Clearwing Moths of Australia and New Zealand (Lepidoptera: Sesiidae)

W. DONALD DUCKWORTH
and
THOMAS D. EICHLIN

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY · NUMBER 180

SERIAL PUBLICATIONS OF THE SMITHSONIAN INSTITUTION

The emphasis upon publications as a means of diffusing knowledge was expressed by the first Secretary of the Smithsonian Institution. In his formal plan for the Institution, Joseph Henry articulated a program that included the following statement: "It is proposed to publish a series of reports, giving an account of the new discoveries in science, and of the changes made from year to year in all branches of knowledge." This keynote of basic research has been adhered to over the years in the issuance of thousands of titles in serial publications under the Smithsonian imprint, commencing with *Smithsonian Contributions to Knowledge* in 1848 and continuing with the following active series:

Smithsonian Annals of Flight
Smithsonian Contributions to Anthropology
Smithsonian Contributions to Astrophysics
Smithsonian Contributions to Botany
Smithsonian Contributions to the Earth Sciences
Smithsonian Contributions to Paleobiology
Smithsonian Contributions to Zoology
Smithsonian Studies in History and Technology

In these series, the Institution publishes original articles and monographs dealing with the research and collections of its several museums and offices and of professional colleagues at other institutions of learning. These papers report newly acquired facts, synoptic interpretations of data, or original theory in specialized fields. These publications are distributed by mailing lists to libraries, laboratories, and other interested institutions and specialists throughout the world. Individual copies may be obtained from the Smithsonian Institution Press as long as stocks are available.

S. Dillon Ripley
Secretary
Smithsonian Institution

SMITHSONIAN CONTRIBUTIONS TO ZOOLOGY • NUMBER 180

Clearwing Moths of Australia and New Zealand (Lepidoptera: Sesiidae)

W. Donald Duckworth
and Thomas D. Eichlin

SMITHSONIAN INSTITUTION PRESS
City of Washington
1974

ABSTRACT

Duckworth, W. Donald, and Thomas D. Eichlin. Clearwing Moths of Australia and New Zealand (Lepidoptera: Sesiidae). *Smithsonian Contributions to Zoology*, number 180, 45 pages, 50 figures, 6 maps, 1974.—The family Sesiidae in Australia and New Zealand is revised and one new species is described. The history, biology, geographical distribution, morphology, and classification of the family are discussed in detail. All the species are reviewed regarding their taxonomic history, distribution, identity, and morphology. A key to species and higher categories is provided. Distribution maps, photographs of adults, illustrations of the male and female genitalia, wing venation, and other aspects of morphology are included.

OFFICIAL PUBLICATION DATE is handstamped in a limited number of initial copies and is recorded in the Institution's annual report, *Smithsonian Year*. SI PRESS NUMBER 5129. SERIES COVER DESIGN: The coral *Montastrea cavernosa* (Linnaeus).

Library of Congress Cataloging in Publication Data
Duckworth, W. Donald
Clearwing Moths of Australia and New Zealand (Lepidoptera: Sesiidae)
(Smithsonian contributions to zoology, no. 180)
Supt. of Docs. no.: SI 1.27: 180.
1. Aegeriidae. 2. Insects—Australia. 3. Insects—New Zealand. I. Eichlin, Thomas D., 1938– joint author. II. Title. III. Series: Smithsonian Institution. Smithsonian contributions to zoology, no. 180.
QL1.S54 no. 180 [QL561.A34] 591'.08s [595.7'81] 74–6058

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 - Price $1.15 (paper cover)

Contents

Clearwing Moths of Australia and New Zealand (Lepidoptera: Sesiidae)

W. Donald Duckworth
and Thomas D. Eichlin

Introduction

The Sesiidae (= Aegeriidae) is a well-defined family, worldwide in distribution. Consisting of over 1000 described species, the adult members of this family are primarily diurnal and highly mimetic in both appearance and behavior. The degree to which species in this family have become modified structurally and behaviorally to resemble their models, primarily bees and wasps, is truly remarkable. The wings are narrow and, in most instances, partially devoid of scales; the abdomen is commonly banded with orange or yellow and narrowed basally either by actual constriction or scaled so as to create an illusion of constriction. In addition, the legs are usually modified to resemble those of the model even to the extent, in some groups, of scale tufts tipped in yellow to simulate the pollen-gathering devices of certain bees.

The larvae are primarily borers in the trunks, bark, stems, or roots of trees, shrubs, and vines or in the stems and roots of herbaceous plants. Some species are inquiline borers in galls on woody and herbaceous plants. Although a great deal of biological data is known for species that occur in temperate regions, particularly the Nearctic and Palearctic, the life histories of species in tropical and subtropical areas are still very incompletely known.

The present study is an outgrowth of research currently underway by the authors on the Western Hemisphere sesiids and represents the first detailed account of all the species known to occur in Australia and New Zealand. As presently defined, the sesiid fauna of this area consists of 14 species in 6 genera, of which one species is described as new, and one, *Synanthedon tipuliformis* (Clerck), is an introduced species from Europe. In addition, two species, *Balataea homotona* Swinhoe and *Dolophrosyne balteata* Durrant, previously assigned to the family have been found to be improperly placed and are herein transferred to other families.

Throughout the course of this study we have been handicapped by the small number of specimens available for study. This is a fairly general situation for the sesiids throughout the world and is undoubtedly due, in large part, to the diurnal flight period and fugitive behavior of the adults, coupled with the endophagous boring habit of the larvae. As a result, most collections are sorely lacking in sufficient material to adequately support modern systematic studies. It is our hope that this paper will serve to stimulate Australian biologists to focus more attention on this unique family of moths.

ACKNOWLEDGMENTS.—The authors wish to acknowledge with gratitude the cooperation and assist-

W. Donald Duckworth, Department of Entomology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560. Thomas D. Eichlin, Laboratory Services/ Entomology, Division of Plant Industry, California Department of Food and Agriculture, Sacramento, California 95814.

ance of the following individuals and institutions that, through their support and encouragement, have materially aided the present study: Dr. I. F. B. Common, Commonwealth Scientific and Industrial Research Organization, Canberra, Australia; Dr. Gordon F. Gross, South Australian Museum, Adelaide; Mr. A. Neboiss, National Museum of Victoria, Melbourne, Australia; Dr. C. N. Smithers, Australian Museum, Sydney; Mr. J. S. Dugdale, Department of Scientific and Industrial Research, Nelson, New Zealand; Mr. Paul E. S. Whalley, Dr. Klaus Sattler, British Museum (Natural History); Mr. I. Lansbury, Hope Department of Zoology, University of Oxford; Dr. P. Viette, Museum National D'Histoire Naturelle, Paris, for lending for study types and other specimens in their charge.

We wish to particularly acknowledge our gratitude to Dr. Ian F. B. Common, CSIRO, whose willingness to share with us his extensive knowledge of Australian Lepidoptera, both through prompt response to our numerous inquiries by mail and directly during a brief visit by one of the authors (Duckworth) to Australia, significantly contributed to the completion of the project.

The authors also wish to acknowledge the assistance of Mr. George Venable, departmental illustrator, for the illustrations and maps; Mrs. Vera Milbank, technician, for bibliographic assistance; Mr. Timothy P. Friedlander, undergraduate fellow, for assistance in all phases of the study; and the National Museum of Natural History Photographic Laboratory for the photographs.

This study was aided in part by a grant from the Secretary's Fluid Research Fund, Smithsonian Research Foundation number 112–715, and a Travel Grant from The Entomological Society of America.

History

As one might expect, considering the limited number of species and infrequency of capture, the previous literature concerning the Australian and New Zealand sesiids is anything but profuse. The initial documentation of the family for this region was by Meyrick (1886) and consisted of the description of two new species (*Sesia isozona* and *Sesia chrysophanes*) from Australia, and *Synanthedon tipuliformis* (Clerck) listed as an introduced species in New Zealand.

Turner (1917), in a paper describing a number of new Australian species in various families, presented a summary of the family Aegeriidae (= Sesiidae) noting that "the known species are of Indo-Malayan origin." Five years later Turner (1922) summarized the family once again in order to include new taxa from Australia resulting from the publication of intervening papers by LeCerf (1917) and Hampson (1919). Although both of the latter papers were primarily concerned with other faunal areas, both included species from Australia and, even more important, higher category concepts of significance to the Australian region. With the publication of Turner's paper, the known sesiid fauna consisted of 15 species in 7 genera, all (except the introduced *S. tipuliformis*) from Queensland and northern Australia.

In contrast to Turner's figures, Dalla Torre and Strand (1925) list 17 species in 11 genera as occurring in Australia, and Gaede (1933) lists 14 species in 8 genera. These publications were worldwide treatments of the family and illustrate the inconsistencies inherent in such ambitious undertakings.

Attempts at family definition for the Australian sesiids were provided by Tillyard (1926) and Common (1970). In both instances only a family level treatment was intended and no more than a few selected species were included.

In addition to the works previously cited, it is important to note a number of publications which, although they have not necessarily included data directly pertaining to the Australian fauna, are of considerable significance in the development of our overall knowledge of the family. Beutenmuller (1901) provided the first comprehensive review of the family in North America, including a systematic review of the literature. In addition, an attempt was made to present all the known biological information concerning the included species. This tradition was continued and expanded by Engelhardt (1946), whose later revision of the family for North America greatly expanded our knowledge of the life histories and habits of the group.

More recently, the publications of Niculescu (1964) and Naumann (1971) have contributed significantly to the higher category concepts within the family and have aided in the clarification of several nomenclatural problems of long standing. Little information has been published regarding

the systematics of the immature stages of sesiids, thus MacKay's (1968) revision of the North American species, based on late instar larvae, provides a vital resource for comparison of higher category concepts as well as for elucidation of larval morphology and species identification.

Morphology

It is not our intention to deal in great detail with the comparative morphology of the Sesiidae in the present paper. The limited nature of the Australian–New Zealand sesiid fauna, together with the lack of significant morphological divergence from patterns observed for the family in other parts of the world, makes it more desirable to present a detailed analysis of character trends as a part of our studies on the Western Hemisphere portion of the family. The family description included in the present study provides a complete summation of structural characteristics for the group and is based on an extensive worldwide survey of the family.

In general, the sesiids are a remarkably homogeneous group morphologically. They are readily recognized superficially by their narrow and more or less transparent wings, clavate or filiform antennae, and the generally elongate, slender abdomen, which is tapered posteriorly and terminated by a more or less prominent anal tuft of scales. The mimetic nature of the group is generally apparent by the pattern and scaling of the wings, by the abdomen being frequently banded or striped with yellow or orange, and by the legs being usually long and variously tufted with scales.

While family recognition is relatively easy, characterization of taxa below the family level requires careful examination of various character systems (e.g., wing venation, genitalia, legs, head, etc.), for the distinguishing differences are frequently quite subtle. The keys provided in the present study are designed to facilitate identification through utilization of easily observed characters; however, they have been correlated with additional characters derived from intensive study of adult morphology as well as data derived from other life stages and biologies, whenever possible.

One portion of sesiid morphology displays unique modifications worthy of particular emphasis. The wings of sesiids are, as mentioned previously, very narrow. It is presumed this reduction has resulted from selection favoring hymenopterous mimicry; however, as the wings become more narrow the mechanisms found in most Lepidoptera for coupling the fore and hindwing during flight become less efficient, especially for the typically rapid flight exhibited by most sesiids. Thus, in the family a number of modifications in the wing-coupling structures have occurred that serve to insure synchronous action of the fore and hindwings.

In most moths the mechanism for wing-coupling consists of a single-spined frenulum arising from the costal sclerite at the base of the hindwing in males and a several-spined (usually three) frenulum in the females. The frenulum is secured to the underside of the forewing by varying devices, generally termed the retinaculum. In the Sesiidae both males and females have developed a single-spined frenulum (two-spined in some females), which is secured by an overfold of subcosta that projects to near the wing membrane. Also, there is a row of scales from the radius, directed anteriorly, which aid in holding the frenulum more firmly in place. The development of a single-spined frenulum and a subcostal retinaculum is generally considered an advanced specialization in moths and one which is generally confined to the males (Braun, 1924). The attainment of this condition by both sexes in sesiids suggests, at least in this one character, a highly derived condition. To our knowledge, no other family of moths has achieved this degree of specialization in this character thoughout its component taxa.

In addition to the advanced frenulum-retinaculum device, the sesiids have further strengthened wing-coupling through the interlocking of the dorsal edge of the forewing with the costal edge of the hindwing. This is accomplished by the rolling downward of the dorsal margin of the forewing and locking firmly into nearly the entire length of the costal margin of the hindwing, which is similarly rolled upward. Each of these margins bears a series of interlocking, recurved spines, which further serve to secure the attachment.

The firm bond attained through the two methods described above has provided the sesiids with the most effective wing-coupling mechanism found in Lepidoptera and undoubledly enhances the swift

and evasive flight behavior typically observed in the family. In addition, the ability to fly rapidly would appear to be a necessary trait if hymenopterous mimicry is to be extended to flight behavior. That this transition has been accomplished by many species of sesiids is readily demonstrated by the numbers of specimens inadvertently captured by collectors of Hymenoptera.

It should be noted in connection with the wing-margin coupling mechanism that it is not possible at this time to adequately evaluate the potential phylogenetic implications of this development in sesiids. Braun (1919), in her study of the wing structure of Lepidoptera, comments as follows: "The possession of the row of costal spines by many of the Trichoptera and by more primitive Lepidoptera indicates that it is a persistent primitive character, and as such indicates common descent of the two groups. The preservation of these spines in many frenate Lepidoptera is one of the few connecting links between them and the Micropterygidae." This would suggest the possibility that the recurved spines which function in the wing-margin coupling mechanism in sesiids are derived from the costal spines, at least in part, and as such represent an evolutionary line in wing-coupling mechanisms based on a persistent ancestral character. However, Braun goes on to say: "The series of costal hooks—the hamuli—which have developed in the more specialized families of Trichoptera as a means of locking the fore and hindwing together, is a specialization not found in the Lepidoptera." Thus, if the recurved wing spines in sesiids are viewed as homologous with hamuli in Trichoptera, a view apparently held by Forbes (1923), then their presence would appear to be most likely due to parallelism. Additional studies of the development of wing-coupling mechanisms in the Lepidoptera are needed to resolve questions of this nature.

The reduction in wing width in sesiids, especially in the forewing, and the interlocking fore and hindwing margins have influenced the venation patterns of the wings in several ways. There is a great reduction in the anal area of the forewing and an unusual lack of reduction in the anal area of the hindwing. In the forewing there is a reduction in the number of veins in many species and the anal area is so reduced that, of the anal veins, only 2A remains and it is frequently reduced. By contrast, the anal area of the hindwing is expansive with patterns that include four anal veins, an extremely significant factor phylogenetically in that the presence of 4A is considered an ancestral condition lost in most of the Lepidoptera. In addition, the anal area of the hindwing, in our opinion, reflects in its venational patterns the three major lines of development in the family and provides characters of value in distinguishing the three subfamilies. The Tinthiinae appear ancestral in retaining 1A (lost and represented by a wing fold in most derived groups of Lepidoptera) but have the other three anals coalescent with 2A. In both the Paranthreninae and Sesiinae, 1A is absent and represented only by a line of scales on the wing fold. In Paranthreninae, 2A and 3A are coalescent, except at the base, and 4A is present. The Sesiinae have 2A, a portion of 3A, and 4A is present.

There is also a unique contrast in the development of the media vein in the fore and hindwing of sesiids. In the forewing the stem of media is lost, as it is in most groups of advanced Lepidoptera. In the hindwing, however, the stem of media is present and has shifted in position toward the costal margin. The three veins normally prominent along the costal margin (Sc, R_1, R_s) are greatly reduced, closely parallel, and concealed within the upfolded costal edge. This condition led early workers to erroneously conclude that these veins were missing in the hindwings of sesiids.

The venation patterns in the wings of sesiids have proved to be of value in delimiting taxa at virtually every level within the family and are detailed in the descriptions of these taxa in the taxonomic portion of this study. However, the homogeneity alluded to earlier in this discussion prevails also in wing morphology and was perhaps best summarized by Comstock (in Beutenmuller, 1901): "Although the members of this family in the course of their evolution have progressed far from the primitive type of the order, they have kept closely together; there is much less variation in the structure of the wings than one would expect to find in a group so highly specialized." Based on our studies of the family to this point, much the same may be said for most character systems found in sesiids.

Biology

Host-plant associations and other biological data are largely lacking for Australian sesiids. However, our current knowledge of seemingly general habits within the family, coupled with biological data accumulated for species in other parts of the world belonging to genera which occur in Australia, is such that certain patterns may be noted and some extrapolation made. Specific information for each Australian species, when known, is included in the descriptive portion of this study.

ADULT.—The most obvious and significant characteristic of clearwing moths is their structural and behavioral modifications related to mimetic associations. While this obvious adaptation is readily recognized by researchers, both past and present, virtually no investigations of a serious nature have been conducted on specific mimic-model relationships within the family. Thus, it is not possible to detail the biological implications of clearwing moth mimicry in other than speculative terms. This area of sesiid biology offers numerous opportunities for productive research on mimicry, adaptive aspects of behavior, and other related phenomena of broad biological significance and, hopefully, will become more widely investigated as the taxonomy of the family is clarified.

In general, clearwing moths are diurnal in adult activity periods, possess behavioral patterns associated with their models, primarily bees and wasps, and do not appear to disperse far from their host-plants. Previous studies on the behavior of selected species in North America (Girault, 1907; Gossard and King, 1918; Nielsen and Balderston, 1973) indicate that chemical sex attractants are utilized by sesiids for mate location. In addition, Nielsen and Balderston (1973) reported evidence for intergeneric sex attraction among sesiids, suggesting that more than one species may utilize the same pheromone (s) for locating mates. This finding, in turn, suggests that additional behavioral, visual, or chemical stimuli, which selects against nonconspecific mates, must come into play once physical proximity is achieved.

Once mating is accomplished, oviposition begins immediately, the eggs generally being deposited singly on or near the host-plant. The eggs are ovate, disc-shaped with flat bottoms, brown in color, with the surfaces weakly sculptured with minute shagreening in hexagonal designs. The time required for incubation varies considerably between species and is probably dependent upon temperature. Upon hatching, the larvae bore into the host-plant directly or after migrating to another area of the plant.

LARVA.—Insofar as is known all sesiid larvae are true borers and, consequently, exhibit the lack of body color and pattern characteristic of lepidopterous larvae with this habit. The time required for development and the number of instars varies considerably, with three years and seven instars being the maximum period and number recorded for a given species. Many species in North America are univoltine and overwinter as late instar larvae, either in the plant or in chambers in the soil.

Host-plant specificity also varies considerably within the family. Some species and/or genera exhibit rather narrow host preferences, while others appear to exploit a broad range of plants. While available data are sketchy, Australian sesiids appear to follow the same pattern. For example, the genus *Melittia* Hubner occurs worldwide and is, so far as is known, host specific on plants in the family Cucurbitaceae. Although the two Australian species, *Melittiachalybescens* Miskin and *Melittia amboinensis* Felder, have not been reared in Australia as yet, the latter species has been reported from cucurbitaceous plants in India (David and Subramaniam, 1962), and it seems reasonable to assume the same association will be found to occur in Australia when appropriate rearings are accomplished. By contrast, *Carmenta chrysophanes* is capable of utilizing a number of different host-plants, which may explain, at least in part, the fact that it is the only native species of the family that is distributed into the more temperate area of Australia.

PUPA.—Pupation occurs in most species of Sesiidae in the larval gallery. Prior to pupation the larva generally tunnels to the surface, leaving only a thin exterior covering, then retreats some distance and prepares a pupal case of bits of plant material and frass. At the time of emergence the pupa moves up the gallery, penetrates the thin covering, extrudes up to two-thirds its length from the gallery, and in this position the adult emerges. This process is facilitated by the retention of freedom of movement in abdominal segments 3 to 7 in the male pupa and 3 to 6 in the female pupa, and by the presence of special structures on the head

and abdomen. The head is heavily sclerotized anteriorly and usually has many ridges and projections. The clypeus often bears a chisel-like projection that is utilized to penetrate the exit region. Movement through the gallery and anchoring during emergence are aided by transverse rows of dorsal spines on abdominal segments 2 to 7 in the males and 2 to 6 in the females, the females having a single row on segment 7 and both sexes having single rows on segments 8, 9, and 10. There are also large spines ventrad on segment 10 and the cremaster is lacking.

NATURAL ENEMIES.—Records of parasites of sesiids are not abundant and those which have been documented are generally in relation to species of economic concern to man. To date, there are no records concerning parasites, predators, or diseases of Australian sesiids. From other areas of the world, however, data indicate parasites in the orders Hymenoptera and Diptera; birds, robberflies (Asilidae), ants, and rodents as predators; and several fungal diseases.

Geographical Distribution

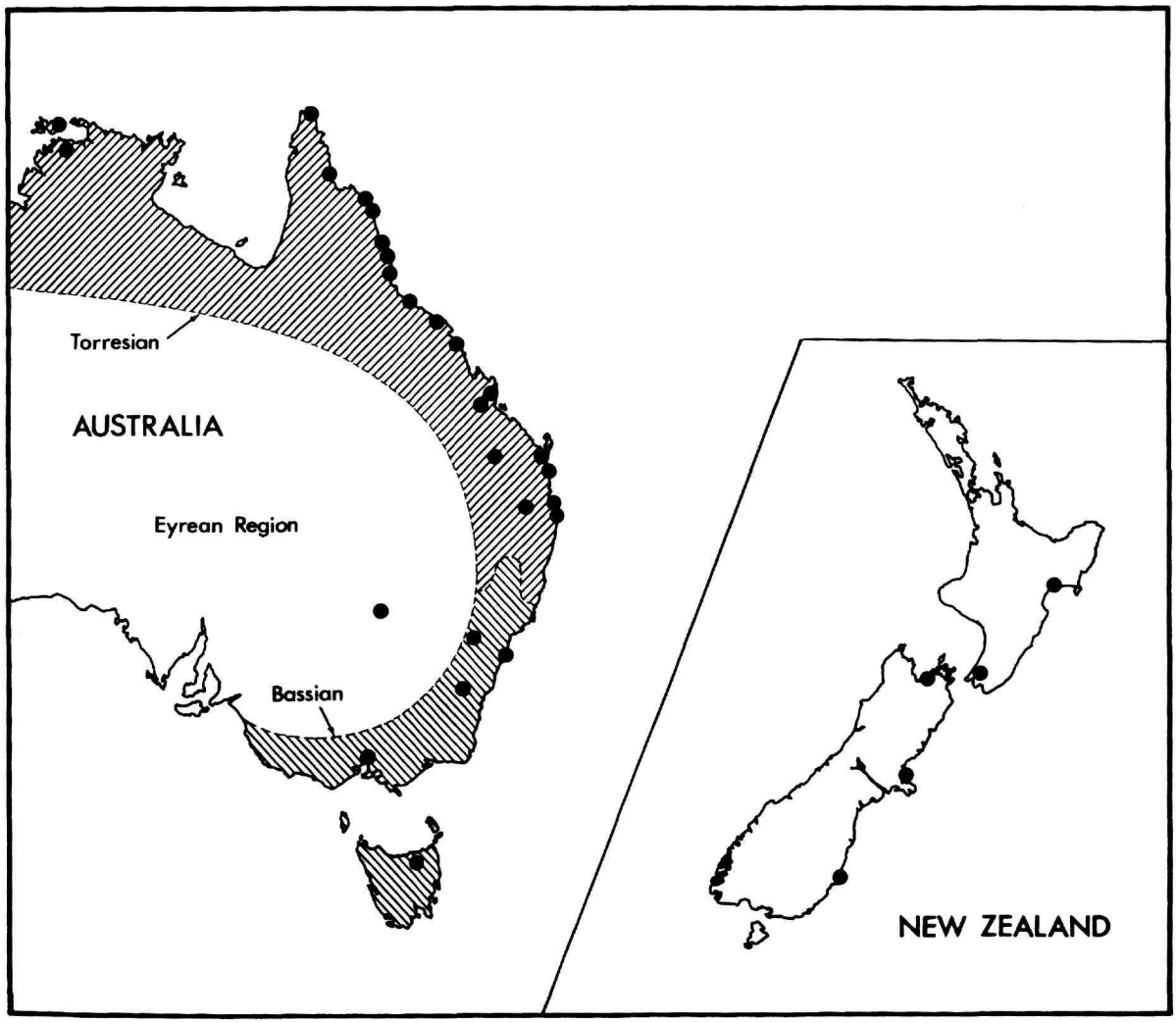
The dearth of collecting records for species of Australian sesiids makes any attempt to analyze distribution patterns both hazardous and tentative. The absence of life-history data, especially host-plant relationships, adds to the problem, as does the lack of precise knowledge concerning the sesiid fauna of adjacent areas (e.g., New Guinea), which has undoubtedly played a significant role in the development of the Australian sesiid fauna. In spite of these restrictive factors, examination of available data suggests certain probabilities worthy of mention at this point.

Spencer (1896) provided the most generally accepted framework of faunal provinces for the Australian mainland and adjacent Tasmania. These provinces are illustrated in Map 1 and can be generally characterized both faunistically and ecologically (see Keast et al., 1959; Mackerras, 1970). The Torresian, covering northern Australia, eastern Queensland, and northeastern New South Wales, has a wet to moist, tropical to subtropical climate, patches of rain forest, a general vegetation ranging from wet sclerophyll forest to open grassland, and a fauna that especially reflects northern elements. The Bassian, extending over southeastern New South Wales, Victoria, southeastern South Australia, southwestern Australia, and Tasmania, has a moist-temperate climate, vegetation ranging from southern rain and wet sclerophyll forest to alpine herb fields, and a fauna frequently reflecting a southern element. The Eyrean, consisting of the more arid interior of the continent within the 500 mm isohyet, has a xerophytic flora and a generally impoverished fauna, frequently reflecting derivation from other provinces through progressive adaptation. As is true with any such faunal scheme, it is necessarily arbitrary, especially at the boundaries, and must be viewed as it relates to the group being studied.

The generalized distribution of Australian sesiids in relation to the faunal provinces is illustrated in Map 1. It is immediately apparent that the family occurs primarily in the Torresian area, the only exceptions being *Carmenta chrysophanes* (Map 6) and *Synanthedon tipuliformis* (Map 5). The latter species is a European introduction into Australia and New Zealand and, consequently, does not relate to the present discussion. Thus, within Australia the sesiids display a distinctly tropical and subtropical distribution with virtually no natural penetration of the other faunal provinces. Obviously, considering the limited records, this is not a definitive picture; however, it seems unlikely that future studies will significantly alter the overall pattern. In fact, the northern and northwestern portions of Australia have only been minimally sampled for Microlepidoptera thus far, which suggests that the major amount of new information on sesiids could be expected to come from the Torresian region.

The presently known distribution of sesiids in Australia indicates a definite relationship with the Indo-Malayan area and would appear to be a part of a northern faunal element as summarized by Mackerras (1970). This portion of the Australian fauna includes organisms with ancient ties to the Oriental region, as well as those that have arrived more recently and relate more directly to New Guinea and the Indonesian chain. Common (1970) included the Sesiidae (= Aegeriidae) among those groups which have reached Australia more recently, and our investigations support that determination. The limited penetration of other than the northern tropical and subtropical areas,

coupled with biological attributes (endophagous boring, hymenopterous mimicry, etc.) that have in other regions allowed radiation into more arid environments, seems a clear indication of recent dispersal into Australia. In the absence of fossil records it is not possible to provide documentation, but it seems to us most likely that the sesiids entered Australia in association with their host-plants during the Indo-Malayan invasion of the late Tertiary. Probable routes of spread during this period are diagrammatically illustrated by Holloway and Jardine (1968, fig. 21), and the geographical and chronological pattern of this incursion has been repeated in numerous publications dealing with many different organisms (Evans, *in* Keast, et al., 1959). If this view of sesiid dispersal is valid, it suggests that endemism at the generic level and above should prove minimal and that many, possibly most, of the Australian species will ultimately be found to occur also in New Guinea and adjacent areas, or at least closely related species.



MAP 1.—Distribution of the Family Sesiidae in Australia and New Zealand.

Unfortunately, as mentioned at the outset of this discussion, the lack of information concerning the sesiid fauna of New Guinea and islands in the Indonesian chain seriously restricts any judgments concerning extra-Australian relationships. As a result, we are unable to draw more than tentative conclusions concerning endemism at the species level in the Australian sesiids. At the generic level and above, however, no endemism is known to occur. In addition, it is our opinion, based on the examination of available material from the Oriental Region, that few, if any, of the species currently known only from Australia are in fact truly endemic. One Australian species, *Melittia amboinensis,* occurs throughout the Indo-Malayan area to India, and while such an extensive range may prove exceptional, it does provide some evidence in support of our position.

As mentioned previously, the only sesiid known to occur in New Zealand is *Synanthedon tipuliformis,* introduced along with its hostplant from Europe. First discovered in New Zealand in the late nineteenth century, it now occurs throughout Tasmania and the coastal areas of New South Wales and Victoria in Australia. The absence of other sesiids in New Zealand lends additional support to our contention that the family is a recent arrival in the Australia-New Zealand area.

Classification

During the course of revisionary studies on the Western Hemisphere Sesiidae over the past few years, the authors have attempted to develop a system of higher categories within the family that not only adequately reflects phylogenetic relationships, as we perceive them, within the faunal area of primary concern, but also encompasses the entire family on a world basis. The results of these efforts are, in part, indicated by the system of classification used in this study. In fact, the present study is an outgrowth of a desire to test our higher classification concepts, utilizing a portion of the family far removed from the Western Hemisphere. The limited number of taxa in the Australian sesiid fauna, coupled with the probability of little or no direct relationship with the Western Hemisphere sesiids, seemed to provide a suitable, albeit limited, opportunity for comparison.

In the development of our classification, we have utilized to great benefit three recent works which have also treated this subject in some detail (Niculescu, 1964; MacKay, 1968; Naumann, 1971). Each of these studies has incorporated new data sources to expand and refine previous concepts, and our efforts have followed a similar pattern. Although it is not our intention to present a detailed account of concepts of higher classification of sesiids in the present paper, a few comments of a general nature seem appropriate.

Without question the most important single work to appear on the family in recent years is that of Naumann (1971). In it Naumann provides a detailed account of previous systems of classification proposed for the family and compares them at some length with his higher category scheme based on an application of Hennig's principles and methods of phylogenetic systematics. Naumann's classification is based on a detailed study of genitalia features and wing venation of the type-species of the Holarctic genera and, to a certain degree, of other species in the Palearctic region. In addition, a great deal of nomenclatural clarification and type-species validation is provided for genera worldwide. As a result of these studies, Naumann proposes a monophyletic origin of obscure derivation for the Sesiidae and subdivides the Holarctic sesiid fauna into two subfamilies, Tinthiinae and Sesiinae, recognized phylogenetically as two sister groups. In our studies a broad range of characters including comparative structural morphology of virtually every portion of the adult anatomy, comparative biological data, and larval morphology, where available, have been utilized for the Western Hemisphere sesiids and a significant number of taxa from other parts of the world. As a result of these studies we propose a subdivision of the family into three subfamilies, Tinthiinae, Paranthreninae, and Sesiinae. Obviously, this change in subfamily classification reflects changes at the tribal and generic levels as well; however, the overall picture is quite similar to Naumann's arrangement in most instances. In our opinion the classification utilized in this study, due primarily to its basis on a broader range of characters derived from a greater representation of the overall family, provides the most effective arrangement for expressing the relationships of the included taxa.

As mentioned previously, a detailed presenta-

tion of the higher categories and phylogeny of the family is intended for inclusion with our studies on the Western Hemisphere sesiids. In the present study all taxa are defined, generally with brief additional comments, in the systematic portion to follow.

One additional observation concerning sesiid classification should be made at this point. Certainly the most surprising aspect encountered in this study was the discovery that all the species of Australian sesiids belong to genera well established in other parts of the world, including the Western Hemisphere. This fact, coupled with data from other studies, tends to reinforce our belief that the enormous number of generic names currently applied to sesiids in some areas of the world (e.g., approximately 186 species in 60 genera for the Ethiopian region) bears little or no relation to reality. While the world sesiid fauna is still too poorly known, especially the tropical portion, to make more than tentative observations concerning generic-level endemism, evidence to date suggests that many of the genera are more widely distributed than has been previously recognized. Moreover, this situation has no doubt been further aggravated by the tendency of some previous workers to describe newly discovered species in new genera, thereby eliminating the time-consuming necessity of determining whether or not they represent new species in previously described genera.

Taxa Transferred to Other Families

During the course of the present study, two taxa were determined to be incorrectly placed in the family Sesiidae. One, a monobasic genus, is transferred to the Stathmopodidae; the other is a species assigned to an appropriate genus in the family Glyphipterygidae.

Family STATHMOPODIDAE

Genus *Dolophrosyne* Durrant

Dolophrosyne Durrant, 1919:120 [type-species: *Dolophrosyne balteata* Durrant, 1919].

Dolophrosyne balteata Durant

Dolophrosyne balteata Durrant, 1919:121.

TYPE-LOCALITY.—Queensland, Australia.

TYPE.—Holotype male, British Museum (Natural History).

DISCUSSION.—This genus and its single included species is here transferred to the family Stathmopodidae. The type-specimen was studied and proved not to be a sesiid. Although precise placement must await careful study of the family Stathmopodidae, the species appears nearest the genera *Snellenia* and *Pseudaegeria*.

Family GLYPHIPTERYGIDAE

Genus *Sagalassa* Walker

Sagalassa Walker, 1856:8 [type-species: *Sagalassa robusta* Walker, 1856].

Sagalassa homotona (Swinhoe), new combination

Balataea homotona Swinhoe, 1892:36.

TYPE-LOCALITY.—Australia.

TYPE.—Holotype male, University Museum, Hope Department of Entomology, Oxford, England.

DISCUSSION.—This species is here transferred to the genus *Sagalassa* in the family Glyphipterygidae. Examination of the type-specimen clearly indicates that the species was improperly placed in the Sesiidae. Turner (1922:59) indicated in a footnote to his tabulation of Australian sesiids that this species belonged in the genus *Miscera* Walker (= *Sagalassa* Walker); however, this transfer apparently went unnoticed and the species has continued to be included in the family until the present time.

Checklist

Family Sesiidae
  Subfamily Tinthiinae
    Tribe Pennisetiini
      Pennisetia Dehne
      = *Anthrenoptera* Swinhoe
      = *Lophocnema* Turner
      = *Diapyra* Turner

P. igniflua (Lucas)
P. eusphyra (Turner)
Tribe Tinthiini
Tinthia Walker
T. xanthospila Hampson
Subfamily Paranthreninae
Tribe Paranthrenini
Albuna Edwards
= *Harmonia* Edwards
= *Parharmonia* Beutenmuller
A. carulifera (Hampson)
= *coracodes* Turner
A. isozona (Meyrick)
A. oberthuri (LeCerf)
= *terrible* Turner
A. zoniota (Turner)
Subfamily Sesiinae
Tribe Melittiini
Melittia Hubner
= *Poderis* Boisduval
M. amboinensis Felder
= *doddi* LeCerf
= *thaumasia* Turner
M. chalybescens Miskin
= *proserpina* Hampson
Tribe Synanthedonini
Synanthedon Hubner
S. tipuliformis (Clerck)
S. cupreifascia (Miskin)
Carmenta Edwards
C. chrysophanes (Meyrick)
= *melanocera* Hampson
= *panyasis* Druce
= *caieta* Druce
C. commoni Duckworth and Eichlin
C. xanthogyna Hampson

Family SESIIDAE

SESIIDAE Boisduval, 1828:29 [Sesiariae; type-genus: *Sesia* Fabricius, 1775].
AEGERIIDAE Stephens, 1829:34.—Naumann, 1971:9 [synonymy]. [Refer to Dalle Torre and Strand, 1925:1–3, for detailed bibliography.]

DIAGNOSTIC CHARACTERS.—Small to fairly large moths, forewing length 5–30 mm. *Head*: Eyes relatively large compared to width and length of head; naked, ringed with short yellow or white scales. Ocelli present. Pilifers with rather strong, spinelike setae of varying length. Mandibles small, flattened, and somewhat hatchet-shaped. Proboscis most often elongate and functional but may be rudimentary and nonfunctional in some species. Maxillary palpus small, 1- to 3-segmented, most species with two segments. Labial palpus 3-segmented, upcurved. Antenna of most species clavate, tapered to point apically, terminated by small scale tuft; males of all but few species with setae ventrally, pectinate in some groups. *Thorax*: Dorsoanterior region of preepimeron with hollow, weakly sclerotized, baglike protuberance on all species except those in the Tinthiinae. *Abdomen*: Generally elongate, slender, tapering posteriorly, often narrowed at base with anal scale tuft most developed on males. *Legs*: Generally elongate, slender; first tarsal segment of hindleg elongate, about one-half length of tibia; tibia with scale tufts near spurs. *Forewing*: Elongate, narrow, varying from mostly hyaline to entirely opaque. *Veins*: R generally with five branches, R_4 and R_5 most often stalked; M lost in cell, often with three branches; Cu with two branches. Dorsal margin of wing folded down, interlocking with upfolded costal margin of hindwing (see discussion of wing-locking mechanism). *Hindwing*: Elongate narrow, somewhat broader than forewing, varying from hyaline to opaque depending on the species. Frenulum single in both sexes. R veins combined (Rs), often hidden in fold; M veins separate; M_3 and Cu_1 joined before or after crossvein. *Anal Veins*: 1A usually degenerate, present in primitive species; 2A present; 3A either short, fused to base of 2A or absent; 4A most often present, absent in primitive species. *Male Genitalia*: Uncus simple in few groups, more often modified and/or fused with tegumen, with lateral setaceous pads or with elongate, paired socii clothed with specialized bifurcate setae; gnathos absent or present in various forms; tegumen simple, reduced, or modified and fused with uncus; vinculum somewhat ring-shaped, extended anteriorly as saccus of varying length and thickness; valva varies from small and quadrangular to elongate and slender, with either simple setae or combination of simple setae of varying shapes and sizes and arrangements of bifurcate or multi-furcate setae; specialized saccular ridge present or absent. Aedeagus generally elongate, very slender, slightly bulbous at base. *Female Genitalia*: Papillae anales generally small and narrow; ostium bursae situated ventrally between sclerites of abdominal segment 8, or in intersegmental membrane between 7 and 8, or on posterior margin of abdominal segment 7; ductus bursae most often elongate, narrow, with sclerotization for the most part con-

Key to the Species and Higher Categories

1. Antennae filiform, without apical scale tuft (Tinthiinae) 2
   Antennae clavate, with apical scale tuft 4

2. Hindwing with vein M_3 arising from Cu_1 well basad of crossvein (Tinthiini) ..... ***Tinthia xanthospila***
   Hindwing with veins M_3 and Cu_1 long-stalked distad of crossvein (Pennisetiini: *Pennisetia*) 3

3. Forewing opaque, dorsally with at least some orange ..... ***Pennisetia igniflua***
   Forewing with hyaline area apically, dorsally with some straw-yellow and tan, without orange ..... ***Pennisetia eusphyra***

4. Hindwing with vein M_3 arising from Cu_1 basad of crossvein; vein 3A absent; forewing with stalk of vein R_4 plus R_5 more than one-half total length of R_4 or R_5 (Paranthreninae: Paranthrenini: *Albuna*) 5
   Hindwing with vein M_3 arising from Cu_1 distad of crossvein, or if basad of crossvein then vein 3A present; forewing with stalk of vein R_4 plus R_5 not more than one-half total length of R_4 or R_5 (Sesiinae) 8

5. Forewing mostly or entirely opaque with at least some blue iridescence dorsally ..... ***Albuna carulifera***
   Forewing mostly hyaline or if mostly opaque, then orange, without blue iridescence 6

6. Abdomen dorsally with one narrow white band; head with front white with brown-black; labial palpus white with brown-black ..... ***Albuna zoniota***
   Abdomen dorsally with two or more yellow or yellow-orange bands; head with front yellow; labial palpus yellow or orange with brown-black 7

7. Head with vertex roughened posteriorly, labial palpus strongly roughened laterally (males) or ventrally (females); thorax with collar yellow; female with cell opaque on forewing, discal spot orange or not defined; abdomen dorsally with yellow narrowly banded on segment 4 and mostly yellow on 6, ventrally without yellow ..... ***Albuna oberthuri***
   Head with vertex smooth, labial palpus mostly smooth; thorax with collar brown-black with some yellow-orange laterally; female with cell hyaline on forewing, discal spot brown-black; abdomen dorsally with broad yellow-orange bands on segments 2, 4, and 6, ventrally with all segments broadly banded yellow-orange ..... ***Albuna isozona***

8. Hindwing with vein M_3 arising from Cu_1 well basad of crossvein; scale-plate present beneath scape of antenna; hindlegs very strongly tufted (Melittiini: *Melittia*) 9
   Hindwing with vein M_3 arising from Cu_1 distad of crossvein; scale-plate beneath scape absent; hindlegs untufted or with slight tufting confined primarily to region of tibial spurs (Synanthedonini: *Carmenta* and *Synanthedon*) 10

9. Forewing at least one-half opaque, with broad apical margin and broad discal spot; abdomen white or solid brown-black ventrally; tufts of hindlegs without orange ..... ***Melittia chalybescens***
   Forewing mostly hyaline, with narrow apical margin and discal spot; abdomen yellow or yellow and orange ventrally; tufts of hindlegs strongly orange laterally ..... ***Melittia amboinensis***

10. Forewing with vein R_2 missing ..... ***Carmenta commoni***
    Forewing with vein R_2 present, often very close to R_1, occasionally fused apically 11

11. Head with antennae mostly orange, front mostly white, labial palpus flattened ventrally, orange with white; forewing with discal spot mostly orange ..... ***Synanthedon cupreifascia***
    Head with antennae not orange, front brown-black with some white laterally, labial palpus not flattened ventrally, yellow with brown-black; forewing with discal spot brown-black 12

12. Abdomen brown-black ventrally, occasionally some yellow on posterior margin of segment 4 ..... ***Synanthedon tipuliformis***
    Abdomen mostly or entirely yellow ventrally 13

13. Forewing mostly hyaline between veins R_4 and R_5 ..... ***Carmenta xanthogyna***
    Forewing opaque between veins R_4 and R_5 ..... ***Carmenta chrysophanes***

fined to posterior portion; ductus seminalis originates from various points along ductus bursae, most often toward posterior end; corpus bursae generally small, obovate and membranous with convolutions or signa in some species. *Eggs*: Generally pale brown to chestnut brown, ovate, disc-shaped, flat, or slightly concave ventrally; surface weakly sculptured with minute shagreening in hexagonal designs. *Larvae*: Pale, color restricted to head and prothoracic shield; ocelli I to IV arranged in trapezoid and remote from V and VI; crochets uniordinal in two transverse rows. *Pupae*: Dorsal abdominal spines in double rows on segments 2 to 7 on male and 2 to 6 on female, single row on 7 in female, both sexes with single rows on 8 to 10; large spines ventrad on 10; cremaster absent; abdominal segments freely movable; head sometimes modified with cutting device, somewhat chisel-like.

Subfamily TINTHIINAE LeCerf

TINTHIINAE LeCerf, 1917:48 [type-genus: *Tinthia* Walker, 1864].

BEMBECIINAE Niculescu, 1964:42.—Naumann, 1971:47 [synonymy].

ZENODOXINAE MacKay, 1968:5.—Naumann, 1971:47 [synonymy].

DIAGNOSTIC CHARACTERS.—Head with maxillary palpus (Figure 1*f*) 1-segmented; antennae filiform (Figure 1*b*), never clavate, without terminal scale tuft. Forewing (Figures 2 and 3) with veins R_4 and R_5 stalked or unstalked; Cu_2 absent or very short. Hindwing with 1A nearly or entirely developed, 2A present, 3A and 4A absent. Male genitalia with valva having only simple setae, without saccular ridges; anellus well developed, sleeve-like; base of saccus and vinculum broad, thick; tegumen simple; uncus a simple projection or reduced to pair of setose knobs; gnathos absent.

DISCUSSION.—This subfamily is represented in the Australian fauna by three species in two genera of two tribes, Pennisetiini and Tinthiini. The Tinthiinae, in our opinion, is the least specialized subfamily of the Sesiidae based on the retention of certain structures, such as 1A in the hindwing, and the absence of many specializations and modifications which occur in the other two subfamilies. The subfamily appears to be best represented, on a world basis, in eastern Asia.

Tribe PENNISETIINI Naumann

PENNISETIINI Naumann, 1971:55 [new name for Bembeciini Niculescu; type-genus: *Pennisetia* Dehne, 1850].

DIAGNOSTIC CHARACTERS.—Head with maxillary palpus 1-segmented; antennae of male with long cilia ventrally (strongly bipectinate on species in other faunal regions). Forewing with stalk of veins R_4 and R_5 less than one-half total length of either vein; Cu_2 absent. Hindwing with veins M_3 and Cu_1 long-stalked distad of crossvein.

DISCUSSION.—This tribe is represented in the Australia-New Zealand area by two species in the genus *Pennisetia*.

Genus *Pennisetia* Dehne

Pennisetia Dehne, 1850:28 [type-species: *Pennisetia anomala* Dehne, 1850, a synonym of *Sesia hylaeiformis* Laspeyres, 1801].

Anthrenoptera Swinhoe, 1892:35 [type-species: *Sphecia contracta* Walker, 1856].—Naumann, 1971:56 [synonymy].

Lophocnema Turner, 1917:78 [type-species: *Lophocnema eusphyra* Turner, 1917]. [New synonymy.]

Diapyra Turner, 1917:79 [type-species: *Sesia igniflua* Lucas, 1894]. [New synonymy.]

Pennisetia igniflua (Lucas), new combination

FIGURES 1*b*, 1*f*, 2, 9, 19, 29, 30; MAP 2

Sesia igniflua Lucas, 1894:133.

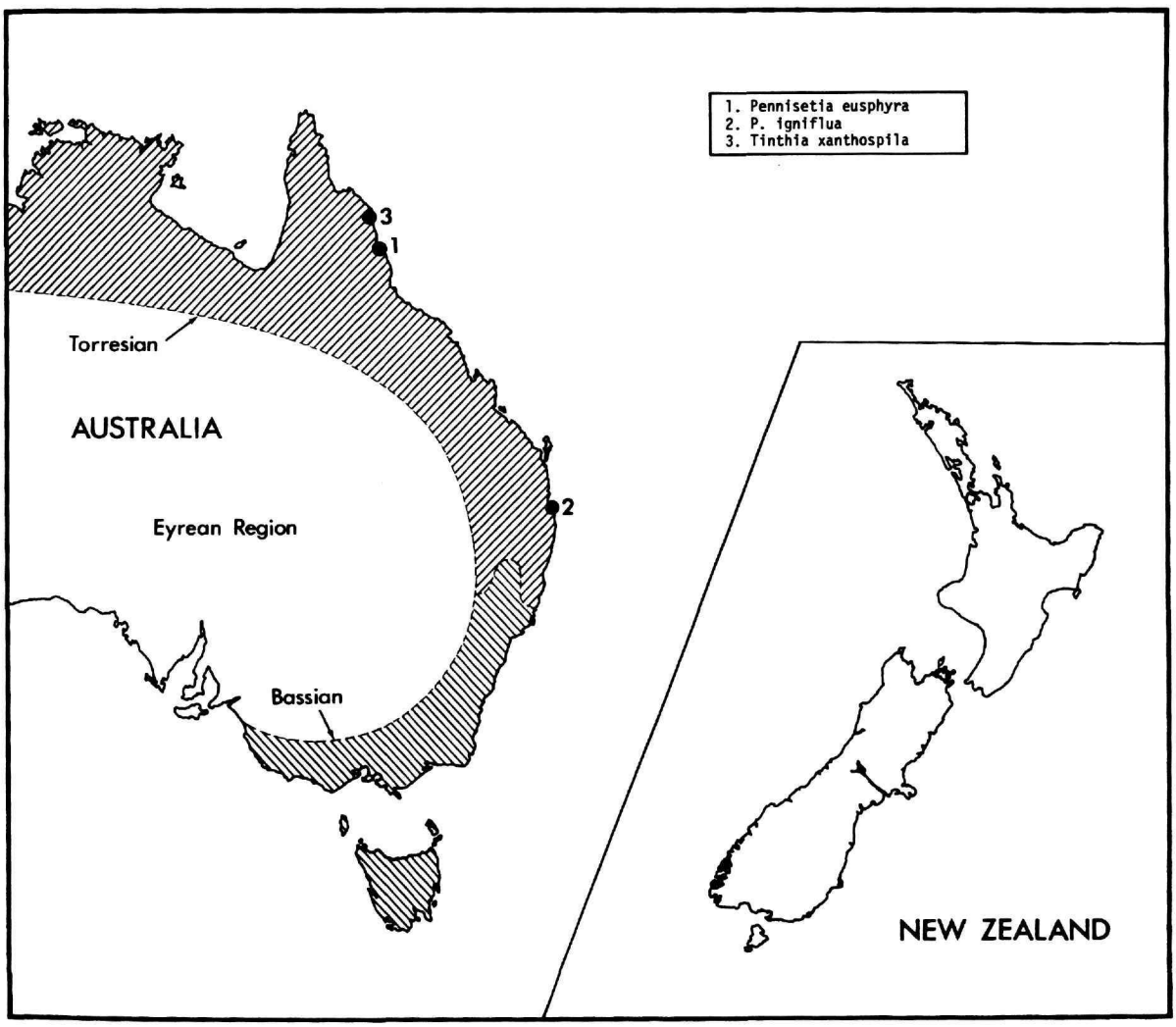
Diapyra igniflua (Lucas).—Turner, 1917:79; 1922:62.

Glossecia igniflua (Lucas).—Hampson, 1919:113.

MALE.—Head with vertex brown-black; occipital fringe brown-black, white laterally; antennae brown-black; front gray-black; labial palpus dorsoventrally flattened, white, third segment brown-black. Thorax mostly brown-black, with narrow, subdorsal, orange stripes on posterior one-half of mesothorax; strongly white beneath wings; lateral tufts of metathorax white. Abdomen somewhat dorsoventrally flattened, widest at segment 4 and tapered to blunt point posteriorly; dorsally brown-black with white laterally on segment 4, and with median tuft on segment 3; ventrally mostly white; anal tuft undeveloped. Legs with coxae and femora mostly white; tibiae laterally mostly brown-black, strongly spined medially and distally; hindtibia with basal one-half white, spurs mostly white;

tarsi mostly brown-black with white basally on most segments, and strongly spined distally on first segment. Forewing opaque; brown-black, strongly orange on basal one-half, and orange forming large spot in apical one-third; ventrally without orange; fringe tipped with white. Hindwing mostly hyaline; margin variously suffused, brown-black; no discal spot; brown-black scales on veins raised, strongest on Cu veins; ventrally with some white powdering apically; fringe brown-black with white at base of scales. Wing length of male, 6 mm. Male genitalia (Figure 9) with valva simple, somewhat truncate apically, produced and expanded basally, clothed on apical one-half with simple setae; saccus elongate; anellus elongate, tubular, somewhat sclerotized ventrally; uncus broad, terminating as two lateral setose knobs; subscaphium broad, platelike; aedeagus elongate, slender, only slightly thicker at base, as long as valva and saccus combined.

FEMALE.—Differs from the male by the following: mesothorax solid orange dorsomedially; abdomen



MAP 2

dorsally with segment 4 mostly white except for brown-black medially, narrowly white on anterior margin of segment 3, often also on segment 2, some white variously on other segments; forewing dorsally with basal two-thirds mostly orange, apical orange spot more extensive than on male, white on tornus; wing length of female, 6–7 mm. Female genitalia (Figure 19) with ostium bursae a small circular opening ventromedially on posterior edge of segment 7; initial short section of ductus bursae slightly sclerotized to origin of ductus seminalis, then slightly expanded, continuing as membranous, elongate tube to obovate corpus bursae; signum of corpus bursae ribbon-like, about two-thirds length of corpus bursae, well sclerotized and pigmented.

TYPE.—The following two syntypes from the South Australian Museum were examined: (1) "B"; "S. A. Museum Specimens" (female). (2) "B"; "TYPE ♀"; "S. A. Museum Specimens," (female). Lucas (1894) in the original description of this species wrote: "♂ ♀ 14–15 mm."; "Brisbane; in scrub."; "Dr. Turner succeeded in capturing seven specimens this year and has courteously given me a pair." Accompanying above-listed syntypes is a single label, "Diapyra igniflua Lucas, I14869, Brisbane, Type." Lucas apparently thought the smaller of the two specimens, syntype 1, was the male of the pair to which he referred, when in fact both specimens are females. Without additional information to the contrary, it is our opinion that the above-listed syntypes represent the original type-series. The better of the two specimens, the first female syntype listed above from the South Australian Museum, has been selected, labeled, and is presently designated the lectotype.

TYPE-LOCALITY.—Brisbane, Queensland, Australia.

HOST PLANT.—*Elaeocarpus grandis* (Elaeocarpaceae).

DISCUSSION.—All 10 specimens examined were from Brisbane. Both Lucas (1894) and Turner (1917) indicated the host of this species as *Elaeocarpus grandis;* however, Tillyard (1926) reported the host-plant to be *Santalum acuminatum.* We have found no record in the literature which verifies this statement and assume the confusion stems from the fact that the two species of plants are both commonly called "quandong trees." The common name was mentioned by Lucas along with the scientific name in the initial publication, and since both Lucas and Turner indicated that the species they were rearing from was *Elaeocarpus grandis,* we consider Tillyard's record in error.

Although *P. igniflua* is only known from Brisbane, the distribution of its known host-plant suggests that it will ultimately be found to occur in rain-forest areas in Queensland and the Northern Territory.

Pennisetia eusphyra (Turner), new combination

FIGURES 8, 28; MAP 2

Lophocnema eusphyra Turner, 1917:79.

MALE.—Head with vertex brown-black, some straw-yellow laterally; occipital fringe brown-black, white laterally; antennae brown-black, strongly powdered tan dorsally; front brown-black, tan laterally and ventrally; labial palpus dorsoventrally flattened, tan with white ventrad. Thorax brown-black with straw-yellow surrounding wing base, extending dorsolaterally to metathorax; ventrally brown-black with tan mixed; metathorax with lateral tufts brown-black. Abdomen dorsally brown-black with segments 4 and 7 golden-yellow, segment 1 white anteriorly, medial tufts on segments 3 to 6 tan except for straw-yellow on 4; ventrally with white on segments 2 to 4; anal tuft golden-yellow dorsally, tan ventrally. Legs tan, with much brown-black on coxae and femora; foretibia strongly roughened; dorsally midtibia strongly tufted basad and distad with paler, spinelike scales; hindtibia very strongly tufted from middle spurs to apex of tibia dorsomedially, broadly fan-shaped at apical spurs; first tarsal segment tufted distad. Forewing opaque except for hyaline area distad of discal spot, extending from vein R_{4+5} to nearly M_3; brown-black mixed with straw-yellow and tan, plus few pale blue scales medially, and some orange apically; forewing ventrally mostly brown-black. Hindwing hyaline with very narrow, brown-black margins; scales on veins raised as on *P. igniflua,* brown-black; no discal spot. Wing length of male, 6 mm. Male genitalia (Figure 8) similar to *P. igniflua,* but with aedeagus longer than combined length of saccus and valva; saccus shorter, and valva more rounded apically than for *P. igniflua.*

FEMALE.—Generally larger, with more pale orange on forewing apically, tibiae not as strongly tufted, otherwise the same as for the male. Wing length of female, 8–9 mm. Female genitalia much the same as *P. igniflua,* but apparently lacking the signum on the corpus bursae.

TYPE.—The following two syntypes from the Australian National Insect Collection were examined: (1) "Lophocnema eusphyra Turn., TYPE"; "Cairns dist., F. P. Dodd"; "LECTOTYPE. Lophocnema eusphyra Turner, 1917, designated by"; "Aust, Nat. Ins. Coll."; "Genitalia Slide By T. D. Eichlin, USNM 76095 ♂" (male). (2) "Cairns dist., F. P. Dodd"; "PARALECTOTYPE, Lophocnema eusphyra Turner, 1917, designated by"; "Aust. Nat. Ins. Coll."; "Genitalia Slide By T. D. Eichlin, USNM 76096 ♀" (female). In the original description Turner (1917) wrote, "N. Q. Kuranda near Cairns; two specimens received from Mr. F. P. Dodd." He described both sexes. Another pair of specimens examined from the National Museum of Victoria, Melbourne, was labeled, "Cairns dist., F. P. Dodd", but it is our opinion that the first pair listed above is the actual syntypic series indicated by Turner. The male syntype listed above from the Australian National Insect Collection has been selected, labeled, and is presently designated as the lectotype.

TYPE-LOCALITY.—Kuranda, Queensland, Australia, near Cairns.

HOST PLANT.—Unknown.

DISCUSSION.—Only four specimens of this species were available for study. Morphologically this species is very similar to *P. igniflua* but may be easily distinguished by differences in the maculation of the wings, legs, and abdomen, which have been detailed above. Turner (1917) placed the two species in separate genera based primarily on the erroneous observation that the males of *P. eusphyra* lack a proboscis. In fact, though tightly coiled on some specimens, both sexes of each species have a well-developed proboscis. Nothing is known of the biology of *P. eusphyra;* however, considering the similarities with *P. igniflua,* it seems likely that the species will ultimately be found on one or more of the numerous species of *Elaeocarpus* found throughout the rain-forest areas from northern New South Wales north along the coast of Queensland.

Tribe TINTHIINI LeCerf

TINTHIINI LeCerf, 1917:148 [type-genus: *Tinthia* Walker, 1864].

ZENODOXINI MacKay, 1968:5.—Naumann, 1971:49 [synonymy].

DIAGNOSTIC CHARACTERS.—Head with maxillary palpus 1-segmented; antennae of male ciliate ventrally; eyes comparatively smaller than other species of Sesiidae. Forewing with veins R_4 and R_5 short-stalked (unstalked on most species elsewhere); Cu_2 absent or very short. Hindwing with vein M_3 arising from Cu_1 well basad of crossvein.

DISCUSSION.—Only one species in this tribe, a member of the genus *Tinthia,* is known to occur in the Australian and New Zealand fauna.

Genus *Tinthia* Walker

Tinthia Walker, 1864:23 [type-species: *Tinthia varipes* Walker, 1864].

Tinthia xanthospila Hampson

FIGURE 3; MAP 2

Tinthia xanthospila Hampson, 1919:115.

Tinthia xanthopila [sic] Hampson, Dalla Torre, and Strand, 1925:183.

MALE.—Head with vertex orange posteriorly, brown-black anteriorly; occipital fringe orange; antennae brown-black (broken); front brown-black; labial palpus smooth, dorsoventrally flattened, orange. Thorax brown-black; collar orange, tegulae mostly orange; metathorax orange. Abdomen missing. Legs with foreleg orange except dorsally on tibia; midleg mostly orange with brown-black dorsally on femur, dorsally and distally on tibia, and all of first tarsal segment; hindleg like midleg but tarsal segments mostly brown-black. Forewing opaque, brown-black with orange spot centered on distal one-half; ventrally orange, also strongly powdered basally. Hindwing hyaline, brown-black, margins narrow though slightly diffuse. Wing length of male, 7 mm. Male genitalia unknown.

FEMALE.—Unknown.

TYPE.—Holotype: Male in the British Museum (Natural History): "Cedar Bay, Queensland, Meek, 1894, Rthschld. 17775"; "Tinthia xanthospila Hmpsn., type ♂"; "Type" (abdomen missing).

TYPE-LOCALITY.—Cedar Bay, Queensland, Australia.

HOST-PLANT.—Unknown.

DISCUSSION.—This species is known only from the type-specimen, which is in imperfect condition. A more detailed characterization of the species must await the acquisition of additional specimens and, hopefully, data concerning its life history.

Subfamily PARANTHRENINAE Niculescu

PARANTHRENINAE Niculescu, 1964:38 [type-genus: *Paranthrene* Hubner, 1819].

SESIINAE Boisduval, Naumann, 1971:58 [in part].

DIAGNOSTIC CHARACTERS.—Head with maxillary palpus (Figure 1*d*) 2-segmented, second segment large, often indented in middle; antennae (Figure 1*a*) clavate with terminal tuft of scales, ciliate ventrally on male (often bipectinate on species of other faunal areas); eyes proportionately larger than for species of Tinthiinae. Forewing (Figure 4) with veins R_4 and R_5 long-stalked, stalk longer than one-half total length of R_4 or R_5; Cu_2 present, often as long as Cu_1. Hindwing with vein M_3 arising from Cu_1 just basad of crossvein; 1A degenerate (to observe, scales must be removed), 2A and 3A coincident except at base, 4A present. Male genitalia with valva having scales multifurcate dorsally and setaceous ventrally and apically, with median area unscaled or with thick, dark scales in saccular region; tegumen reduced; gnathos small, rounded or bifurcate, often with teethlike processes on ventral margin; uncus wide, elongate, about three to five times longer than tegumen, clothed lateroapically with long setaceous scales, mostly bilobed apically; vinculum narrow, saccus relatively short.

DISCUSSION.—Included in this subfamily for Australia-New Zealand are four species of *Albuna* in the tribe Paranthrenini. The subfamily Paranthreninae occurs worldwide with its greatest diversity appearing in the Eastern Hemisphere.

Tribe PARANTHRENINI Niculescu

PARANTHRENINI Niculescu, 1964:38 [type-genus: *Paranthrene* Hubner, 1819] .

DIAGNOSTIC CHARACTERS.—Refer to description given for subfamily. The data provided for the subfamily will suffice for distinguishing the nominal tribe since no other tribes are represented in the fauna under consideration.

DISCUSSION.—This tribe in the area under study contains one genus, *Albuna,* with four included species.

Genus *Albuna Edwards*

Albuna Edwards, 1881:186 [type-species: *Aegeria hylotomiformis* Walker, 1856, now considered a synonym of *Aegeria pyramidalis* Walker, 1856].

Harmonia Edwards, 1882:54 [type-species: *Harmonia morrisoni* Edwards, 1882, now considered a synonym of *Carmenta fraxini* Edwards, 1881].

Parharmonia Beutenmuller, 1894:89 [new name for *Harmonia* Edwards].

DISCUSSION.—This genus is closely related to *Paranthrene,* but may be differentiated by the following characters: antennae of male ciliate ventrally but not pectinate; forewing with bases of vein R_3 and stalk of veins R_4 and R_5 connected by a crossvein, not connate; male genitalia with gnathos having spinelike processes on ventral margin, and with lateral portions of uncus naked or sparsely clothed with setaceous scales (Australian species).

Albuna carulifera (Hampson), new combination

FIGURES 10, 20, 31, 32; MAP 3

Paranthrene carulifera Hampson, 1919:108.

Paranthrene caerulifera Hampson.—Turner, 1922:62 [invalid emendation].

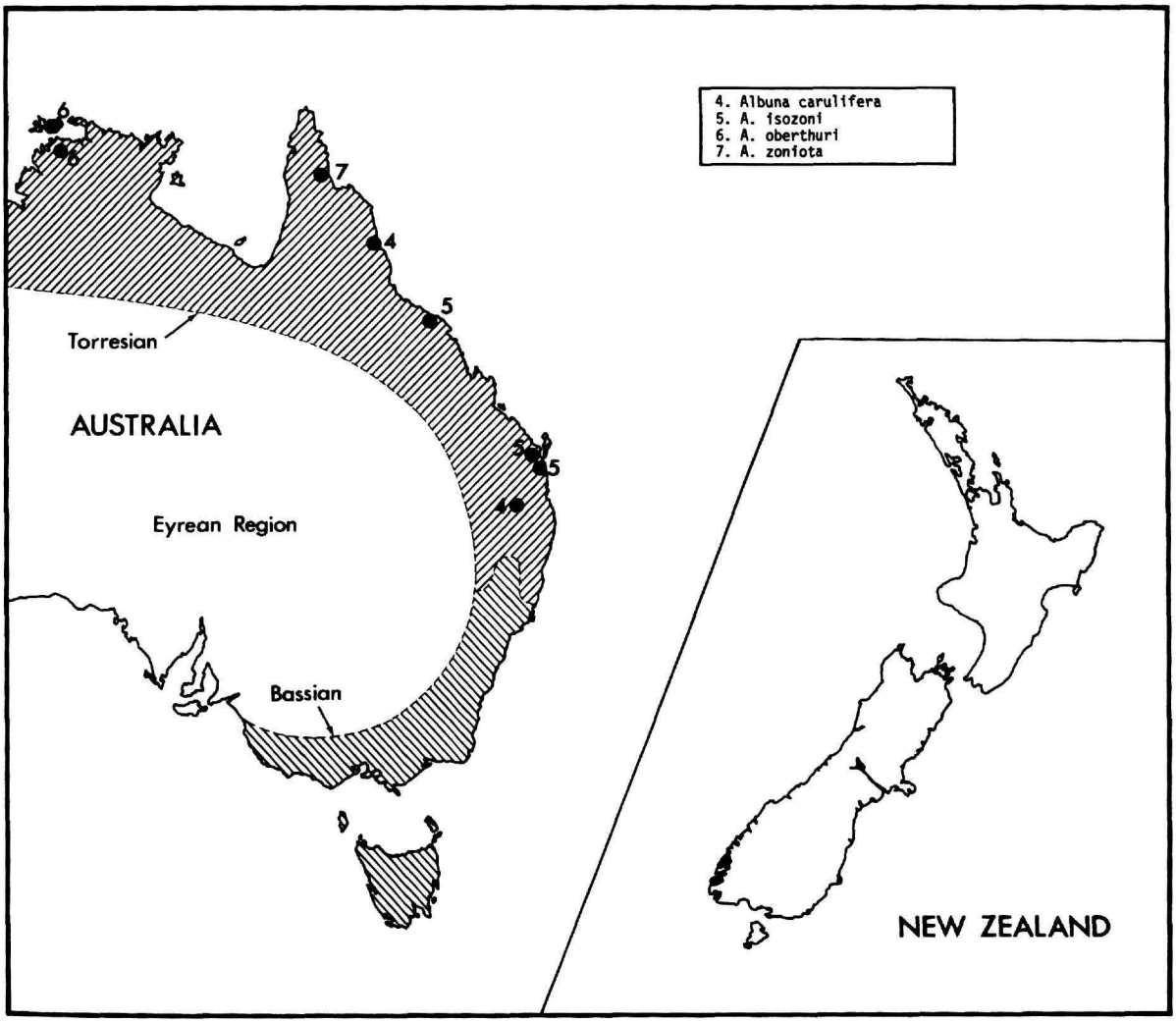
Trochilium coracodes Turner, 1922:61. [New synonymy.]

Conopia coracodes (Turner).—Dalla Torre, and Strand, 1925: 109.

MALE.—Head with vertex brown-black; occipital fringe brown-black dorsally, white laterally; antennae brown-black, scape white; front brown-black with white laterally; labial palpus broadly roughened, brown-black, strongly mixed with white dorsally and ventrally. Thorax brown-black, mixed with white beneath wings and laterally above wings. Abdomen brown-black, lightly powdered pale yellow and white, scattered laterally and ventrally on each segment; anal tuft narrowly edged with white laterally. Legs brown-black;

tibiae white mixed with brown-black, roughened, especially on hindlegs; tibial spurs mostly white; tarsi with some white at joints. Forewing mostly opaque with hyaline streaks basally, brown-black with iridescent blue medially, lightly powdered with few white scales on discal spot and costal margin toward base; ventrally with some white near base. Hindwing hyaline, well-developed discal spot, veins and narrow margins brown-black. Wing length of male, 11 mm. Male genitalia (Figure 10) with valva bluntly pointed apically, thick, dark, multifurcate scales on costal portion, setaceaous scales apically, dense cluster of dark, spinelike scales on saccular ridge near base of valva; gnathos bifurcate, each lobe with about three or four spinelike processes along margin; saccus short, somewhat pointed apically; aedeagus short; otherwise typical of species of Paranthrenini.

FEMALE.—Differs from the male by the following: thorax without white mixed beneath and laterally above wings, but with small white spot laterally on anterior margin; abdomen entirely brown-black,



MAP 3

anal tuft fairly elongate relative to females of most species of Sesiidae, truncate apically; legs entirely brown-black, foretibia tufted on posterior edge; forewing entirely opaque, with blue iridescence medially as on male; hindwing broadly opaque, brown-black with blue iridescence from costa to vein 2A, but with broad hyaline band along apical and anal margins, and small hyaline areas at wing base. Wing length of female, 13 mm. Female genitalia (Figure 20) with ductus bursae elongate, slender, membranous with narrow sclerotized ring near ostium bursae; ductus seminalis arising just anterior to sclerotized ring; corpus bursae obovate, without signum.

TYPES.—Holotype: Female, in the British Museum (Natural History): "Type"; "Kuranda, QUEENSLAND, 31.I.1905, Dodd, 13025"; "Walsingham Collection, 1910–427, 13025"; "Paranthrene caerulifera Hmpsn., type ♀"; "Genitalia Slide by T. D. Eichlin, USNM 76150 ♀" (*A. carulifera*). Holotype: Male, in the Austalian National Insect Collection: "Trochilium coracodes Turn."; "HOLOTYPE, Trochilium coracodes Turner, 1922"; "Aust. Nat. Ins. Coll."; "Toowoomba, Q., 27/2/21, Bernard"; "Genitalia Slide By T. D. Eichlin, USNM 76087 ♂" (*A. coracodes*).

TYPE LOCALITIES.—Kuranda, Queensland (*A. carulifera*); Toowoomba, Queensland (*coracodes*).

HOST-PLANT.—Unknown.

DISCUSSION.—Turner (1922) mentions two specimens of *A. coracodes,* one of which is the above-listed male. The other, supposedly a female, could not be located. He apparently described only the male. After examining the types of both names, it is our conclusion that they are conspecific, Hampson's *Paranthrene carulifera* having priority over Turner's more recently described *Trochilium coracodes.* This species probably occurs throughout the western coastal regions of Queensland. The types were collected in late January and February.

Albuna isozona (Meyrick), new combination

FIGURES 4, 11, 33; MAP 3

Sesia isozona Meyrick, 1886:689.
Trochilium isozonum (Meyrick).—Turner, 1917:80.
Paranthrene isozona (Meyrick).—Hampson, 1919:104.

MALE.—Head with vertex smooth, brown-black, yellow-orange anteriorly; occipital fringe pale yellow dorsally, white laterally; antennae brown-black; front yellow; labial palpus relatively smooth, pale yellow with some brown-black near apex. Thorax with collar brown-black dorsally, yellow-orange laterally; large yellow patches anteriorly and subdorsally; yellow patches beneath wings; metathorax yellow. Abdomen brown-black; dorsally with segments 2, 4, 6, and 7 very broadly banded yellow; ventrally with all segments broadly banded yellow on posterior one-half; anal tuft fan-shaped, brown-black, strongly mixed with yellow scales. Legs with coxae and femora brown-black; tibiae brown-black, strongly yellow medially and dorsally; tarsi brown-black with some yellow at joint. Forewing mostly hyaline; costal margin, anal margin, well-developed discal spot, and apical margin brown-black; Cu strongly powdered yellow, distal edge of discal spot and veins to apical area powdered yellow. Hindwing hyaline; very narrow brown-black margins; fairly strong discal spot brown-black with pale yellow posteriorly. Wing length of male, 10–11 mm. Male genitalia (Figure 11) much like *A. coracodes,* but with gnathos rounded, not bilobed, with 10–12 spinelike processes on ventral edge; valva with multifurcate scales not extending as far apically, and not as many spinelike scales in saccular region; aedeagus relatively larger and somewhat differently shaped.

FEMALE.—Quite different from male: head with occipital fringe orange dorsally, pale yellow laterally; antennae brown-black dorsally, orange ventrally; labial palpus relatively smooth, orange. Thorax much like male. Abdomen dorsally brown-black with segments 2, 4, and 6 broadly banded yellow-orange; ventrally with all segments broadly banded yellow-orange on posterior one-half of segments; anal tuft shorter than male, yellow-orange with brown-black laterally. Legs essentially like male. Forewing mostly opaque with relatively broad margins and discal spot brown-black; remaining opaque areas orange; hyaline area in cell and just distad of discal spot; fringe brown-black, tipped with orange. Hindwing hyaline; narrow margins, veins, and well-developed discal spot brown-black, with some orange at wing base, on discal spot, and on tips of fringe; ventrally with more orange basally and discal spot orange. Wing length of female 11 mm. The genitalia were completely destroyed by fungi or insects on the only

female specimen examined. The abdomen was examined carefully but no remnants of the genitalia could be found. The entire specimen was in such poor condition that no photograph is provided of the female.

TYPE.—The following specimens were examined: (1) "Paratype"; "Maryborough, Queensland, G.M."; "Paranthrene isozona Meyr., 1/1, E. Meyrick det. in Meyrick Coll."; "isozona Meyr."; "Meyrick Coll. B.M. 1938–290" (male, in British Museum [Natural History]). (2) "Sesia isozona Meyr., Queensland" (handwritten but not believed to be that of Meyrick); "Queensland"; "Aus. Nat. Ins. Coll."; "On permanent loan from MaCleay Museum, University of Sydney" (male, in Austalian National Insect Collection). (3) "Wide Bay, Queensland"; "Austr. Mus. Collection" (female, in Australian Museum, Sydney, abdomen removed). Meyrick (1886) in the original description wrote, "Maryborough, Queensland; eight specimens (Australian Museum and Coll. Masters)." Most of the syntypes mentioned could not be located. Of the three specimens listed above as possible syntypes, the first one, a male in the British Museum (Natural History), has labels indicating to us that it is most likely a valid syntype. For this reason the male syntype in the British Museum (Natural History) has been selected, labeled, and is presently designated as the lectotype.

TYPE LOCALITY.—Maryborough, Queensland.

HOST PLANT.—Unknown.

DISCUSSION.—This species, at least superficially, resembles *A. oberthüri* LeCerf (compare to description of latter species). If the two species are closely related, *A. isozona* may be found to be a borer in some species of native vine as was indicated for a specimen of *A. oberthüri*. Other than the fact that all specimens examined were taken in January, nothing else is known of the biology of *A. isozona*. One male was examined from Bowen, Queensland.

Albuna oberthüri (LeCerf), new combination

FIGURES 1*a*, 1*d*, 12, 21, 34, 35; MAP 3

Phlogothauma oberthüri LeCerf, 1916:251.
Paranthrene oberthüri (LeCerf).—Hampson, 1919:104.
Sciapteron terrible Turner, 1917:81; 1922:61 [synonymy].
Phlogothauma oberthüri LeCerf.—Dalla Torre and Strand, 1925:171.

MALE.—Head with vertex brown-black, with long setaceous scales on posterior margin, which may be chaetosemae; occipital fringe white; antennae brown-black; front yellow; labial palpus broadly roughened laterally, flattened ventrally, yellow with brown-black laterally and apically. Thorax with collar yellow; mesothorax brown-black with yellow around wing bases dorsally, yellow narrowly on posterior margin. Abdomen dorsally brown-black with segments 2, 4, 6, and 7 banded yellow; ventrally mostly yellow; anal tuft fan-shaped, brown-black. Legs with forecoxa brown-black, orange laterally; femur brown-black; foretibia broadly tufted laterally, with some orange on basal one-half; midtibia with orange on basal one-half and at distal spurs; hindtibia with orange at spurs, dorsally roughened; tarsi brown-black laterally, some pale yellow mesally. Forewing mostly hyaline; discal spot oblique, brown-black, outlined with pale yellow; veins, costal margin, and narrow apical margin brown-black with some pale yellow at apex, suffuse brown-black between Cu veins extending somewhat basad below cell. Hindwing hyaline with very narrow brown-black margins. Wing length of male, 11–12 mm. Male genitalia (Figure 12) much like *A. isozona* but differs by the following: valva shorter, more broadly rounded apically, with much broader margin of setaceous scales apically, margin of scales extending almost to middle of valva, basal projection of sacculus broader; gnathos with only four spinelike processes on ventroapical margin.

FEMALE.—Differs considerably from male. Head with vertex yellow, roughened posteriorly; occipital fringe yellow dorsally, white laterally; antennae yellow-orange, brown-black apically; front yellow; labial palpus strongly tufted ventrally on segments 1 and 2, segment 1 brown-black, 2 and 3 yellow. Thorax with collar yellow; mesothorax dorsally mostly yellow with brown-black medially on anterior one-half as narrow subdorsal stripes, and brown-black ventrally; metathorax brown-black. Abdomen dorsally brown-black, with segment 4 narrowly banded yellow on posterior margin, segment 6 solid yellow; ventrally brown-black; anal tuft truncate, yellow with some brown-black laterally. Legs with foreleg having coxa and femur brown-black, tibia brown-black with broad lateral tuft and extensive area of orange; mid and hindlegs with coxae yellow, femora brown-black, mid-

tibia orange on basal two-thirds and dorsally, hind-tibia orange at median spurs and dorsally; tarsi brown-black with orange ventrally and often distally. Forewing mostly opaque, orange, with small oblong hyaline spot between veins M_3 and Cu_1, sometimes extending just above M_3; margins and veins brown-black dorsally, less so ventrally. Hindwing hyaline, with very narrow brown-black margins; crossveins and costa orange; orange at base on anal margin. Wing length of female, 12–14 mm. Female genitalia (Figure 21) with posterior section of ductus bursae relatively broad, at least twice as wide as anterior portion of ductus bursae, slightly sclerotized, remainder of ductus bursae slender, membranous, at least four times as long as posterior section; ductus seminalis arises about midpoint of slender portion of ductus bursae; corpus bursae small, obovate, without signum.

TYPES.—The following syntypes of *A. oberthüri* were examined; 9 (1–5 in Museum National D'Histoire Naturelle; 6–9 in British Museum [Natural History]): (1) "LECTOTYPE"; "TYPE"; "Australle, Port-Darwin, Recu de Dodd, en Decembre 1909"; "Phlogothauma oberthüri LeCerf, ♂ Type, Et. Lep. comp. XII fig. 3141, XIV p. 251, F LE CERF det. 1917"; "Ex Collection Ch. Oberthur acquise en IV–1925 par R. Biedermann" (male). (2) "Allotype"; "Australle, Port-Darwin, Recu de Dodd, en Decembre 1909"; "Phlogothauma oberthüri Le Cerf, ♀ Type, Et. Lep. comp. XII fig. 3142, XIV p. 251, F. LE CERF det. 1917"; "Ex Collection Ch. Oberthür acquise in IV–1925 par R. Biedermann" (female). (3) "Australle, Port-Darwin, Recu de Dodd, en Decembre 1909"; "Pholgothauma oberthüri Le Cerf, ♂ Type, Et. Lep. comp. XII fig. 3141, XIV p. 251, F LE CERF det. 1917"; "Ex Collection Ch. Oberthür acquise en IV–1925 par R. Biedermann'; "Genitalia Slide By T. D. Eichlin, USNM 76136 ♂" (male) (4) "Australle, Port-Darwin, Recu de Dodd, en Decembre 1909"; "Phlogothauma oberthüri Le Cerf, ♀ Type, Et. Lep. comp. XII fig. 3142, XIV p. 251, F LE CERF det. 1917"; "Ex Collection Ch. Oberthür acquise en IV–1925 par R. Biedermann" (female). (5) Same as #4 above, female, abdomen missing. (6) "Port Darwin, N. Australia, F.P.D.–10" (male). (7) Same as #6 above, male. (8) "Port Darwin, N. Australia, F.P.D.–10" (female). (9) Same as #8 above, female. Le Cerf (1914) in the original description wrote, "Types: 5 ♂, 6 ♀, Kuranda, Queensland (Australie), ex Dodd; Collections Ch. Oberthür et F. Le Cerf." Later LeCerf (1916: Pl 376, Figs, 3141, 3142) wrote, *"Phlogothauma oberthüri* ♂ ♀ nov. sp. Australie, Port-Darwin; ex Dodd (1909–1910)." Apparently, the correct locality is Port Darwin as corrected by LeCerf in 1916 and not Kuranda as originally stated in 1914. The first male syntype listed above from the Museum National D'Histoire Naturelle has been selected, labeled, and is presently designated as the lectotype. The following syntypes of *Sciapteron terrible* were examined: 8 (all in Australian National Insect Collection): (1) "Port Darwin, F. P. Dodd"; "Sciapteron terrible Turn., ♂ TYPE" (male). (2) "P. Darwin, Jan. 09, F. P. Dodd"; "PARALECTOTYPE, Sciapteron terrible Turner, 1917, designated by"; "Aust. Nat. Ins. Coll." (male). (3) "Port Darwin, F. P. Dodd"; "PARALECTOTYPE, Sciapteron terrible Turner, 1917, designated by"; "Aust. Nat. Ins. Coll." (female). (4) "Port Darwin, F. P. Dodd"; "PARALECTOTYPE, Sciapteron terrible Turner, 1917, designated by"; "Aust. Nat. Ins. Coll."; "Genitalia Slide By T. D. Eichlin, USNM 76085 ♂" (male). (5) "Port Darwin, F. P. Dodd" (female). (6) "P. Darwin, Jan. 09, F. P. Dodd"; "Sciapteron terrible Turn., ♀ TYPE" (female). (7) "P. Darwin, Jan. 09, F. P. Dodd" (male). (8) "P. Darwin, Jan. 09, F. P. Dodd" (female). Turner (1917) describes both sexes and further states, "N.A. Port Darwin in January: eight specimens received from Mr. F. P. Dodd. Melville Island; one specimen from Mr. S. F. Hill, who informs me that it was bred from a gall-like swelling on the stem of a native vine." The syntype from Melville Island was not found. There are other specimens available with much the same labeling as those listed above, which makes it difficult to determine exactly which specimens are actually valid syntypes. However, we are fairly certain that the first male syntype listed above from the Australian National Insect Collection has Turner's label on it, and therefore, has been selected, labeled, and is presently designated as the lectotype.

TYPE-LOCALITY.—Port Darwin, Northern Territory (*A. oberthüri* and *S. terrible*).

HOST PLANT.—Unknown.

DISCUSSION.—Apparently, Dodd collected several specimens from the same locality in 1909 and 1910, sending portions of the series to various collections. Le Cerf first and then Turner described as new that portion of the series which each had at his disposal for examination. In all, we examined 48 specimens from several museum collections. Although the host-plant is not known, the syntype from Melville Island was reported to be from the stem of a native vine. It should be possible to spot the gall-like swellings and successfully document the host-plant by rearing the insect.

Albuna zoniota (Turner), new combination

FIGURES 22, 36; MAP 3

Paranthrene zoniota Turner, 1922:62
Paranthrene zonionota [sic] Turner, Dala Torre, and Strand, 1925:169.

MALE.—Unknown.

FEMALE.—Head with vertex brown-black; occipital fringe white, brown-black dorsally; antennae brown-black; front mostly white, some brown-black medially; labial palpus smooth, mostly white but with brown-black at base and apex, also dorsally and laterally on distal one-half of segment 2. Thorax brown-black with very narrow subdorsal white stripes, and white laterally on collar. Abdomen brown-black; dorsally with segment 4 banded white on posterior margin; ventrally with some white on posterior margin of each segment; anal tuft brushlike, brown-black. Legs mostly brown-black with white on coxa and femur of foreleg, on tibial tufts, and at joints of tarsal segments. Forewing mostly hyaline, but with apical margin fairly broad, discal spot well developed, slightly oblique, margins, discal spot, and veins brown-black. Hindwing hyaline with brown-black on narrow margins, rectangular discal spot, and veins. Wing length of female, 11 mm. Female genitalia (Figure 22) with ductus bursae sclerotized near ostium bursae, gradually expanding in anterior one-half to elongate, relatively narrow corpus bursae.

TYPE.—Holotype: Female, in National Museum of Victoria, Melbourne: "Claudie R., 28.12.14"; "Paranthrene zoniota Turn., Type"; "Type, T-4460."; "Gentialia Slide By T. D. Eichlin, USNM 76149 ♀."

TYPE-LOCALITY.—Claudie River [Cape York Peninsula], Queensland.

HOST-PLANT.—Unknown.

DISCUSSION.—This species is known only from the female holotype, which lacks accompanying biological data. The month and the sex on the above specimen do not agree with the data given in the original description, but this specimen is the only one known to us, is from the correct locality, has Turner's type-label affixed, and is deposited in the museum to which Turner referred. It is our opinion that the two discrepancies are errors, and the above-listed specimen is in fact the holotype of Turner.

Subfamily SESIINAE Boisduval

SESIINAE Boisduval, 1828:29 [type-genus: *Sesia* Fabricus, 1775].
AEGERIINAE sensu LeCerf, 1917:148.—Naumann, 1971:58 [synonymy].
SESIINAE Boisduval.—Naumann, 1971:58 [in part].

DIAGNOSTIC CHARACTERS.—Head with maxillary palpus (Figure 1*e*) 2-segmented, second segment much reduced in most species; antennae clavate with terminal scale tuft, with short cilia ventrally on male, pectinate only on certain species of Melittiini and Sesiini (not on species in this study); eyes average proportionately larger than species of Paranthreninae and Tinthiinae. Forewing (Figures 5, 6, and 7) generally with stalk of veins R_4 and R_5 one-half or less than one-half the total length of R_4 or R_5; Cu_2 as in the Paranthreninae. Hindwing with vein M_3 and Cu_1 short-stalked distad of crossvein except in the Melittiini, which has M_3 arising from Cu_1 well basad of crossvein as in Tinthiini; 1A degenerate, its prior position indicated by a line of scales on wing fold, 2A, 3A, and 4A present. Male genitalia generally with tegumen and uncus fused, with exact limits of each difficult to determine; gnathos most often well developed; socii present, varying; subscaphium

present; vinculum narrow, saccus often elongate; valva variously modified, often with specialized scales.

DISCUSSION.—The Sesiinae contain the largest number of species by a wide margin when the family is viewed on a world basis. Within the area of the present study, there are seven species in three genera, representing two tribes, Melittiini and Synanthedonini.

This highly successful group is, in our opinion, the most advanced subfamily in the Sesiidae, being more highly evolved in morphological specializations and behavioral adaptations. The various tribes of Sesiinae are quite diverse; however, within each tribe the species display a great deal of structural homogeneity.

Tribe MELITTIINI LeCerf

MELITTIINI LeCerf, 1917:148 [type-genus: *Melittia* Hubner, 1819].

DIAGNOSTIC CHARACTERS.—Head with second segment of maxillary palpus nearly as large as first segment; antennae strongly clavate, short cilia ventrally on male (pectinate on some species in other parts of the world). Hindwing with vein M_3 arising from Cu_1 well basad of crossvein as in species of Tinthiini. Male genitalia with valva thick, well sclerotized, mostly naked at least on basal one-half, simple spinelike scales concentrated into dense dark patches apically; saccus thick, often long, as long as valva in some species; uncus most often bifurcate apically with socii generally represented by dense dark pads of short spinelike scales on mesal surface.

DISCUSSION.—In Australia this tribe consists of a single genus, *Melittia,* with two known species. The group is distributed worldwide, its range undoubtedly influenced by the evolution and dispersal of its principal host-plants, species of the family Cucurbitaceae.

Genus *Melittia* Hubner

Melittia Hubner, 1819:128 [type-species: *Melittia anthedoniformis* Hubner, 1819, now considered a synonym of *Sphinx bombiliformis* Cramer, 1782].

Poderis Boisduval, 1874:433 [type-species: *Melittia anthedoniformis* Hubner, 1819].

DISCUSSION.—This easily recognized genus contains some of the largest and most colorful species of sesiids. The genus *Melittia* in eastern and-southeastern Asia south to Australia is comprised of a complex of closely related species, some highly variable in maculation. Apart from those characters mentioned above for the tribe Melittiini and those described in detail later for the species, the following structures are unique to *Melittia*: head and eyes proportionately larger than most other species of Sesiidae, with plate of broad flat scales projecting from beneath scape of antenna over middle of eye; hindleg with tibia and tarsi most often very strongly tufted, particularly mesally and dorsally.

Melittia amboinensis Felder

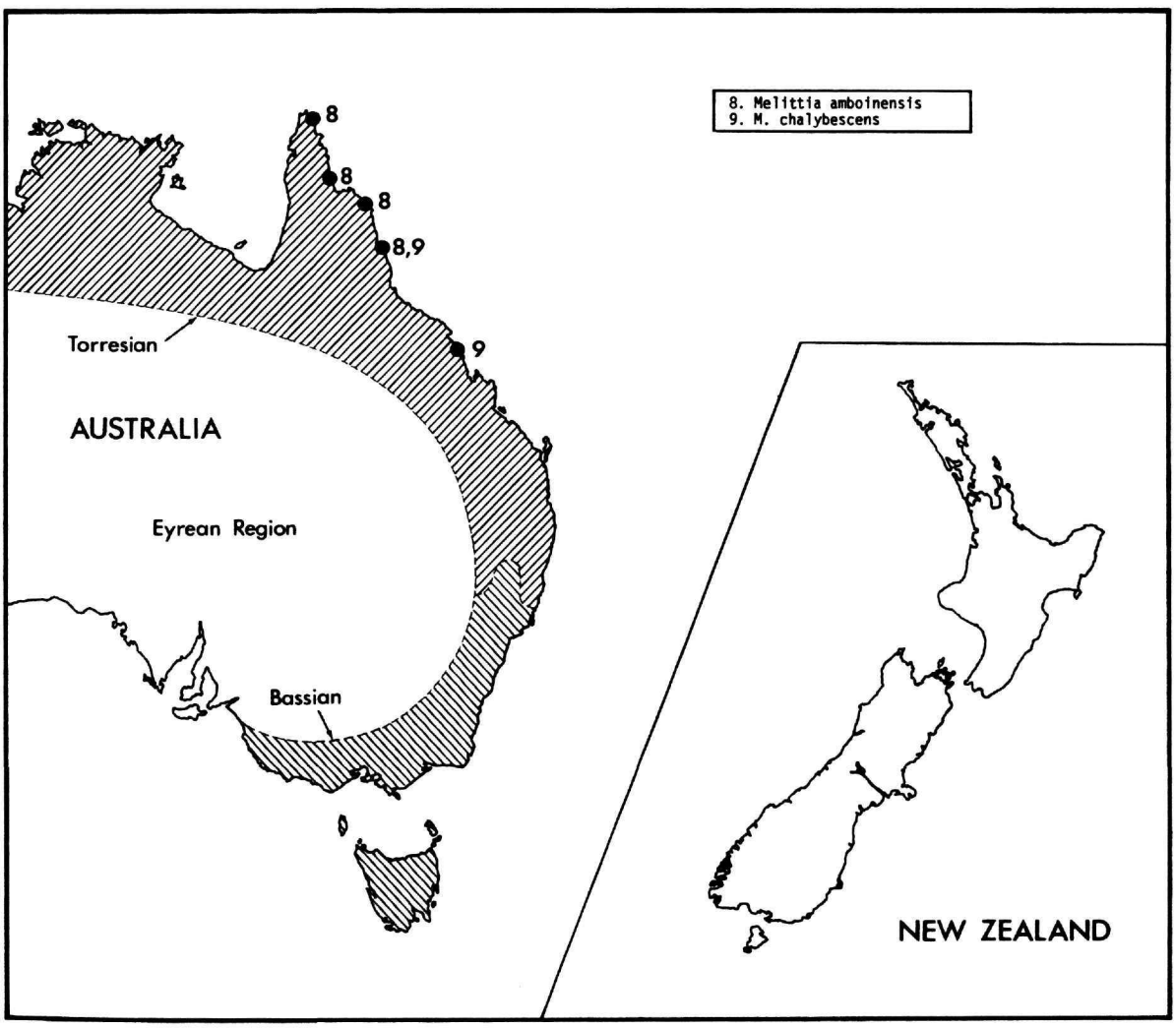
FIGURES 5, 13, 23, 37, 38, 39; MAP 4

Melittia amboinensis Felder, 1861:28.
Melittia doddi LeCerf, 1916, figs. 3119, 3120.
Melittia amboinensis var. *doddi* LeCerf, 1917:196.
Melittia thaumasia Turner, 1917:81; 1922:61 [synonymy].

MALE.—Head with vertex roughened, gray-black with some white around ocelli; occipital fringe white with brown-black mixed dorsally; antennae brown-black, orange ventrally with pale yellow on porterior edge and some white powdering dorsally and anteriorly; front gray-black, white laterally and ventrally; labial palpus roughened, dorsolaterally flattened, brown-black with white ventrally and mixed mesally; scale-plate beneath scape of antenna brown-black. Thorax dorsally brown-black with much yellow-orange mixed on collar, on anterior margin, above wing bases, and on posterior one-half of thorax, including metathorax and lateral tufts; ventrally mostly white. Abdomen dorsally brown-black with each segment narrowly banded yellow or orange on posterior edge, often with yellow or orange powdering especially on segments 3 and 5; ventrally and laterally yellow or yellow and orange. Legs with coxae and femora brown-black with white on margins; midtibia brown-black, variously banded white laterally, midtarsi brown-black, first segment white at base; hindtibia with tufts white dorsally, strongly orange laterally, brown-black ventrally, tarsal tufts mostly brown-black with some orange laterally. Forewing mostly hyaline, with narrow

margins, discal spot, and veins brown-black, some white powdered on apical margin; anal margin at wing base brown-black with yellow. Hind-wing hyaline, with very narrow brown-black margins. Wing length of male, 12–14 mm. Male genitalia (Figure 13) with valva somewhat expanded apically; apical margin nearly straight, oblique, though slightly expanded ventrally; distal one-half of the valva densely covered, except for narrow area apically near ventral margin, with simple spinelike dark scales, directed basad, forming broad, very thick dark patch on distal one-fourth of valva dorsad of somewhat differentiated scale area on ventral margin, valva on mediobasal one-half with concave area outlined dorsally by thin sclerotized ridge; saccus less than one-half length of valva, relatively broadly expanded apically; uncus more narrow than tegumen, bilobed apically with dense dark scale pads on mesal surfaces; aedeagus elongate, narrow on apical one-half, expanded on basal one-half.

FEMALE.—Essentially exhibits same patterns and



MAP 4

variations of maculation as male, often with more orange on thorax, tufts of hind-tibia, and powdered on some abdominal segments dorsally. Wing length of female, 13–14 mm. Female genitalia (Figure 23) with ostium bursae near posterior margin of segment 7; ductus bursae with very narrow sclerotized ring on posterior end, then membranous, elongate, very narrow, with ductus seminalis arising on posterior one-fourth; corpus bursae relatively small, ovate, with many folds, signum consisting of broad rugose area, pigmented on folds.

TYPES.—Unknown (*M. amboinensis*). The following two syntypes of *M. doddi* from the Museum National D'Histoire Naturelle were examined: (1) "TYPE"; "Melittia amboinensis Feld. s. sp. Doddi LeCerf, ♂ Type, Et. Lep. comp. XII fig. 3119, XIV p. 196, F LE CERF det. 1917"; "Australie, Kuranda (Queensland) Dodd, 1907"; "[fig. 3119]" (male). (2) "Allotype"; "Australie, Queensland, Kuranda, Dodd, 1913"; "Et. Lep. comp. XII fig. 3120, XIV p. 196, F LE CERF det. 1917"; "[fig. 3120]" (female). The original description of Le Cerf (1916) consisted of two figures, a male and a female. In the subsequent text volume (1917), LeCerf considered *M. doddi* as a variation of *M. amboinensis* and wrote, "Types: 3 ♂ ♂, 2 ♀, Australia, Kuranda (Queensland) ex Dodd (1907–1913), Coll. Ch. Oberthür." Despite the later publication, the type-series should consist of only the two specimens figured, and thought by us to be those listed above as syntypes. The male syntype from the Museum National D'Histoire Naturelle has been selected, labeled, and is presently designated as the lectotype. The following two syntypes of *M. thaumasia* from the Australian National Insect Collection were examined: (1) "Kuranda, F. P. Dodd" (male). (2) "Kuranda, N.Q., F.P.D." (sex undetermined, abdomen missing). Turner (1917) wrote, "N.Q. Kuranda near Cairns in January; two specimens received from Mr. F. P. Dodd." The male syntype in the Australian National Insect Collection has been selected, labeled, and is presently designated as the lectotype.

TYPE-LOCALITIES.—Amboina Island (*M. amboinensis*); Kuranda, Queensland (*M. doddi* and *M. thaumasia*).

HOST-PLANTS.—Cucurbitaceae: *Trichosanthes anguina* (snake gourd) and *Cephalandra indica* (these hosts recorded for *M. amboinensis* in India).

DISCUSSION.—Based on our current knowledge of this complex, we do not believe the numerous color variations throughout the extensive range of *M. amboinensis* can be construed as representing subspecies. The descriptions presented here refer to the color form "doddi" LeCerf from the northern coast of Queensland. The species *M. amboinensis* occurs from India through the islands to Australia. The following biological information was extracted from published accounts of *M. amboinensis* on snake gourd in India (David and Subramaniam, 1962:192–193). The boring of the larva in the main stem or vine results in elongated galls two to three inches long and up to three-fourths inch thick. Attack by this insect causes the plant to become stunted with poor foliage. The mature larva leaves the gall and pupates in the soil in a specially prepared earthen cocoon, emerging as an adult in about three weeks.

Melittia chalybescens Miskin

FIGURES 14, 40, 41; MAP 4

Melittia chalybescens Miskin, 1892:59.
Melittia proserpina Hampson, 1919:92. [New synonymy.]

MALE.—Head with vertex brown-black, much white mixed; occipital fringe white, brown-black dorsally; antennae brown-black, often lightly powdered white with some pale yellow apically and orange ventrally; front brown, white laterally; labial palpus roughened, dorsoventrally flattened, brown-black with much white mixed; scale plate beneath antennae brown. Thorax brown-black with some olive mixed; mesothorax with lateral tufts brown-black and white mixed. Abdomen dorsally brown-black with some steel-blue on posterior margin of segments 2, 4, 6, and 7, deeper black on posterior edge of each segment and on anal tuft; ventrally mostly white. Legs mostly brown-black; foreleg with coxa white mesad, tarsi with white or pale yellow on most segments; midleg with some pale blue on tibia and first tarsae, segment dorsad; hindleg with tibia and tarsi strongly tufted dorsally and mesally, white mixed dorsally on tibia, and with red-brown spinelike scales mixed on dorsal edge and on distal end, lateral spurs tufted white; white spot laterally on tarsi. Forewing about one-half opaque; margins, discal spot, and veins brown-black, with white powdering on very broad apical

margin and on some veins; hyaline area distad of discal spot somewhat triangular, from vein Cu narrowing to R_{4+5}; hyaline in cell basad of very broad discal spot and hyaline below Cu to wing base. Wing length of male, 14–15 mm. Male genitalia (Figure 14) very much like *M. amboinensis,* but differs from latter mainly by having apex of valva broadly rounded.

FEMALE.—Similar to male except for following: abdomen dorsally and ventrally solid brown-black, anal tuft tipped with white; forewing more opaque, cell with only narrow hyaline streak, wing length of female, 16 mm. The female genitalia on the only known specimen were found to be in very poor condition upon dissection, lacking the corpus bursae and most of the ductus bursae, and, therefore, have not been described or illustrated.

TYPES.—Holotype: Male in South Australian Museum: "Melittia chalybescens Miskin, 2527"; "MacKay, 2527"; "S. A. Museum Specimen"; "Genitalia Slide By T.D. Eichlin USNM 76102 ♂" (*M. chalybescens*). Holotype: Female in British Museum (Natural History): "Type"; "Kuranda, QUEENSLAND IV.1907, Dodd, 13024"; "Walsingham Collection, 1910–427 13024"; "Melittia proserpina Hmpsn., type ♀" (*M. proserpina*).

TYPE-LOCALITIES—Mackay, Queensland (*M. chalybescens*); Kuranda, Queensland (*M. proserpina*).

HOST-PLANT.—Unknown.

DISCUSSION.—It is our opinion that *M. proserpina* is conspecific with *M. chalybescens,* the differences in maculation being well within the expected range of sexually dimorphic variation observed for sesiids in continuing studies by the authors on this family on a world basis. Only two males and one female could be found for examination. This species is much like a species from southern China in maculation and both form part of a closely related complex of species including the many forms of *M. amboinensis,* separable mainly on structures of the genitalia.

Tribe SYNANTHEDONINI Niculescu

SYNANTHEDONINI Niculescu, 1964:40 [type-genus: *Synanthedon* Hubner, 1819].

AEGERIINI Stephens, 1829:34 [Aegeriidae].

SYNANTHEDONINI Niculescu.—MacKay, 1968:5 [in part; Synanthedontini, emended by MacKay, 1969].

AEGERIINI Stevens.—Naumann, 1971:81. [New synonymy.]

DIAGNOSTIC CHARACTERS.—Head small but with eyes proportionately large; maxillary palpus with segment 2 greatly reduced; antennae clavate, often weakly so, male with short ventral cilia, apparently never pectinate; labial palpus often smoothly scaled. Hindwing with M_3 and Cu_1 short-stalked distad of crossvein. Male genitalia with valva mostly clothed with special bifurcate scales, most often with saccular ridge present; saccus narrow; juxta generally somewhat triangular with elongate lateral processes on membranous anellus; gnathos well developed, platelike, usually with median ventral extension; socii most often elongate, tapered to point apically, clothed with special bifurcate scales.

DISCUSSION.—This tribe is represented in Australia by five species in two genera, *Synanthedon* and *Carmenta.* The Synanthedonini is a very large group of fairly homogeneous species and, in our opinion, represents the most advanced and actively evolving group of species in the family.

Genus *Synanthedon* Hubner

Synanthedon Hubner, 1819:129 [type-species: *Sphinx oestriformis* Rottemburg, 1775, now considered a synonym of *Sphinx vespiformis* Linnaeus, 1761].

DISCUSSION.—This genus and *Carmenta* conform to the structural features described for the tribe. The two genera are separable from each other by a combination of male and female genitalia features. The male genitalia of *Synanthedon* species have the saccular ridge either much expanded and modified, absent, or, as on most species, a small, oblique ridge, relatively straight with variously modified scales, and the saccus is generally very short, less than one-third as long as the valva. The females of both genera have a long slender ductus bursae; however, on species of *Synanthedon* the ductus bursae is generally membranous with sclerotization confined most often to the posterior one-third or less, and the ductus seminalis rises from the ductus bursae nearer the posterior end, most often on the posterior one-third.

Synanthedon tipuliformis (Clerck)

FIGURES 1c, 1e, 15, 25, 43, 44; MAP 5

Sphinx tipuliformis Clerck, 1759:9, figs. 1, 2.

Synanthedon tipuliformis (Clerck).—Staudinger, 1901:401. [Refer to Dalle Torre and Strand, 1925:50–55, for a detailed bibliography.]

MALE.—Head with vertex brown-black; occipital fringe yellow, some brown-black mixed dorsally; antennae brown-black; front brown-black, white laterally; labial palpus smooth, yellow with broad brown-black band laterally. Thorax brown-black; dorsally with very narrow subdorsal yellow stripes, and large patch of yellow beneath wing. Abdomen dorsally brown-black, with segments 2, 4, 6, and 7 very narrowly banded yellow on posterior margin, yellow laterally on segments 1 and 2; ventrally brown-black; anal tuft fan-shaped, brown-black. Legs yellow mesally; mostly brown-black laterally, with yellow laterally on forecoxa; tibiae with spurs yellow and yellow bands around tibiae at both pairs of spurs; tarsi ringed with yellow at joints. Forewing mostly hyaline; relatively broad apical margin, large discal spot, veins and other margins brown-black with yellow powdered variously between veins and on anal margin; ventrally yellow powdering more extensive. Hindwing hyaline; narrow margin and veins brown-black; costal margin yellow, and fringe near wing base pale yellow; discal spot small, triangular, brown-black. Wing length of male, 7–8 mm. Male genitalia (Figure 15) with valva having basal one-half of sacculus devoid of scales and without saccular ridge; remainder of elongate valva clothed with bifurcate scales except for patch of dark simple scales on ventral margin medially; saccus very short; socii relatively long.

FEMALE.—Similar to male except: abdomen with yellow banding dorsally only on segments 2, 4, and 6, anal tuft shorter, brushlike; forewing dorsally often with more yellow powdering on apical margin between veins. Wing length of female, 8–9 mm. Female genitalia (Figure 25) with ostium bursae at bottom of sclerotized U-shaped pocket-like area; initial posterior section of ductus bursae short, somewhat sclerotized, very narrow, tubular, with ductus seminalis arising at anterior end of this section, remaining anterior portion of ductus bursae elongate, slender, membranous, expanding somewhat to obovate corpus bursae.

TYPE.—Unknown.

TYPE-LOCALITY.—Unknown.

HOST-PLANTS.—Currant, gooseberry, and raspberry.

DISCUSSION.—The so-called "current borer" is a cosmopolitan species in temperate regions of the world where its host-plants have been introduced from Europe. It occurs in New Zealand, particularly on South Island, throughout Tasmania, and coastal regions of New South Wales, and Victoria. Apparently, specimens were first identified as *S. tipuliformis* from New Zealand in an article by Thomson (1884). It has been known from Tasmania since 1917, and first collected in continental Australia in October and November 1926, in suburban gardens around Melbourne, Victoria (Pescott, 1935). The female moth deposits 20 to 60 eggs on young wood near the buds on the host-plant. The newly hatched larva bores into the plant, feeding and maturing within the pith as it migrates downward in the cane. The cream-white larva with brown head reaches a maximim size of about 13–15 mm in length, overwintering just prior to reaching this stage within the cane a short distance above ground level. After some feeding in the spring of the year, the mature larva cuts a small, circular exit hole nearly through the bark and pupates. The mobile pupa works itself out of the exit hole at the time of adult emergence. Frequently, the pupal exuviae can be found protruding from canes of infected bushes.

Synanthedon cupreifascia (Miskin)

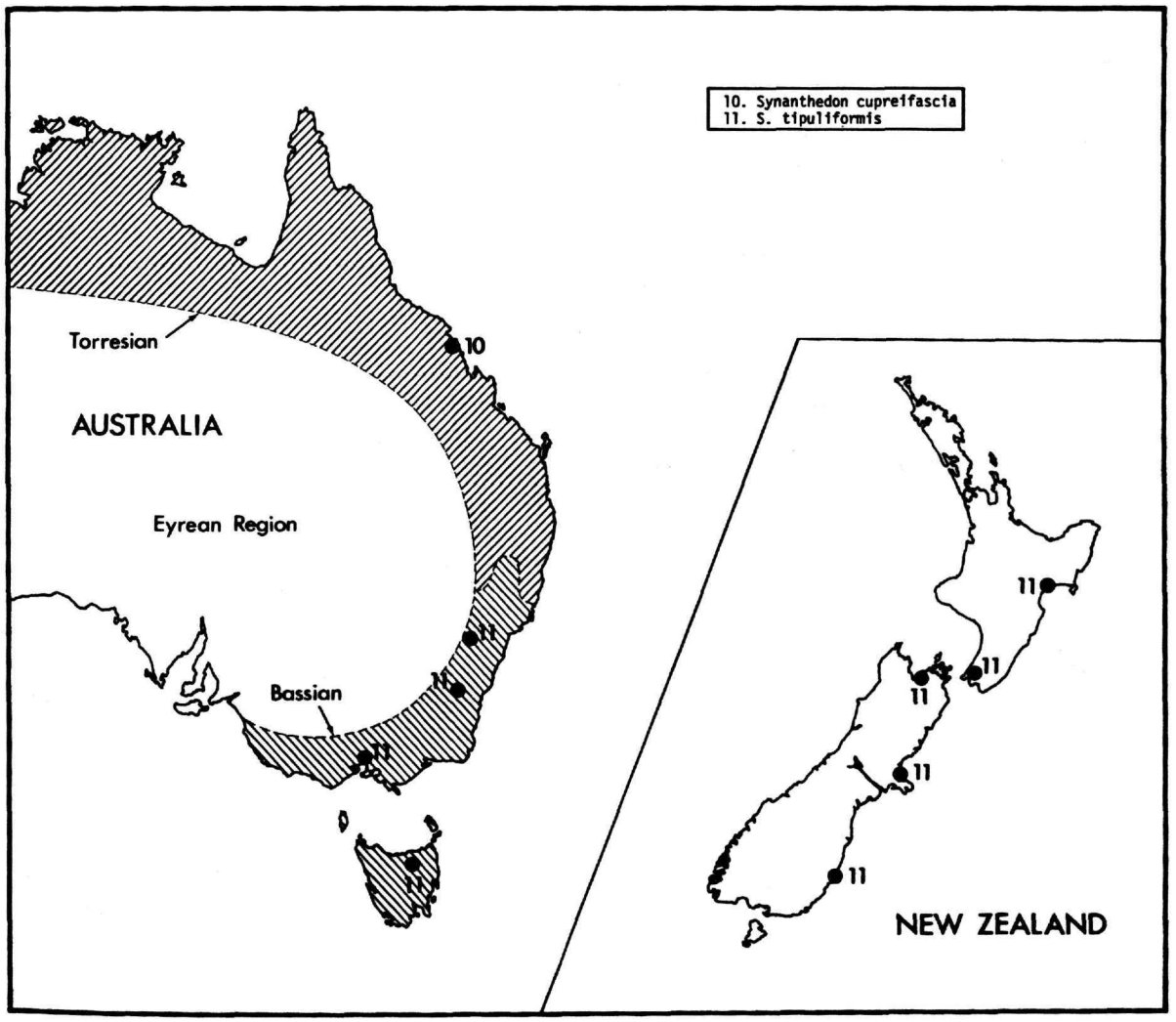
FIGURES 6, 24, 42; MAP 5

Trochilium cupreifascia Miskin, 1892:58.
Synanthedon cupreifascia (Miskin).—Hampson, 1919:61.

MALE.—Unknown.

FEMALE.—Head with vertex brown-black, some orange laterally; occipital fringe white laterally with brown-black and straw-yellow mixed dorsally; antennae orange, some brown-black apically; front white, some brown-black dorsally and ventrally; labial palpus flattened ventrally, orange, white ventrally. Thorax brown-black with orange on anterior and posterior margins of mesothorax; some orange at wing base dorsally; white variously beneath wing. Abdomen mostly brown-black, segments 1 and 2 banded orange on posterior one-half, segments 4, 5, and 6 with narrower orange bands on posterior margin; segment 7 narrow; ventrally with pale yellow bands on posterior margin of each segment. Legs with forecoxa brown-

black with pale yellow and orange laterad; femora brown-black with orange or pale yellow distad; tibiae brown-black with orange dorsally and on distal tuft, pale yellow laterally on middle one-third, tufted brown-black mesally; tarsi brown-black with orange mesad. Forewing mostly hyaline with very narrow margins and veins brown-black; discal spot mostly orange with brown-black on basal margin, and some orange powdering on margins and veins, powdering much stronger ventrally; venation of holotype aberrant on both forewings with only remnants of R_5 present, but second specimen has typical *Synanthedon* venation. Hindwing hyaline, veins and very narrow margins brown-black with some orange powdering ventrally. Wing length of female, 11 mm. Female genitalia (Figure 24) with ductus bursae elongate, slender, membranous except for sclerotized, short posterior end, which is refolded over itself forming short, sclerotized sleevelike section; ductus seminalis arises posteriorly near sclerotized section; corpus bursae obovate, without signum.



MAP 5

TYPE.—Holotype: Female, in South Australian Museum, Adelaide: "Trochilium cupreifascia Miskin, 2528"; "2528, Mackay"; "S. A. Museum Specimens" (abdomen missing).

TYPE-LOCALITY.—Mackay, Queensland.

HOST-PLANT.—Unknown.

DISCUSSION.—This species is known only from the type and one additional female specimen in the British Museum (Natural History), both from Mackay. There is no biological information available on *S. cupreifascia.*

Genus *Carmenta* Edwards

Carmenta Edwards, 1881:184 [type-species: *Aegeria pyralidiformes* Walker, 1856].

DISCUSSION.—As distinguished from *Synanthedon,* species of *Carmenta* have the following genitalic characters: male with saccular ridge having terminal portion downcurved toward ventral margin of valva, this portion often being only a remnant of a longer ridge, and saccus most often long, at least one-third as long as valva; female with ductus bursae often sclerotized for at least one-half its length, with ductus seminalis arising midway between posterior end and corpus bursae or nearer to the latter. Unfortunately, no single character or combination of characters has been found externally that would permit placement of species into either *Carmenta* or *Synanthedon* without examination of the genitalia.

Carmenta chrysophanes (Meyrick), new combination

FIGURES 7, 16, 26, 48, 49, 50; MAP 6

Sesia chrysophanes Meyrick, 1886:689.

Synanthedon chrysophanes (Meyrick).—LeCerf, 1917, figs. 3942, 3943.

Trochilium chrysophanes (Meyrick).—Turner, 1917:80.

Conopia melanocera Hampson, 1919:71. [New synonymy.]

Conopia chrysophanes (Meyrick).—Hampson, 1919:71.

Aegeria panyasis Druce, 1889:201.—Hampson, 1919:71 [synonymy].

Aegeria caieta Druce, 1899:202.—Hampson, 1919:71 [synonymy].

Trochilium chrysophanes (Meyrick).—Turner, 1922:60.

Conopia panyasis (Druce).—Dalle Torre and Strand, 1925: 115.

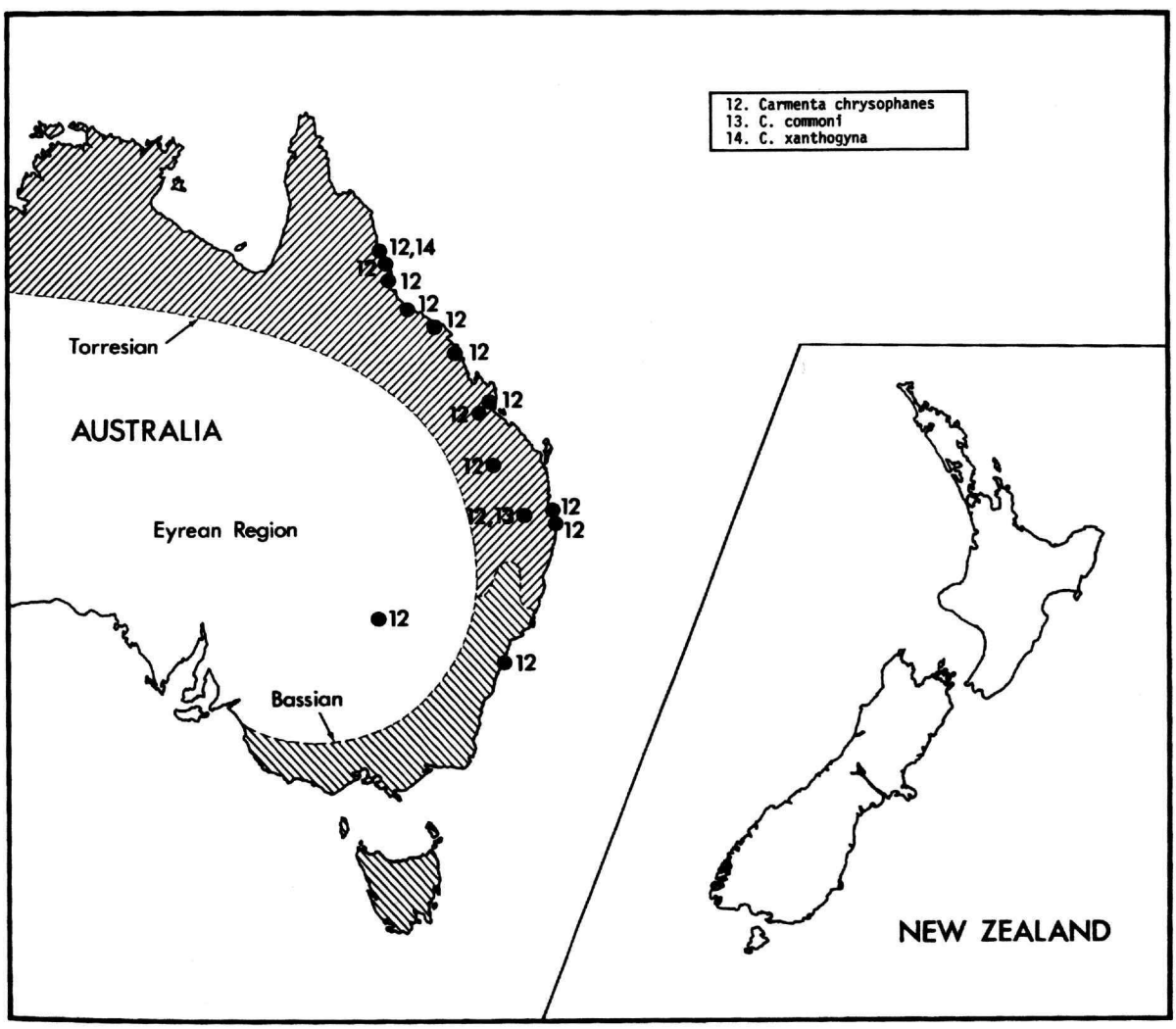
Trochilium chrysophanes (Meyrick).—Tillyard, 1926:423.

MALE.—Head with vertex brown-black; occipital fringe yellow with brown-black mixed dorsally; antennae brown-black with or without pale yellow or white spot apically, scape yellow; front brown-black, white laterally; labial palpus smooth, yellow with brown-black dorsoapically. Thorax brown-black, with subdorsal yellow stripes; ventrally mostly yellow; metathorax yellow, lateral tufts yellow. Abdomen dorsally brown-black, with segments 4 and 6 mostly yellow or yellow-orange, segment 2 narrowly yellow in posterior margin; ventrally mostly yellow except segment 7 with brown-black; anal tuft narrow, brown-black with yellow laterally. Legs with forecoxa mostly yellow with brown-black mesad; femora brown-black; fore and midtibiae yellow with some brown-black laterodapically, hindtibia laterally brown-black with yellow at spurs, which also are yellow; tarsi brown-black, yellow ventrally and at joints. Forewing mostly hyaline; margins, discal spot, and veins brown-black with yellow variously between veins on somewhat broad apical margin and lightly powdered yellow on costal margin, yellow more extensive ventrally. Hindwing hyaline; very narrow margins brown-black; discal spot very small, triangular, brown-black; costal margin ventrally mostly yellow; fringe yellow toward wing base. Wing length of male, 7–8 mm. Male genitalia (Figure 16) with valva elongate, relatively narrow; saccular ridge apically downturned nearly to ventral edge of valva, expanded, clothed with spinelike simple scales, main portion of saccular ridge with bifurcate scales; socii and lateral extensions of juxta elongate; saccus short, about one-fourth to one-fifth length of valva, unique for known species of *Carmenta;* aedeagus elongate, narrow, somewhat bulbous basad.

FEMALE.—Differs from male by following: head with occipital fringe completely yellow; abdomen dorsally with yellow or orange on all segments, but only on posterior margin of segments 2 or 3, anal tuft brushlike, yellow or orange with brown-black laterally; legs with more yellow, hindtibia entirely yellow; wing length of female, 7–10 mm. Female genitalia (Figure 26) with posterior one-half to one-third of ductus bursae lightly sclerotized, straight, remaining anterior portion membranous, slightly broader, widest near corpus bursae; ductus seminalis arises from ductus bursae at juncture of membranous section with sclerotized

section; corpus bursae relatively small, without signum, shaped as figured.

TYPES.—The following syntype of *C. chrysophanes* was selected by J. D. Bradley in 1956 as a lectotype, but he apparently did not publish this selection. This specimen in the British Museum (Natural History) has the following label: "Bowen, N. Queensland, A.S./90." Meyrick (1886) in the original description wrote, "Bowen, Queensland; three specimens taken by Mr. A. Simson (Coll. Raynor and Masters)." Since the data on the label of the above specimen agrees with that given for the type-series, and in the absence of additional syntypes, it is our conclusion that the "90" probably does not refer to the year 1890, which would therefore, postdate Meyrick's description of the species. We agree with Bradley's selection of this specimen, and thereby designate it as the lectotype. The following three syntypes of *C. melanocera* from the British Museum (Natural History) were examined: (1) "Type"; "Mulgrave River, N. QUEENSLAND, soft wood tree, ex 24 IX 1899,



MAP 6

Dodd, 13057"; "Walsingham Collection, 1910–427, 13057"; "Conopia melanocera Hmpsn., type ♂"; "B.M. Genitalia slide ♂, IFBC, 1397" (male). (2) "Type"; "Mulgrave River, N. Queensland, soft wood tree, ex 29.IX.1899, Dodd, 13058"; "Conopia melancera Hmpsn., type ♀" (female). (3) "Mulgrave River, N. Queensland, soft wood tree, ex 20.IX.1899, Dodd, 13059"; "Walsingham Collection, 1910–427., 13059" (male). Hampson (1919) wrote, "Queensland, Kuranda (Dodd), 3 ♂ Johnson R. (Dodd) 2 ♂, 1 ♀ type, bred from a soft-wooded tree, Walsingham Coll. Exp. 20 mill." Apparently, there were six specimens in the type-series, five males and one female. The above-listed specimens represent the two males and one female from "Johnson R.," an apparent misspelling of "Johnstone River," which is on the Mulgrave River. The three syntypes from Kuranda were not located. The first male syntype listed above from the British Museum (Natural History) has been selected, labeled, and is presently designated as the lectotype. The following holotype male of *C. panyasis* in the British Museum (Natural History) was examined: "TYPE"; "Taylor Range, Brisbane, Queensland, F. P. Dodd"; "Brisbane, 10.10.97"; "Aegeria panyasis Druce, Type"; "66"; "Presented by J. J. Jocey Esq., Brit. Mus. 1931–291"; "B. M. Genitalia slide No. 4454, ♂." The following holotype female of *A. caieta* in the British Museum (Natural History) was examined: "Type"; "Taylor Range, Brisbane, Queensland F. P. Dodd"; "Ex. coll. Druce"; "Aegeria caieta Druce, Type"; "=panyasis Drce., ♀,F. Le Cerf det."; "67"; "B.M. Genitalia slide No. 4467, ♀."

TYPE-LOCALITIES.—Bowen, Queensland (*Carmenta chrysophanes*); Kuranda and Johnstone River, Queensland (*Conopia melanocera*); Taylor Range, Brisbane, Queensland (*Aegeria panyasis* and *A. caieta*).

HOST-PLANTS.—*Alphitonia excelsa*, galls on *Exocarpos* species (Santalaceae), and specimens from Brisbane that had been reared from fig branches were examined.

DISCUSSION.—This is apparently a common, wide ranging, somewhat variable species with the ability to utilize a variety of host-plants. Specimens in the northern portions of the range, with some exceptions, tend to be orange, while specimens in the southern regions are yellow. The presence or absence of white spots on the antennae is characteristic of specimens in both portions of the range. The genitalia of all specimens examined demonstrated little or no variation. Illidge (1900) reported discovering larvae of this species beneath a decayed portion of bark at the juncture of a dead branch with the main trunk of *Alphitonia excelsa* in early September. The adults had all emerged within a month of the discovery of the larvae. In the same article it was mentioned that adults had been captured flying about flowers overhanging a small creek. The series of specimens from galls on *Exocarpos* species were reared from their host in Canberra.

Carmenta commoni, new species

FIGURES 17, 45; MAP 6

MALE.—Head with vertex brown-black; occipital fringe yellow with brown-black mixed dorsally; antennae (broken) brown-black, scape yellow ventrally; front brown-black, white laterally; labial palpus smooth, yellow with brown-black apically. Thorax brown-black with narrow subdorsal yellow stripes; large yellow spot beneath wings extending more narrowly to collar; metathorax with yellow spot dorsomedially, lateral tufts yellow. Abdomen dorsally brown-black with pale yellow or white band on posterior one-half of segment 4 and narrowly on posterior margin of segment 7; ventrally brown-black; anal tuft somewhat wedge-shaped with sides turned downward, yellow-orange dorsally and ventrally, and brown-black laterally. Legs mostly brown-black with yellow on forecoxa, on ventral margin of femora, and on most of tibiae (hindlegs missing). Forewing with vein R_2 missing; mostly hyaline; margins, veins, and discal spot brown-black with some yellow powdered between veins on apical margin; ventrally with more yellow on apical margin, and yellow on costal margin, distal edge of discal spot and at wing base. Hindwing hyaline; very narrow margins, tiny triangular discal spot and veins brown-black; fringe yellow at wing base; ventrally with yellow on costal margin. Wing length of male, 8.5 mm. Male genitalia (Figure 17) with saccular ridge of valva broadly expanded, clothed with long spinelike simple scales, apically downcurved to ventral margin on which scales much shorter, then divided with one portion of ridge projected basad, other portion projected distad and with-

out scales, both latter portions of ridge being parallel to ventral edge of valva; saccus more than one-third length of valva; gnathos with ventromedial plate expanded laterally; aedeagus with twelve or more minute cornuti on vesica.

FEMALE.—Unknown.

TYPE.—Holotype: Male in the British Museum (Natural History): "Holotype"; "Type"; "Toowoomba, Brisbane distr."; "Asynedon brisbanica Le Cf., ♂ Holotype, F. LE CERF det." [manuscript name]; "Tring Ms. 406"; "Rothschild Bequest B.M. 1939–1"; "Genitalia Slide By T. D. Eichlin, USNM 76155 ♂"; "Holotype ♂, Carmenta commoni Duckworth & Eichlin, 1973" (male).

TYPE-LOCALITY.—Toowoomba, Queensland.

HOST-PLANT.—Unknown.

DISCUSSION.—This species is known only from the unique male type. Its placement in the genus *Carmenta* is somewhat tentative and will need to be verified through an examination of the female genitalia. The male genitalia, while exhibiting some characters of typical *Carmenta* species, have some structures similar to certain species of *Synanthedon,* these species having been heretofore placed in the genus *Thamnosphecia* Spuler. The loss of vein R_2 on the forewing is also characteristic of a few species of *Carmenta* from North America. We take pleasure in dedicating this species to Dr. I. F. B. Common, Division of Entomology, CSIRO, Canberra, Australia.

Carmenta xanthogyna (Hampson), new combination

FIGURES 18, 27, 46, 47; MAP 6

Lepidopoda xanthogyna Hampson, 1919:54.

MALE.—Head with vertex brown-black; occipital fringe yellow, brown-black mixed dorsally; antennae dorsally brown-black with green-blue iridescence, yellow apically; front brown-black with white laterally, labial palpus smooth, yellow, broadly banded brown-black laterally to apex. Thorax brown-black with green-blue iridescence; narrow subdorsal yellow stripes and some yellow anteriorly at wing base; ventrally mostly yellow; metathorax with some yellow, lateral tufts mixed with yellow. Abdomen brown-black with green-blue iridescence; segments 2 to 7 narrowly banded pale yellow on posterior margin, faintly indicated on segment 1, and with broad yellow patch laterally on segments 1 and 2; ventrally brown-black with varying medial pale yellow stripe; anal tuft narrowly fan-shaped, brown-black with some yellow medially and white laterally. Legs mostly brown-black with green-blue iridescence; foreleg yellow with some brown-black on tibia and tarsi; midleg yellow mesally, and yellow on dorsal and apical tufts of tibia; hindleg with tibia yellow mesally, and slightly mixed dorsally on apical tuft of tibia and mesally at tarsal joints, first tarsal segment tufted dorsally and ventrally. Forewing mostly hyaline; apical margin abruptly interrupted by hyaline area between veins R_4 and R_5; margins, veins, and elongate, narrow discal spot brown-black, lightly powdered yellow on apical and costal margins between veins, more strongly powdered on costa ventrally. Hindwing hyaline; very narrow margins, tiny discal spot and veins brown-black; ventrally with costal margin mostly yellow. Wing length of male, 11 mm. Male genitalia (Figure 18) with valve relatively elongate, tapered to point apically, with saccular ridge downcurved and elevated apically, terminating on ventral edge at middle of valva, elevated portion of ridge clothed with simple spinelike scales; saccus nearly one-third length of valva; slender processes of juxta elongate, extending nearly to gnathos; gnathos relatively small for species of *Carmenta,* but with well-developed ventromedial plate; socii elongate; aedeagus elongate, slender with several minute cornuti on vesica.

FEMALE.—Differs considerably from the male by the following: antennae without yellow apically; less brown-black on labial palpus; thorax mostly yellow except for brown-black of mesothorax, on collar dorsally, on tegulae, patch posteriorly and patch near center dorsomedially; abdomen dorsally mostly yellow with some brown-black on anterior margin of each segment, ventrally yellow, and anal tuft short, yellow with some brown-black mixed laterally; and legs mostly yellow. Wing length of female, 15 mm. Female genitalia (Figure 27) with ductus bursae well sclerotized on most of posterior one-half, slightly expanded and membranous on anterior one-half; ductus seminalis arises from ductus bursae just anterior to sclerotized portion; corpus bursae relatively small, ovate, without signum.

TYPES.—The following four syntypes all from

the British Museum (Natural History) were examined: (1) "TYPE" "Kuranda, QUEENSLAND, 7-1-1906, Dodd 13053"; "Walsingham Collection, 1910-427, 13053"; "Lepidopoda xanthogyna Hmpsn., type ♂"; "Genitalia Slide By T. D. Eichlin, USNM 76151 ♂" (male). (2) "Type"; "Kuranda, Queensland, 18.I.1906, Dodd, 13054"; "Walsingham Collection, 1910-427., 13054"; "Lepidopoda xanthogyna Hmpsn., Type 2" (female). (3) "Co-type";

"Kuranda, Queensland, 12.1.1906, Doss, 13055"; "Walsingham Collection, 1910-427., 13055", "Lepidopoda xanthogyna Hmpsn., Paratype ♀"; "Genitalia Slide By T. D. Eichlin, USNM 76152 ♀" (female). (4) "Kuranda, Queensland, 20.I.1906, Dodd, 13056"; "Walsingham Collection, 1910-427, 13056"; "Lepidopoda xanthogyna Hmpsn."; "Rothschild Bequest, B. M. 1939-1" (female). Data as given by Hampson (1919) in the original description included, "Queensland, Kuranda (Dodd), 1 ♂, 3 ♀ type; Walsingham Coll. Exp. ♂ 30, ♀ 36 mill." The male syntype listed above from the British Museum (Natural History) has been selected, labeled, and is presently designated as the lectotype.

TYPE-LOCALITY.—Kuranda, Queensland.

HOST-PLANT.—Unknown.

DISCUSSION.—This species is known only from the four excellent specimens of the type-series. Consequently, nothing is known of its biology other than that the above specimens were collected in mid-January.

Literature Cited

Beutenmuller, W.
1894. Studies of Some Species of North American Moths. *Bulletin of the American Museum of Natural History*, 6:87-89.
1901. Monograph of the Sesiidae of America, North of Mexico. *Memoirs of the American Museum of Natural History*, 1:217-315.

Boisduval, J. A.
1828. *Europaeorum Lepidopterorum, index methodicus.* 103 pages. Paris.
1874. Species général des Lépidoptères Hétérocères.... Volume 1 *in* Roret, *Collection des Buffon.* iv + 568 pages, 11 plates. Paris.

Braun, Annette F.
1919. Wing Structure of Lepidoptera and the Phylogenetic and Taxonomic Value of Certain Persistent Trichopterous Characters. *Annals of the Entomological Society of America*, 12 (4):349-367.
1924. The Frenulum and Its Retinaculum in the Lepidoptera. *Annals of the Entomological Society of America*, 17 (3):234-257.

Clerck, C.
1759. *Icones Insectorum rariorum cum nominibus eorum trivialibus, locisque e C. Linnaei . . . Systema Naturae allegatis.* Part 1, pages 1-16. Holmiae.

Common, I. F. B.
1970. Lepidoptera (Moths and Butterflies). In *The Insects of Australia.* Commonwealth Scientific and Industrial Research Organization. Canberra, Australia: Melbourne University Press.

Cramer, P.
1782. *Papillons exotiques des trois parties du Monde, l'Asie, l'Afrique, et l'Amerique.* Volume 4, 252 pages. Amsterdam: S. J. Baalde.

Dalla Torre, K., and E. Strand
1925. *Lepidopterorum Catalogus, Aegeriidae.* Volume 31, 202 pages. Berlin.

David, B. Vasantharaj, and T. R. Subramaniam
1962. A Note on the Occurrence of the Lepidopterous Borer on Snake Gourd Vines. *Madras Agricultural Journal*, 49 (6):192-193.

Dehne
1850. Beschreibung einer neuen Setia (*Sesia* Fabr.) mit Federfuhlern, *Pennisetia anomala* m. *Stettin Entomologische Zeitung*, 11:28-29.

Druce, H.
1899. Descriptions of Some New Species of Heterocera. *Annals and Magazine of Natural History*, series 7, 4 (21):200-205.

Durrant, J. H.
1919. Three New Genera of Tineina Resembling Aegeriidae. *Novitates Zoologicae*, 26:120-122.

Edwards, H.
1881. New Genera and Species of the Family Aegeridae. *Papilio*, 1:179-208.
1882. Notes on N. American Aegeridae, with Descriptions of New Forms. *Papilio*, 2:52-57.

Engelhardt, George P.
1946. The North American Clear-Wing Moths of the Family Aegeriidae. *United States National Museum Bulletin*, 190: vi + 222 pages.

Fabricius, J. C.
1775. *Systema Entomologiae, sistens Insectorum classes, ordines, genera, species, adjectis synonymis, locis, descriptionibus, observationibus.* 832 pages. Korte: Flensburgi et Lipsiae.

Felder, C.
1861. Lepidopterorum Amboinensium a Dre. L. Dole-

schall annis 1856–58 collectorum species navae diagnosibus collustratae a Dre. C. Felder, II Heterocera. *Sitzungsherichte der Kaiserlichen Akadamie der Wissenschaften,* 43 (1):25–44.

Fereday, R. W.
1869. *Sesia tipuliformis* in New Zealand. *The Entomologists' Monthly Magazine,* 6:146.

Forbes, W. T. M.
1923. The Lepidoptera of New York and Neighboring States, part 1. *Cornell University Agricultural Experiment Station Memoir,* 68:3–729.

Gaede, M.
1933. Family: Aegeriidae. Volume 10 *in* Seitz, *Die Gross-Schmetterlinge der Erde.* Pages 775–802.

Girault, A. A.
1907. The Lesser Peach Tree Borer. *United States Department of Agriculture, Bureau of Entomology Bulletin,* 68 (4):31–48.

Gossard, H. A., and J. L. King
1918. The Peach Tree Borer. *Ohio Agricultural Experiment Station Bulletin,* 329:55–87.

Hampson, G. F.
1919. A Classification of the Aegeriadae of the Oriental and Ethiopian Regions. *Novitates Zoologicae,* 26: 46–119.

Holloway, J. D., and N. Jardine
1968. Two Approaches to Zoogeography: A Study Based on the Distributions of Butterflies, Birds, and Bats in the Indo-Australian Area. *Proceedings of the Linnean Society of London,* 179 (2):153–188.

Hubner, J.
1819. *Verzeichniss bekannter Schmettlinge* [sic]. 431 pages. Augsburg [1816–1827].

Illidge, R.
1900. Miscellanea Entomologica: Or Odd Notes on the History and Transformations of Various Insects. *Proceedings of the Royal Society of Queensland,* 15:133–136.

Keast, A., R. L. Crocker, and C. S. Christian (eds.)
1959. Biogeography and Ecology in Australia. *Monographiae Biologica,* 8:1–640.

Laspeyres, J. H.
1801. *Sesiae Europae, inconibus et descriptionibus illustratae.* Pages 1–31. Berolini.

LeCerf, F.
1916. Page 8 *in* Volume 12 (page 251 *in* Volume 14) *in* Oberthür, Etudes de Lépidoptérologie comparée. Figures 3119, 3120.
1917. Pages 137–388 *in* Volume 14 *in* Oberthür, Contributions a l'étude des Aegeriidae, description et iconographie d'especes et de formes nouvelles ou peu connues. In *Études de Lépidoptérologie comparée.*

Linnaeus, C.
1761. *Fauna Svecica.* Editio altera, volume 2. Stockholmiae.

Lucas, T. P.
1894. Description of New Australian Lepidoptera, with Additional Localities for Known Species. *Proceedings of the Linnean Society of New South Wales,* series 2, 8:133–166.

MacKay, M. R.
1968. The North American Aegeriidae (Lepidoptera): A Revision Based on Late-Instar Larvae. *Memoirs of the Entomological Society of Canada,* 58:3–112.

MacKay, M. R.
1969. Correction. *The Canadian Entomologist,* 101 (4): 424.

Mackerras, I. M.
1970. Composition and Distribution of the Fauna. In *The Insects of Australia.* Commonwealth Scientific and Industrial Research Organization. Canberra, Australia: Melbourne University Press.

Meyrick, E.
1886. Revision of Australian Lepidoptera. *Proceedings of the Linnean Society of New South Wales,* 1:685–802.

Miskin, W. H.
1892. New Species of Australian Macro-Lepidoptera (Heterocera). *Proceedings of the Royal Society of Queensland,* 8:58–59.

Naumann, C. M.
1971. Untersuchungen zur Systematik und Phylogenese der Holarktischen Sesiiden (Insecta, Lepidoptera). *Bonner Zoologische Monographies no. 1, Zoologisches Forschungsinstitut und Museum Koenig.* 190 pages. Bonn, West Germany.

Niculescu, E. V.
1964. Les Aegeriidae: Systematique et phylogenie. *Linneana Belgica,* 3:34–45.

Nielsen, D. G., and C. P. Balderston
1973. Evidence for Intergeneric Sex Attraction among Aegeriids. *Annals of the Entomological Society of America,* 66 (1):227–228.

Prescott, R. T. M.
1935. The Currant Borer Moth (*Aegeria tipuliformis* Clerck). *Journal of the Department of Agriculture* (Victoria), 35:497–498.

Rottemburg, S. A. von
1775. Anner Kungen zu den Hufnagelischen Tabellen der Schmetterlinge. *Der Naturforscher,* 6:105–111.

Spencer, W. B.
1896. Summary of the Zoological, Botanical, and Geological Results of the (Horn) Expedition. *Report of the Horn Expedition,* 1:139–199.

Staudinger, O., and H. Rebel
1901. *Catalog der Lepidopteren des palaearctischen Faunengebietes.* Edition 3, part 1, 411 pages. Berlin.

Stephens, J. F.
1829. *Systematic Catalogue of British Insects.* Part 2, 388 pages. London.

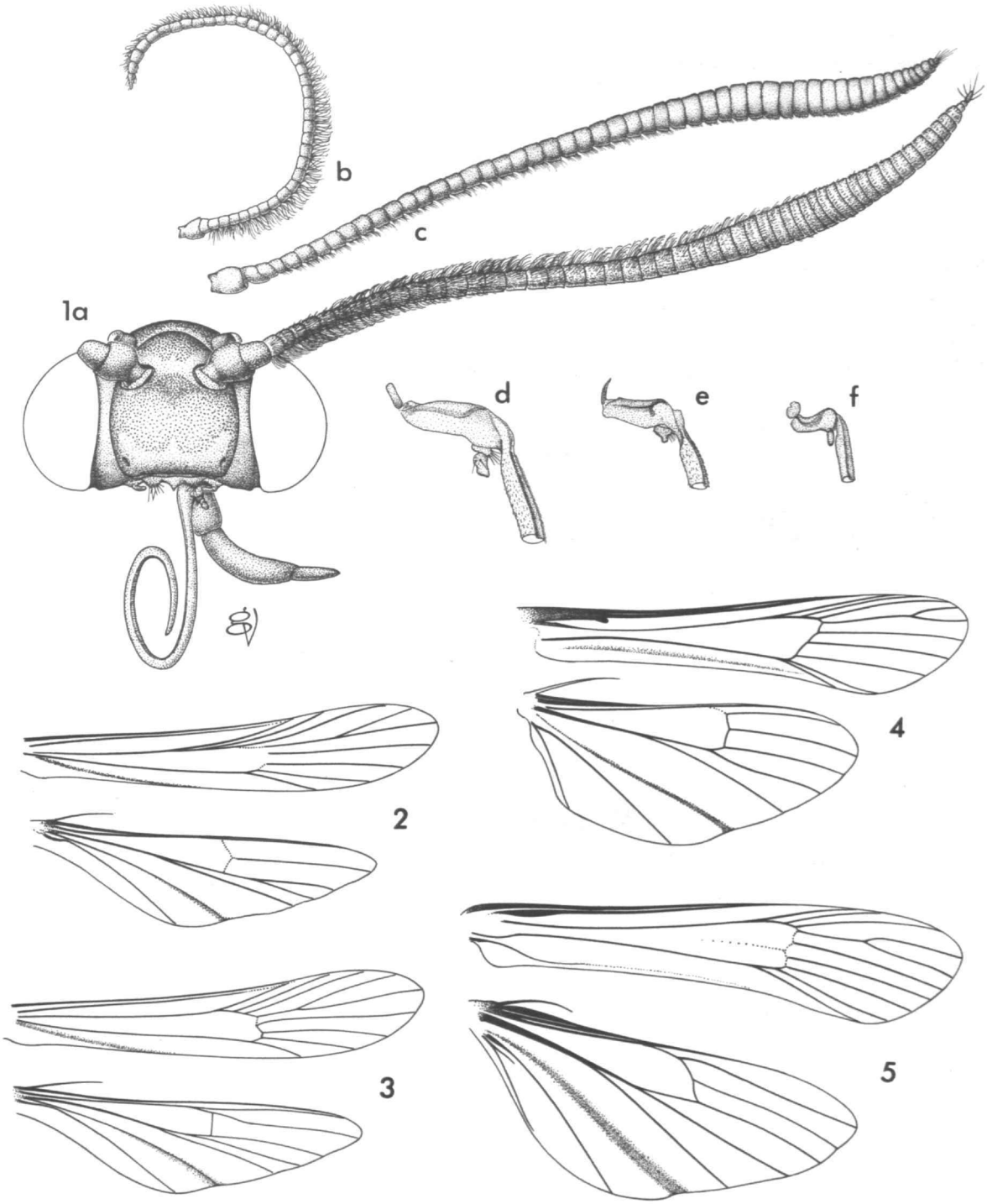
Swinhoe, Charles
1892. *Catalogue of Eastern and Australian Lepidoptera Heterocera in the Collection of the Oxford University Museum*, Part 1: *Sphinges & Bombyces*. Volume 8, 324 pages, 8 plates.

Thomson, G. M.
1884. General Notes: Introduced Moths in New Zealand. *New Zealand Journal of Science* (Dunedin), 2:229–230.

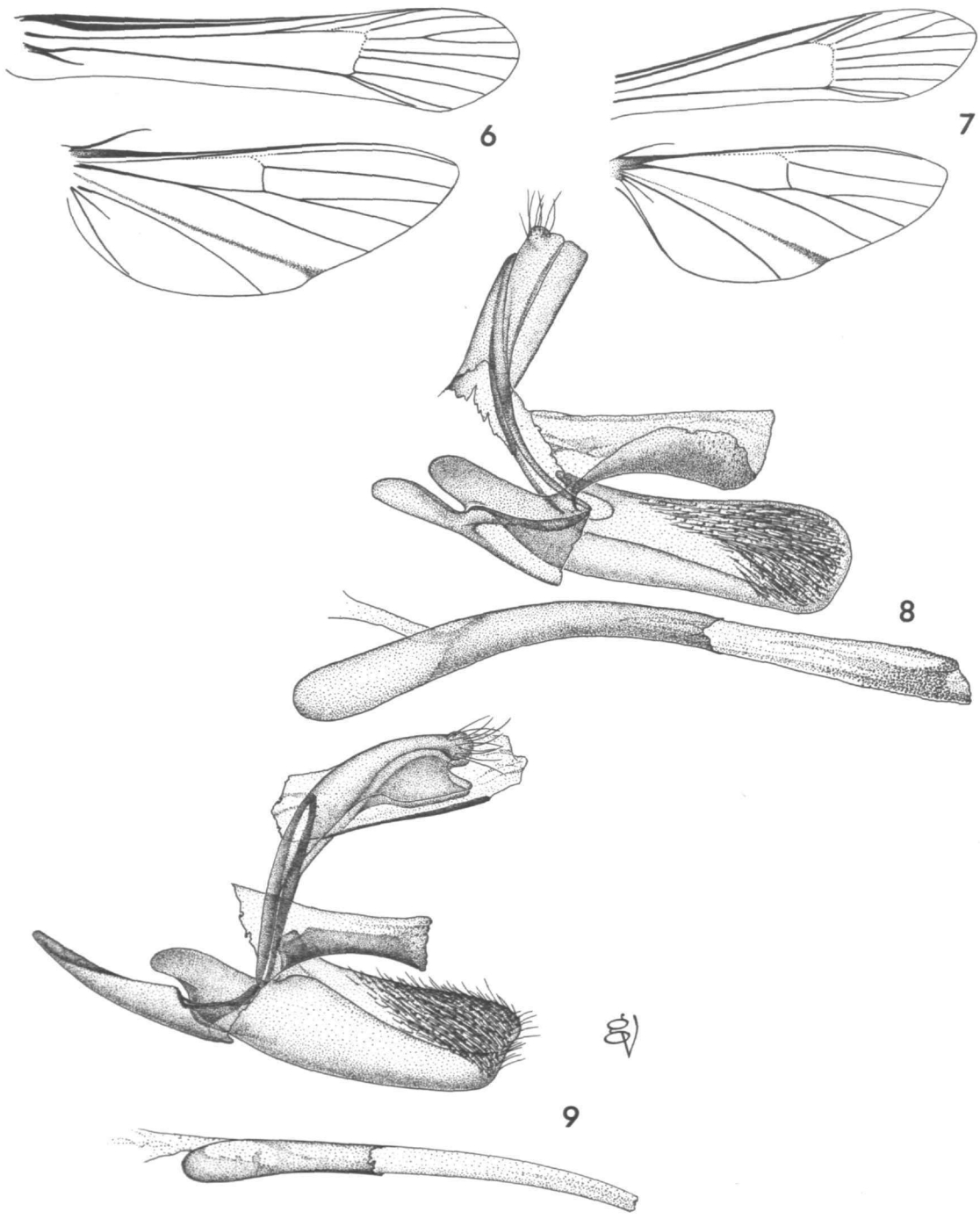
Tillyard, R. J.
1926. *The Insects of Australia and New Zealand*. xi + 560 pages, 44 plates. Sydney: Angus & Robertson.

Turner, A. J.
1917. Lepidopterological Gleanings. *Proceedings of the Royal Society of Queensland for 1917*, 29:70–106.
1922. Studies in Australian Lepidoptera. *Proceedings of the Royal Society of Victoria*, 35 (N.S.):26–62.

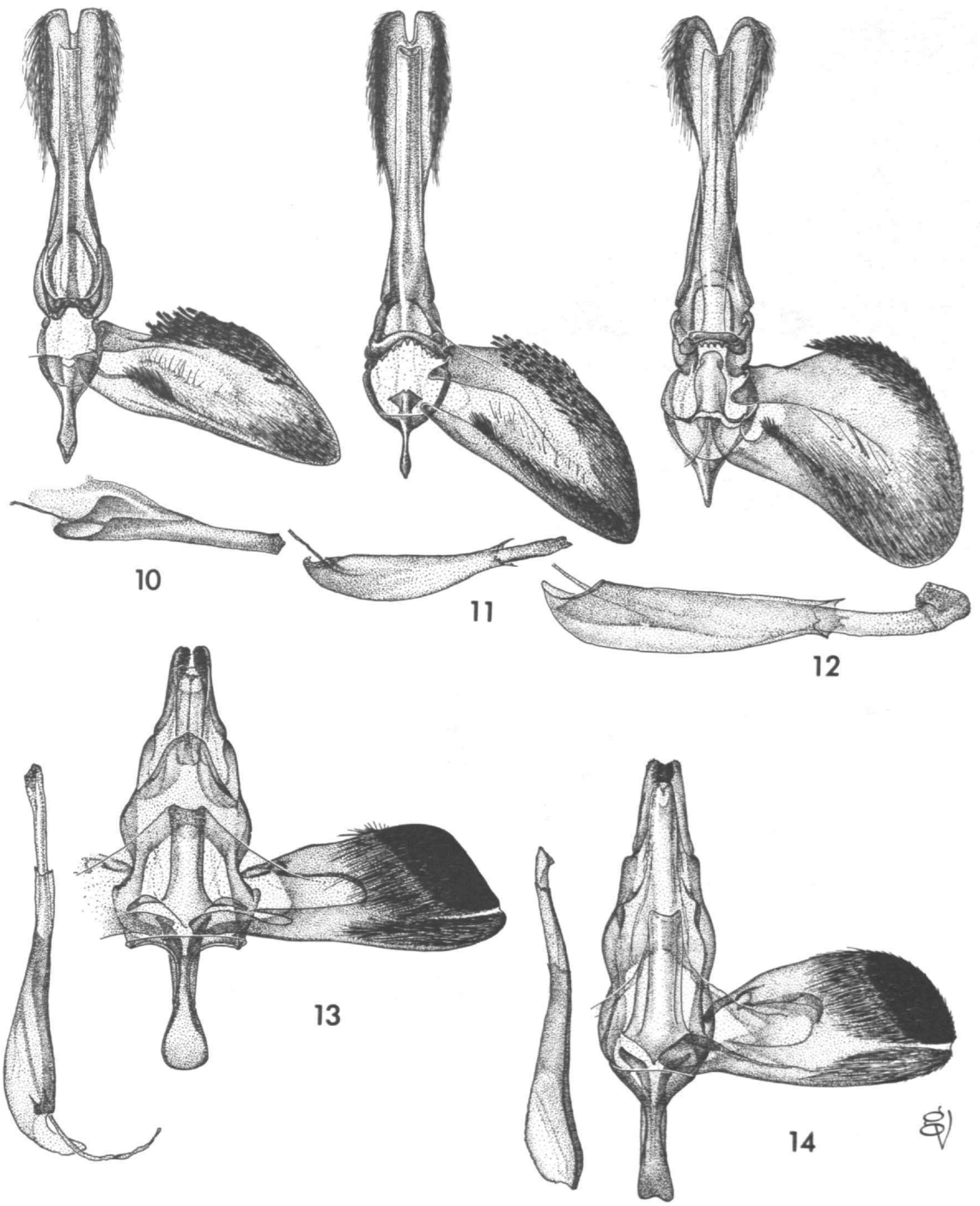
Walker, F.
1856. *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum*. Part 8, 271 pages. London: British Museum.
1864. *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum*. Part 31, 321 pages. London: British Museum.



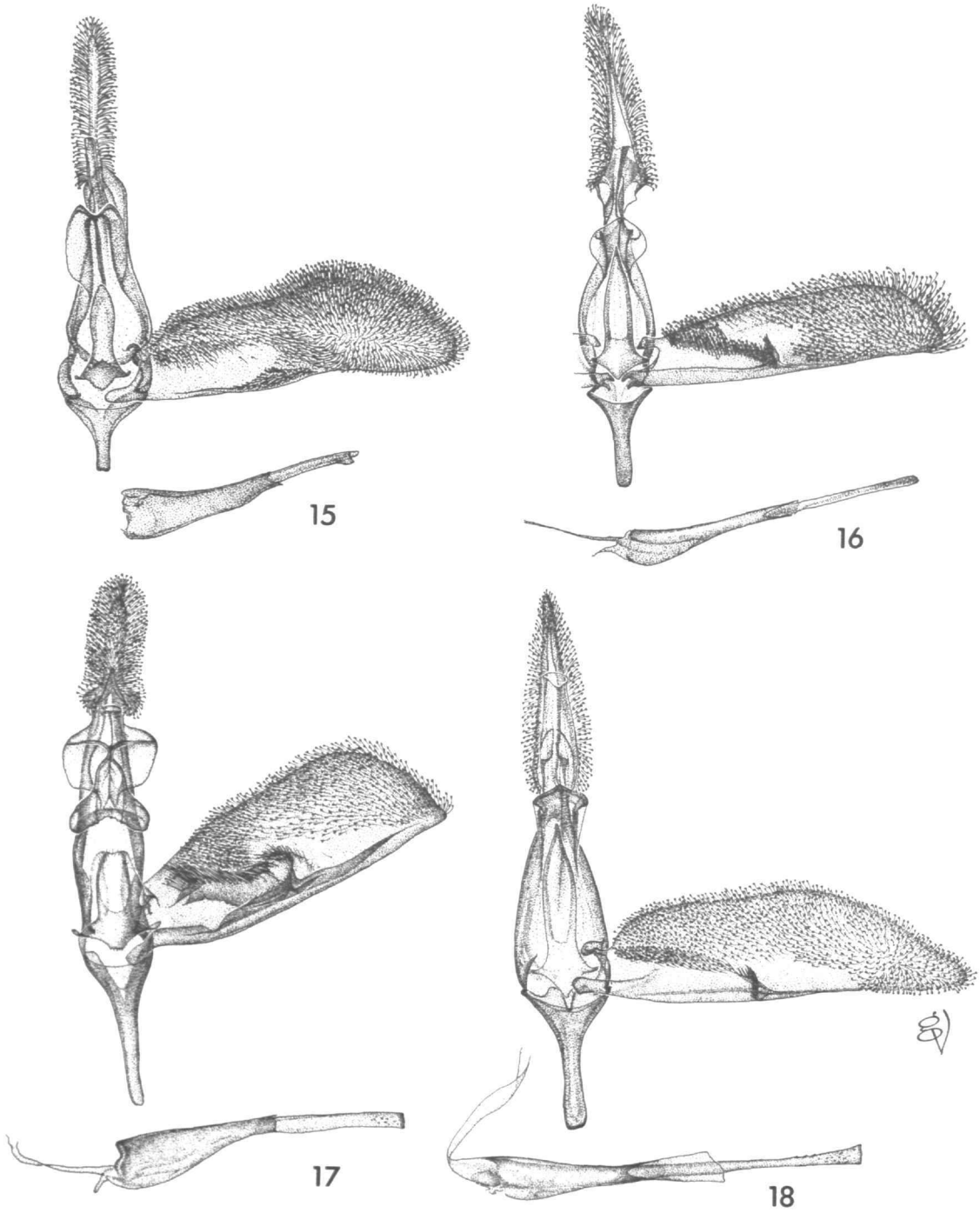
FIGURES 1–5.—Head morphology, wing venation: 1*a*, head of *Albuna oberthuri* (Le Cerf), frontal view, scales removed; *b*, antenna of *Pennisetia igniflua* (Lucas); *c*, antenna of *Synanthedon tipuliformis* (Clerck); *d*, maxilla of *A. oberthuri*; *e*, maxilla of *S. tipuliformis*; *f*, maxilla of *P. igniflua*; 2, wing venation of *P. igniflua*; 3, wing venation of *Tinthia xanthospila* Hampson; 4, wing venation of *Albuna isozona* (Meyrick); 5, wing venation of *Melittia amboinensis* Felder.



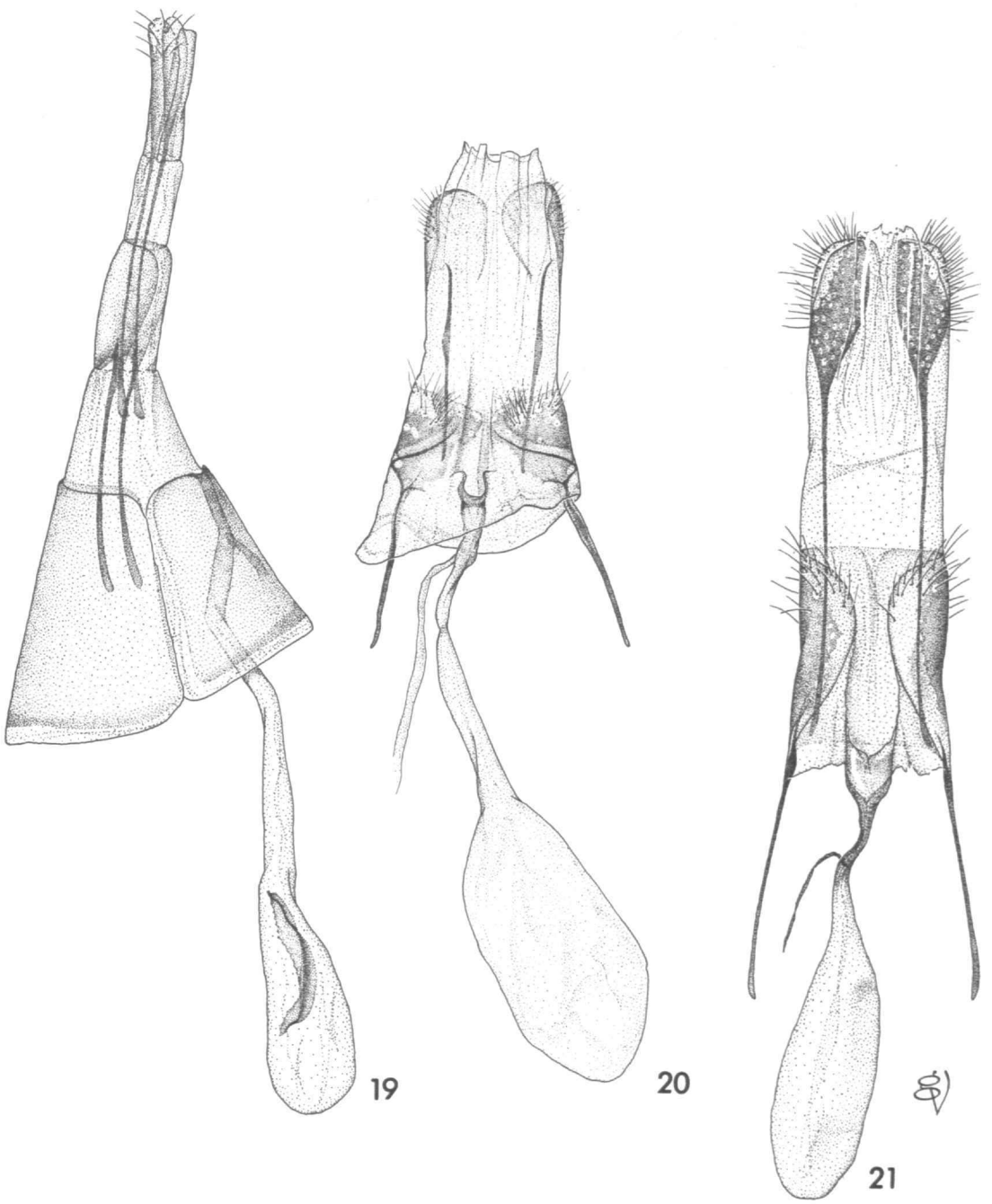
FIGURES 6–9.—Wing venation, male genitalia: 6, wing venation of *Synanthedon cupreifascia* (Miskin); 7, wing venation of *Carmenta chrysophanes* (Meyrick); 8, lateral view of male genitalia of *Pennisetia eusphyra* (Turner) (left valva, aedeagus removed); 9, lateral view of male genitalia of *P. igniflua* (Lucas) (left valva, aedeagus removed).



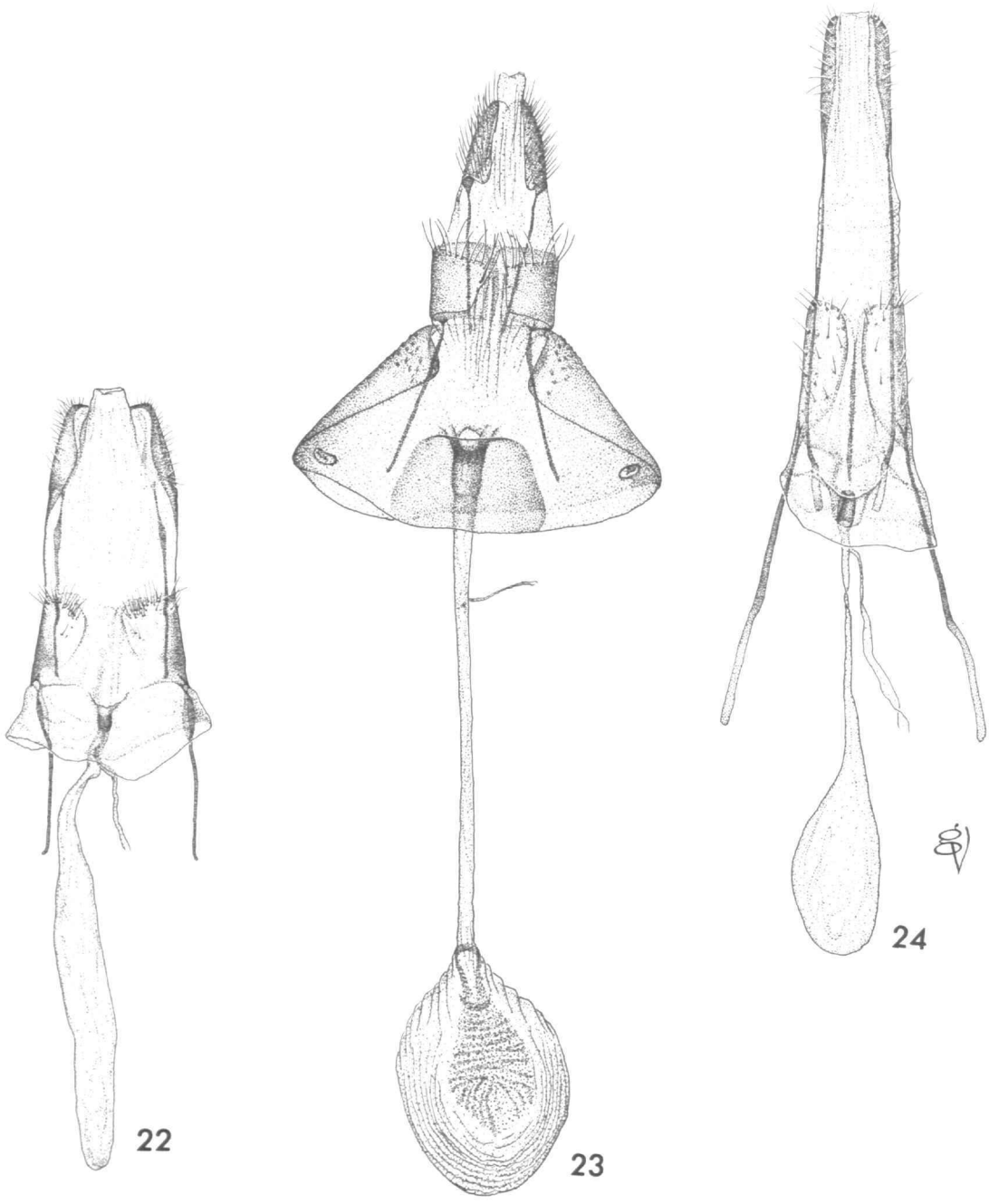
FIGURES 10–14.—Ventral view of male genitalia (left valva, aedeagus removed; lateral view of aedeagus): 10, *Albuna carulifera* (Turner); 11, *A. isozona* (Meyrick); 12, *A. oberthuri* (LeCerf); 13, *Melittia amboinensis* Felder; 14, *M. chalybescens* Miskin.



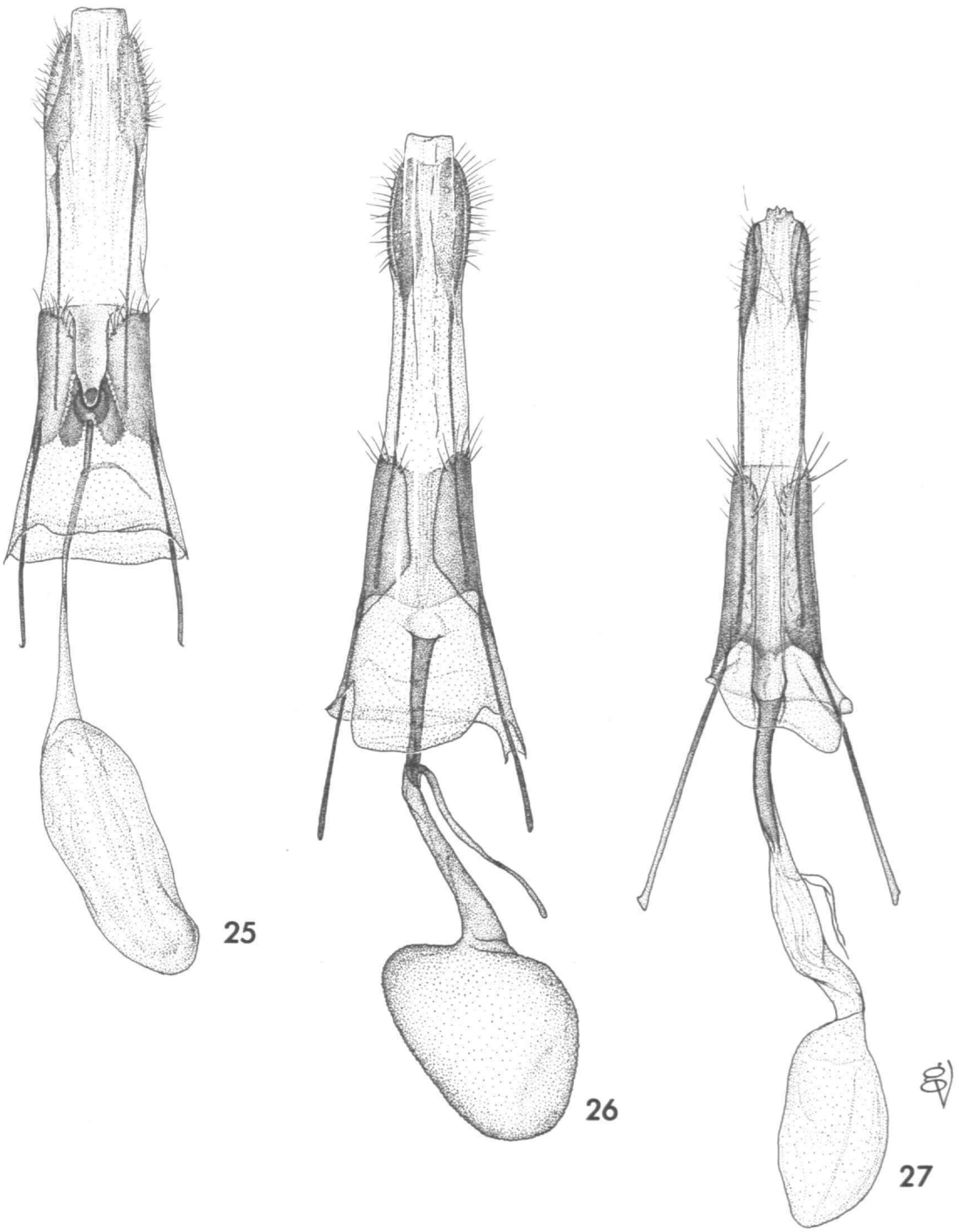
FIGURES 15–18.—Ventral view of male genitalia (left valva, aedeagus removed; lateral view of aedeagus): 15, *Synanthedon tipuliformis* (Clerck); 16, *Carmenta chrysophanes* (Meyrick); 17, *C. commoni* n. sp.; 18, *C. xanthogyna* (Hampson).



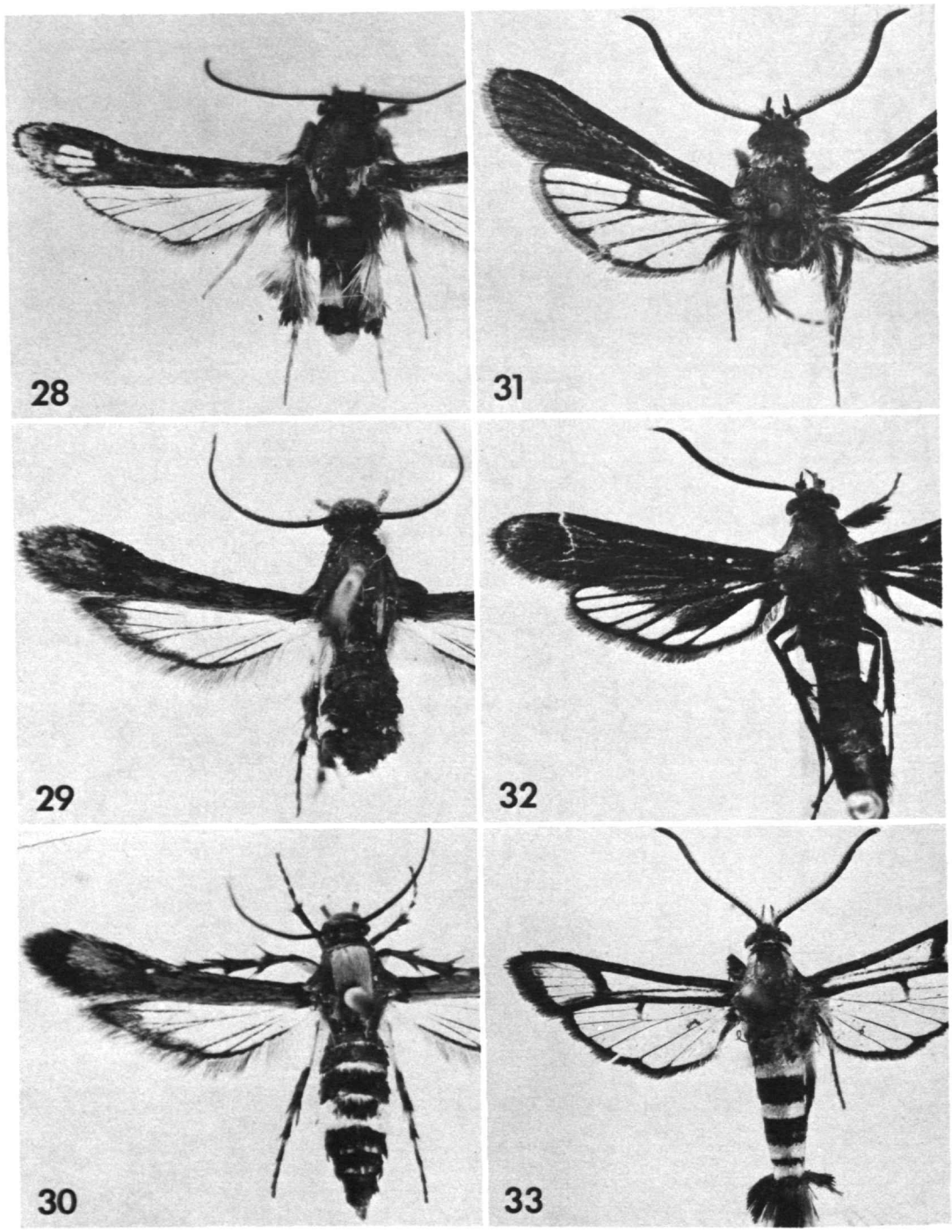
FIGURES 19–21.—Female genitalia: 19, lateral view of *Pennisetia igniflua* (Lucas); 20, ventral view of *Albuna carulifera* (Turner); 21, ventral view of *A. oberthuri* (LeCerf).



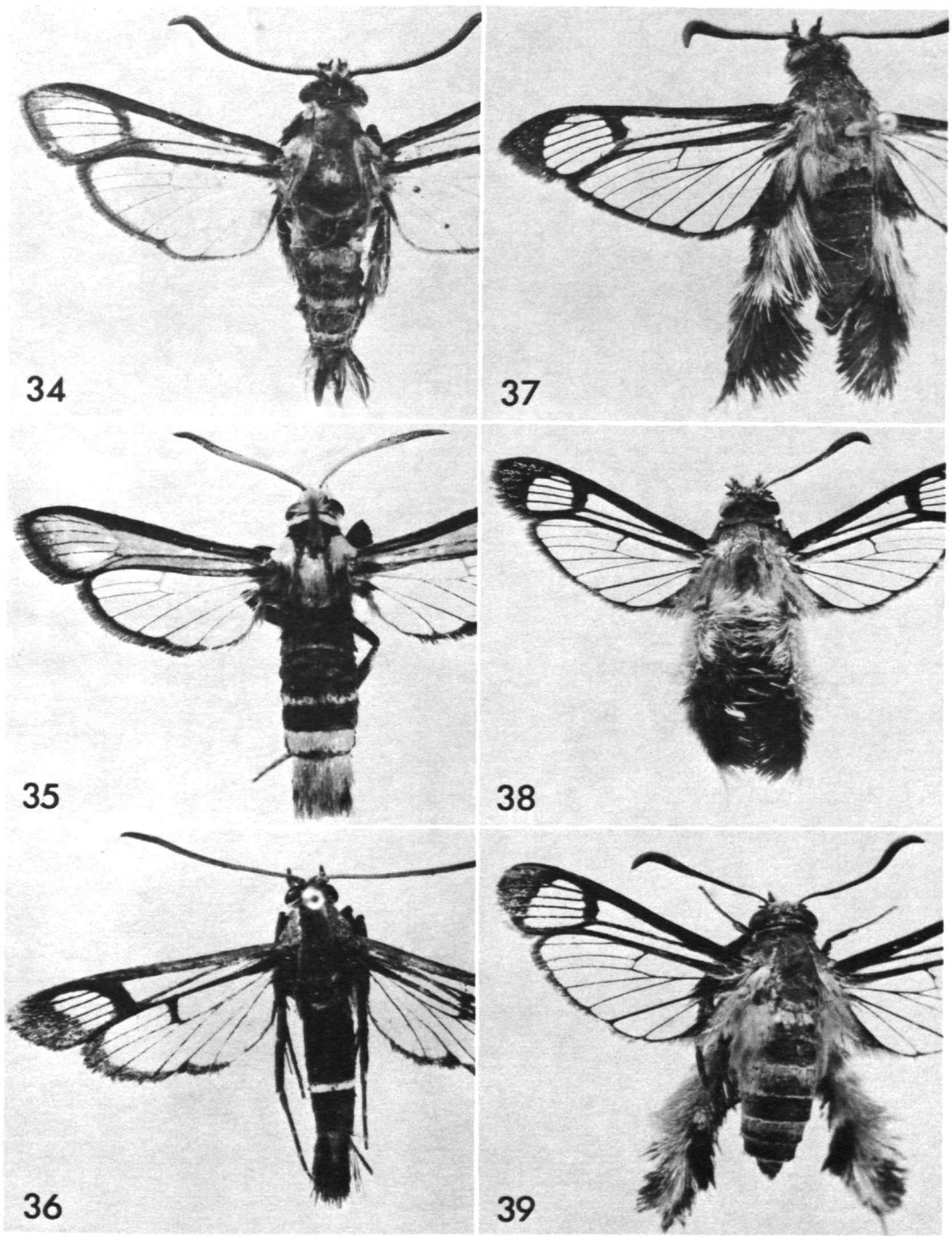
FIGURES 22–24.—Ventral view of female genitalia: 22, *Albuna zoniota* (Turner); 23, *Melittia amboinensis* Felder; 24, *Synanthedon cupreifascia* (Miskin).



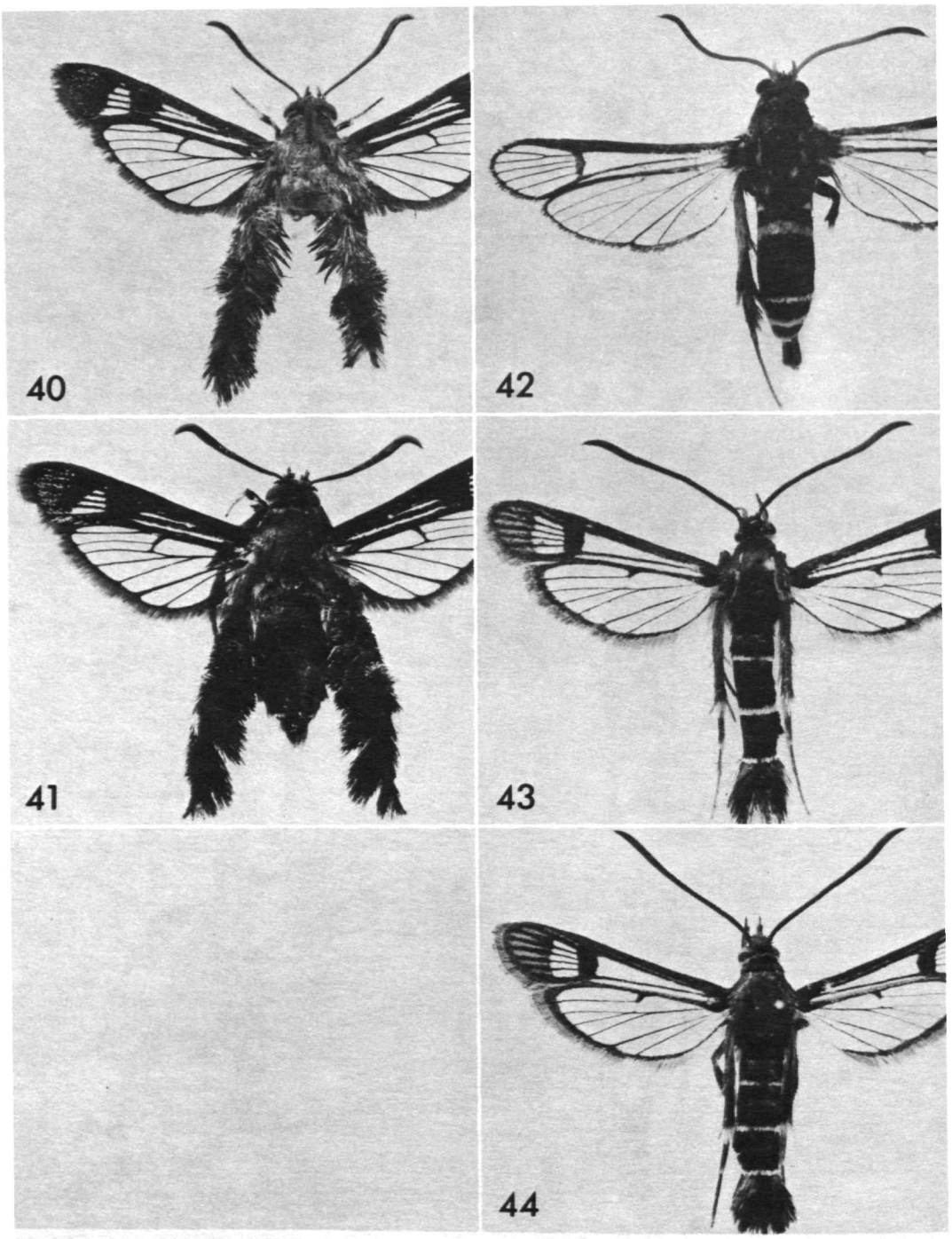
FIGURES 25–27.—Ventral view of female genitalia: 25, *Synanthedon tipuliformis* (Clerck); 26, *Carmenta chrysophanes* (Meyrick); 27, *C, xanthogyna* (Hampson).



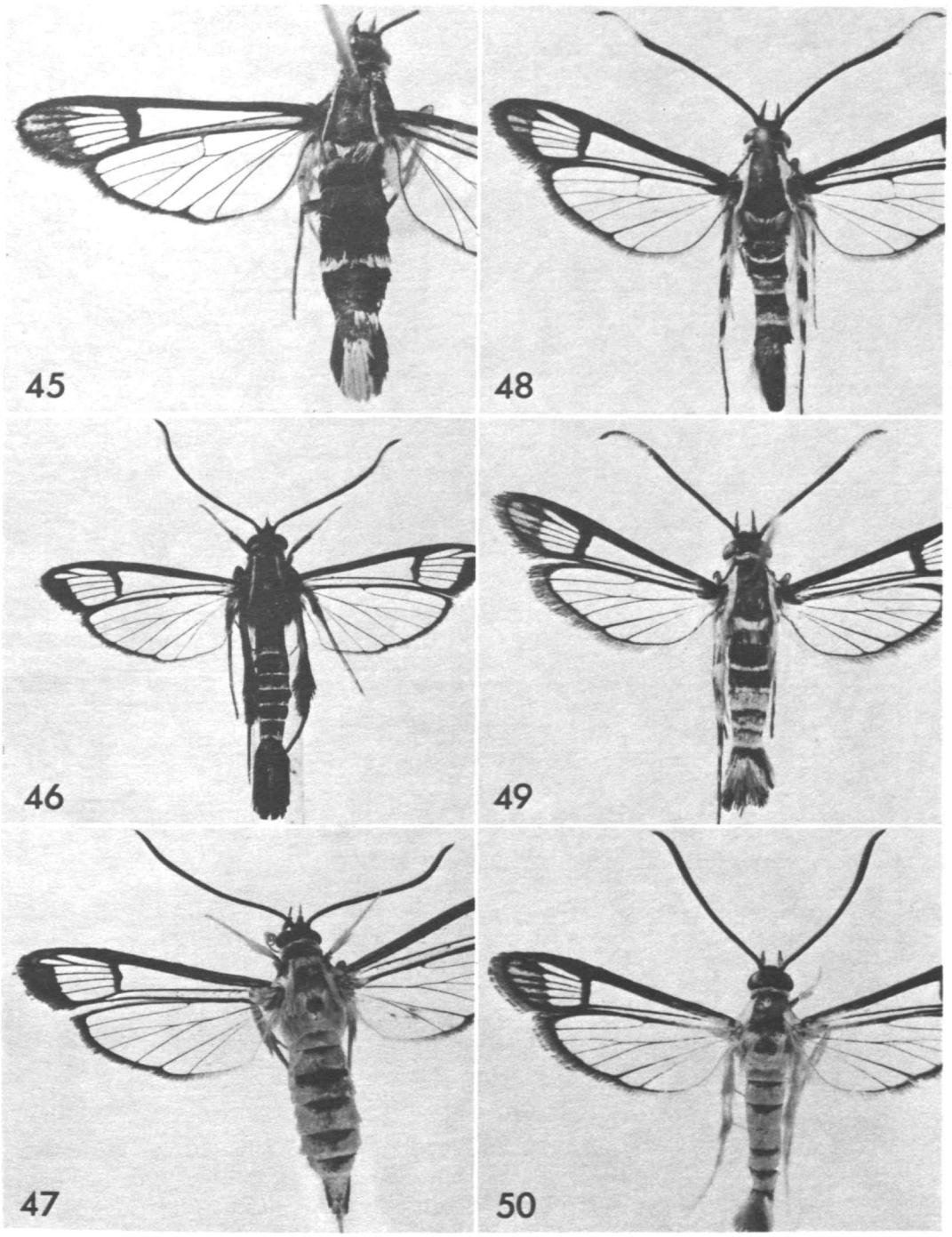
FIGURES 28–33.—Left wings and bodies: 28, *Pennisetia eusphyra* (Turner), male; 29, *P. igniflua* (Lucas), male; 30, *P. igniflua*, female; 31, *Albuna carulifera* (Turner), male; 32, *A. carulifera*, female; 33, *A. isozona* (Meyrick), male.



FIGURES 34–39.—Left wings and bodies: 34, *Albuna oberthuri* (LeCerf), male; 35, *A. oberthuri*, female; 36, *A. zoniota* (Turner), female; 37, *Melittia amboinensis* Felder, male; 38, *M. amboinensis*, female; 39, *M. amboinsis*, female.



FIGURES 40–44.—Left wings and bodies: 40, *Melittia chalybescens* Miskin, male; 41, *M. chalybescens*, female; 42, *Synanthedon cupreifascia* (Miskin), female; 43, *S. tipuliformis* (Clerck), male; 44, *S. tipuliformis*, female.



FIGURES 45–50.—Left wings and bodies: 45, *Carmenta commoni*, new species, male; 46, *C. xanthogyna* (Hampson), male; 47, *C. xanthogyna*, female; 48, *C. chrysophanes* (Meyrick), male; 49, *C. chrysophanes*, female; 50, *C. chrysophanes*, female.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1974—546-365/24

Publication in Smithsonian Contributions to Zoology

Manuscripts for serial publications are accepted by the Smithsonian Institution Press, subject to substantive review, only through departments of the various Smithsonian museums. Non-Smithsonian authors should address inquiries to the appropriate department. If submission is invited, the following format requirements of the Press will govern the preparation of copy.

Copy must be typewritten, double-spaced, on one side of standard white bond paper, with 1½" top and left margins, submitted in ribbon copy with a carbon or duplicate, and accompanied by the original artwork. Duplicate copies of all material, including illustrations, should be retained by the author. There may be several paragraphs to a page, but each page should begin with a new paragraph. Number consecutively all pages, including title page, abstract, text, literature cited, legends, and tables. The minimum length is 30 pages, including typescript and illustrations.

The *title* should be complete and clear for easy indexing by abstracting services. Taxonomic titles will carry a final line indicating the higher categories to which the taxon is referable: "(Hymenoptera: Sphecidae)." Include an *abstract* as an introductory part of the text. Identify the *author* on the first page of text with an unnumbered footnote that includes his professional mailing address. A *table of contents* is optional. An *index*, if required, may be supplied by the author when he returns page proof.

Two *headings* are used: (1) text heads (boldface in print) for major sections and chapters and (2) paragraph sideheads (caps and small caps in print) for subdivisions. Further headings may be worked out with the editor.

In *taxonomic keys,* number only the first item of each couplet; if there is only one couplet, omit the number. For easy reference, number also the taxa and their corresponding headings throughout the text; do not incorporate page references in the key.

In *synonymy,* use the short form (taxon, author, date:page) with a full reference at the end of the paper under "Literature Cited." Begin each taxon at the left margin with subsequent lines indented about three spaces. Within an entry, use a period-dash (.—) to separate each reference. Enclose with square brackets any annotation in, or at the end of, the entry. For *references within the text,* use the author-date system: "(Jones, 1910)" and "Jones (1910)." If the reference is expanded, abbreviate the data: "Jones (1910:122, pl. 20: fig. 1)."

Simple *tabulations* in the text (e.g., columns of data) may carry headings or not, but they should not contain rules. Formal *tables* must be submitted as pages separate from the text, and each table, no matter how large, should be pasted up as a single sheet of copy.

Use the *metric system* instead of, or in addition to, the English system.

Illustrations (line drawings, maps, photographs, shaded drawings) can be intermixed throughout the printed text. They will be termed *Figures* and should be numbered consecutively; however, if a group of figures is treated as a single figure, the components should be indicated by lowercase italic letters on the illustration, in the legend, and in text references: "Figure 9*b*." If illustrations (usually tone photographs) are printed separately from the text as full pages on a different stock of paper, they will be termed *Plates,* and individual components should be lettered (Plate 9*b*) but may be numbered (Plate 9: figure 2). Never combine the numbering system of text illustrations with that of plate illustrations. Submit all legends on pages separate from the text and not attached to the artwork. An instruction booklet for the preparation of illustrations is available from the Press on request.

In the *bibliography* (usually called "Literature Cited"), spell out book, journal, and article titles, using initial caps with all words except minor terms such as "and, of, the." For capitalization of titles in foreign languages, follow the national practice of each language. Underscore (for italics) book and journal titles. Use the colon-parentheses system for volume, number, and page citations: "10(2):5-9." Spell out such words as "figures," "plates," "pages."

For *free copies* of his own paper, a Smithsonian author should indicate his requirements on "Form 36" (submitted to the Press with the manuscript). A non-Smithsonian author will receive 50 free copies; order forms for quantities above this amount with instructions for payment will be supplied when page proof is forwarded.