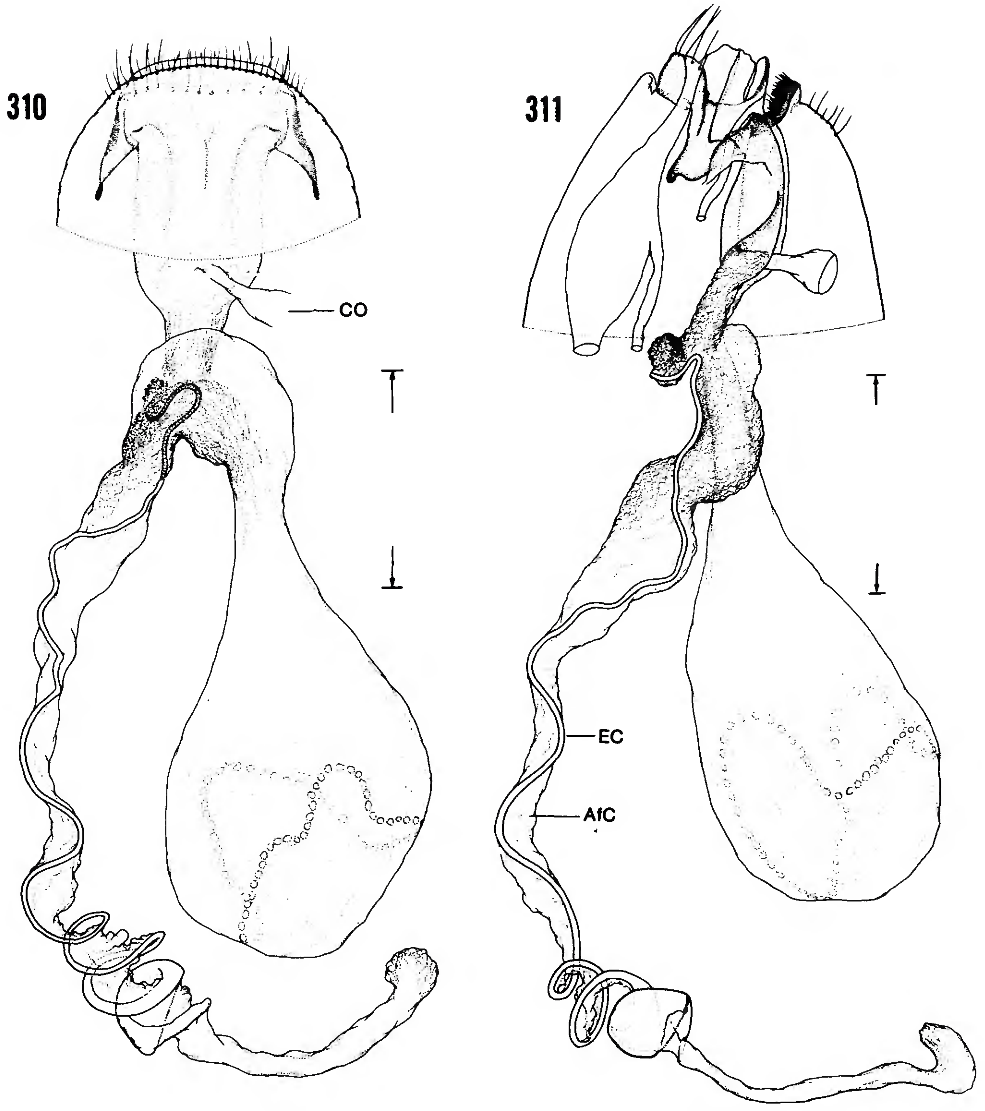
FIGURES 302–305.—Male genitalia. *Pseudopostega euryntis* (Meyrick): 302, ventral view. *Pseudopostega kempella* (Eyer): 303, ventral view. *Pseudopostega protomochla* (Meyrick), lectotype: 304, ventral view. *Pseudopostega* species, Dominica: 305, ventral view. (All scales = 0.2 mm.)



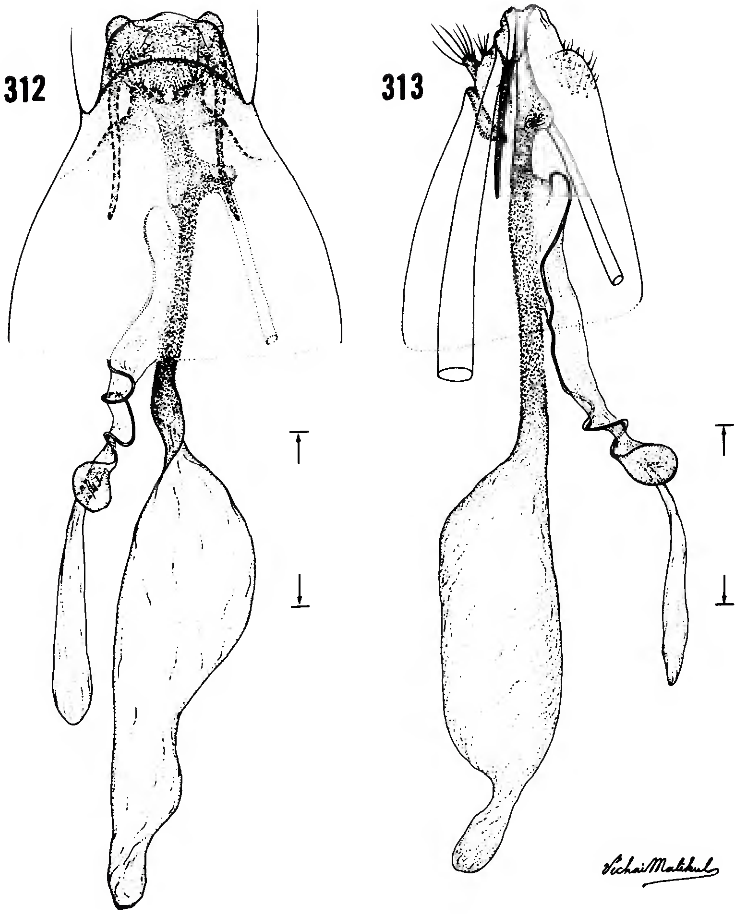
FIGURES 306, 307.—Female genitalia. *Notiopostega atrata*, new species, paratype: 306, ventral view; 307, lateral view. (Scale = 0.25 mm.)



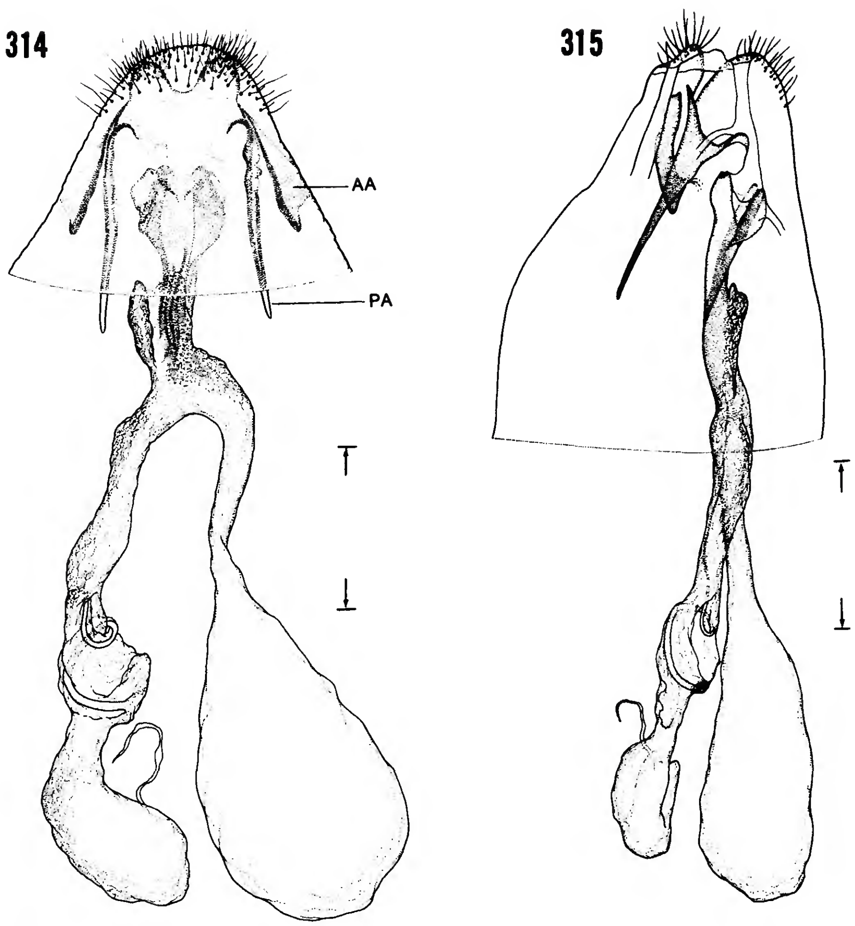
FIGURES 308, 309.—Female genitalia. *Opostegoides gephyraea* (Meyrick): 308, ventral view. *Opostegoides malaysiensis*, new species, paratype: 309, ventral view. (All scales = 0.25 mm.)



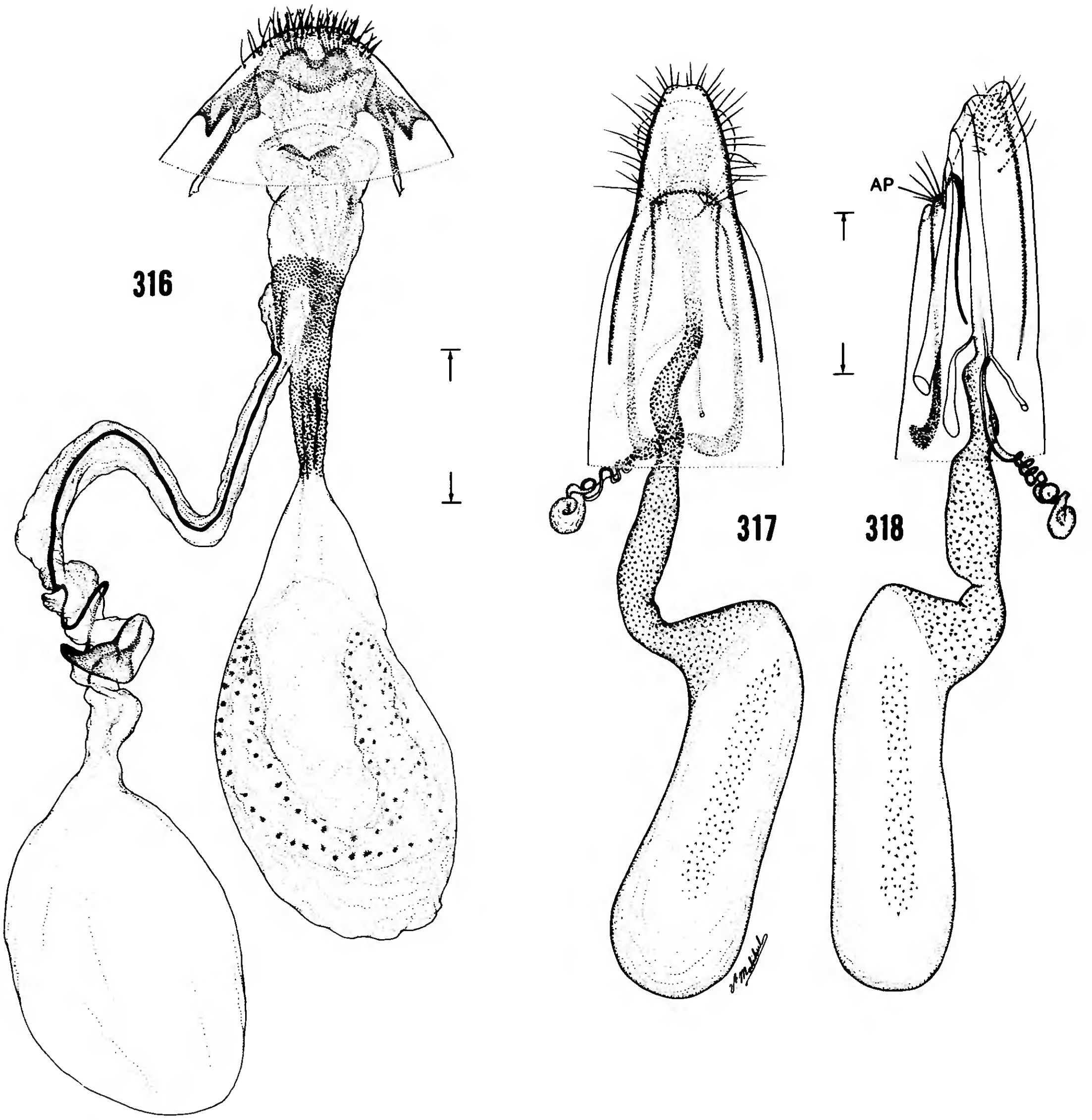
FIGURES 310, 311.—Female genitalia. *Opostegoides scioterma* (Meyrick): 310, ventral view; 311, lateral view. (Scale = 0.25 mm.)



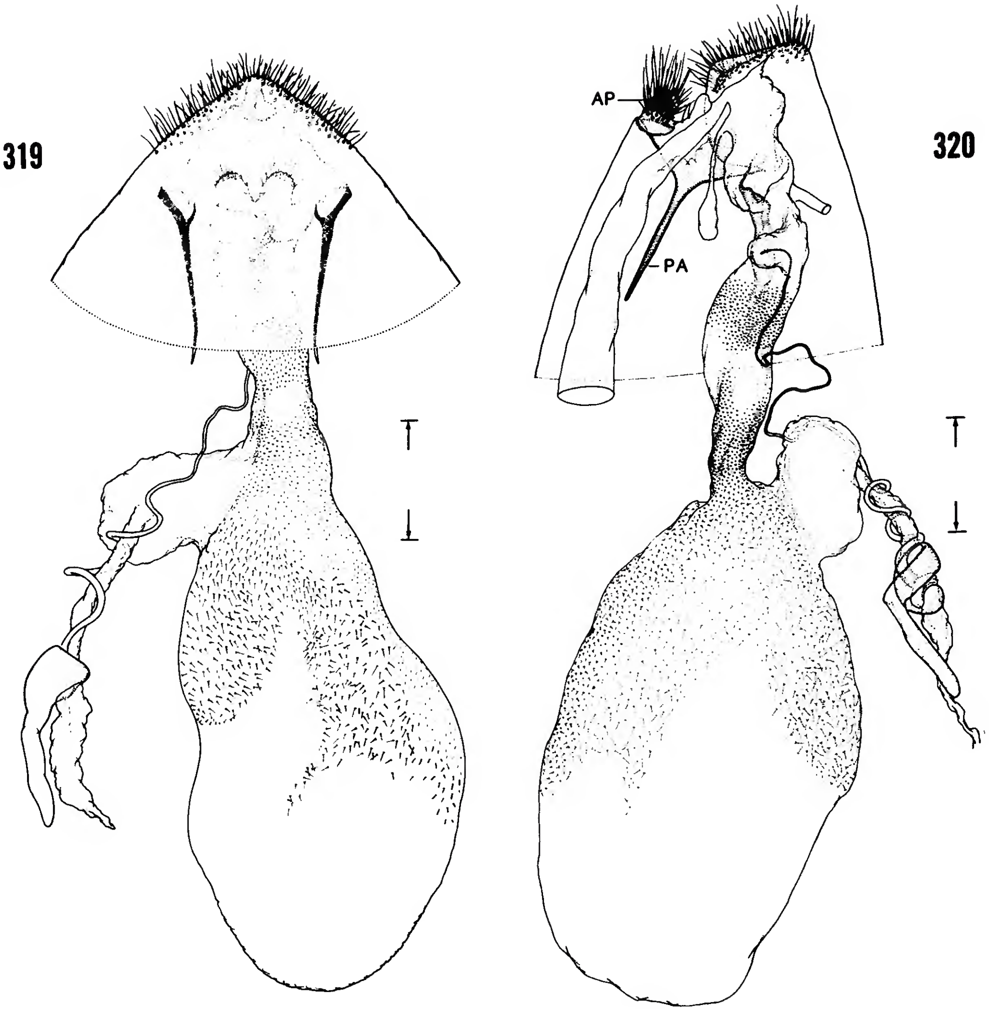
FIGURES 312, 313.—Female genitalia. *Paralopostega callosa* (Swezey), paralectotype: 312, ventral view; 313, lateral view. (Scale = 0.25 mm.)



FIGURES 314, 315.—Female genitalia. *Opostega salaciella* (Treitschke): 314, ventral view; 315, lateral view. (Scale = 0.25 mm.)



FIGURES 316–318.—Female genitalia. *Opostega spatulella* Herrich-Schäffer, lectotype: 316, ventral view. *Pseudopostega* species, Dominica: 317, ventral view; 318, lateral view. (All scales = 0.25 mm.)



FIGURES 319, 320.—Female genitalia. *Pseudopostega bistrigulella* (Braun): 319, ventral view; 320, lateral view. (Scale = 0.25 mm.)

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