

A TAXONOMIC REVISION OF THE INDIAN SPECIES
OF THE FAMILY COSSIDAE (LEPIDOPTERA)

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(With 35 Text-figures and 3 Plates)

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INTRODUCTION

(a) *General*

Members of the family Cossidae, known as the goat-moths, or the carpenter-moths, include certain species which were described as early as 1758 by Linnaeus, 1775 by Fabricius and 1779 by Cramer. Dalla-Torre (1923) who prepared the catalogue of the family recorded nearly 500 species, belonging to 57 genera. It included 35 species belonging to eight genera from the Indian region (including India, Bangladesh, Pakistan, Bhutan, Burma and Srilanka). Although, a large number of species of the family has since been described from various parts of the world, those from the countries mentioned above have been very few. These comprise four species from India, described by Fletcher (1928) (two species) and Arora (1965, 1974) (two species), and two species from Burma described by Bryk (1950). In so far as the species from other parts of the Orient are concerned, considerable advance has been made by Roepke (1948, 1957) who studied the material of this family from Sumatra and Malaysia, and Daniel (1962) who studied South and South-Eastern species of the genus *Zeuzera* Latreille. Roepke (1948) states (p. 216) " This species [*lineata* Gaede] of the genus *Zeuzera* as well as the entire family of eastern Cossids are not yet sufficiently worked out " He (1957) reported and described eight genera and 55 species (including two new genera and 27 new species) from Malaysia. Among these, *Phragmataecia castaneae* Hübner, *Xyleutes ceramicus* (Walker), *X. mineus* (Cramer), *X. pardicolor* (Moore), *X. persona* (Le Guillou), *X. strix* (Linn.), *Zeuzera coffeae* Nietner and *Z. indica* Herrich-Schäffer occur in the Indian region also. As regards the study of the family Cossidae in the Palaearctic region, Daniel's work (1940 to 1965) on the genera *Catopta* Staudinger, *Cossus* Fabricius, and *Holcocerus* Staudinger is important, especially because of the transfer of certain Indian species of the genus *Cossus* Fabricius, viz. *C. cashmirensis* Moore,

C. acronyctoides (Moore) and *C. pallidalae* Hampson to the genus *Catopta* Staudinger, though erroneous in case of *C. acronyctoides* and *C. pallidalae*, and *C. rufidorsia* Hampson to the genus *Holcocerus* Staudinger.

Except for a few references, as above, the taxonomy of the Indian Cossidae has remained almost neglected since the publication of "Moths of India" series by Hampson (1905). The taxonomic study of the Indian species has been undertaken with a view to add to our knowledge of this family which is of considerable economic importance on account of the wood-boring habit of their larvae. These cause considerable damage to a variety of plants in the forests and plantations in India and neighbouring countries. The damage done by different species is of varied nature ; some species are characterised by forming galleries which are not detected unless the tree is sawn, as is the case with *Xyleutes ceramicus* (Walker) which attacks teak. The damage caused by *X. persona* (Le Guillou) is also in the form of numerous galleries and the wounds caused by this species may be sufficient to kill the plant. *Zeuzera coffeae* Nietner is another well-known pest of coffee and is commonly called the coffee-borer or the red-borer, which is also reported to attack as many as 35 different host plants (Beeson, 1941), including sandal-wood, citrus, cotton, jasmine and teak. The larvae, the presence of which is detected by the pellets of frass on the ground below the infested branch, affect only that part of the tree where they bore, but if the tree is young, the attack can be fatal.

Another point of interest regarding the Cossidae is that phylogenetically it is one of the most primitive families in the order Lepidoptera and is believed to have retained the ancient or the generalised type (Turner, 1918 and Seitz, 1929) of neuration among the Lepidoptera-Heteroneura. Seitz (1912) refers to its relationship with the Microlepidopteren families, the Tortricidae and Hepialidae. Turner (1918, 1946) has claimed that presumably all the major families have evolved from Cossidae by a process of reduction of the veins, etc. His hypothesis has led him to propose a new family name *Protocossidae* to denote its ancestral status. Gaede (1929) has commented on the highly remarkable features of the family, e.g., the large and hard wings in certain species (though not active fliers) ; reduced proboscis and labial palpi in certain species or their absence in others, the very large eyes, etc. He, however, opined (p. 539) "We can easily distinguish different types of lepidoptera among the *Cossidae* ; they deviate so much from each other that even the homogeneousness of the family is doubted and some lepidopterologists are of opinion that the characteristics common to the family are for the greater part merely to be considered as resemblance by convergency, produced by endophyte habits of the larvae." These view points on the primitive or specialised features, are of interest and importance in the study of Cossidae.

The taxonomy of the Indian species has been dealt with in detail in the following pages on the basis of the material belonging to 31 species, two of which are new. A new subspecies is also proposed. Apart from a huge collection of this family in the Zoological Survey of India, collections, both determined and undetermined, present in other institutes such as Indian Agricultural Research Institute, New Delhi, Forest Research Institute, Dehra Dun, and British Museum (Natural History), London, were also available for this study. Types of the several species of F. Moore located in Berlin Museum, of F. Bryk's species in Riksmuseum, Stockholm, and those of T. B. Fletcher's in the Indian Agricultural Research Institute, New Delhi, were also available for this study.

I am greatly indebted to Dr. A. P. Kapur, Director, Zoological Survey of India, Calcutta, for suggesting the problem and for his expert and valuable guidance.

My grateful thanks are due to the following persons and authorities who kindly loaned the type material or named collection of various species present in their institutes : to Dr. H. J. Hannemann of the Institute für Spezielle Zoologie und Zoologische Museum, Berlin ; to the Director, Riksmuseum, Stockholm (Sweden) ; to Dr. S. Pradhan, Head of the Entomology Division, Indian Agricultural Research Institute, New Delhi ; and to Dr. P. N. Chatterji, Forest Research Institute, Dehra Dun.

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(b) *Abbreviations used*

A, Anal veins.

a, Areole.

- aa*, Anterior apodeme.
am, Ampulla.
an, Juxta of the anellus.
anl, Anellus lobes.
ar, Arolium.
B.M., British Museum (Nat. Hist.), London.
Ber.Mus., Institute fur Spezielle Zoologie und Zoologische Museum, Berlin.
b, Bulla.
c, Clasper.
cb, Corpus bursae.
ch, Costal hump.
cl, Cucullus.
cn, Cornutal spines/process.
coll, Collector.
colln, Collections.
cr, Coiled sclerotised ribbon.
db, Ductus bursae.
dc, Discal cell.
e, Eye.
ex, Example.
ex. colln, From the collections of.
F. R. I., Forest Research Institute, Dehra Dun.
fig, Figure.
fr, Frenulum.
gn, Gnathos.
h, Harpe.
I. A. R. I., Indian Agricultural Research Institute, New Delhi.
Indian Mus., Indian Museum, Calcutta.
j, Juxta.
mc, median cell.
N. P. C., National Pusa Collections.
ob, Ostium bursae.
oc, Ocellus.
Ox. Univ. Mus., Oxford University Museum.
pa, Posterior apodeme.
Paris Mus, Paris Museum.
Rm, Riksmuseum.
rs, Receptaculum seminalis.
rt, Retinaculum.
s, Socii.
sc, Saccus.
scl, Sclerotisation on the dorsal side of the genital plate.
sg, Signum.
sp, Sclerotisation on the ventral side of the genital plate.
spr, Spina basalis process.
tbs, Tibial spurs.
teg, Tegumen.
ts, Tarsal spines.
Type loc, Type locality.
u, Uncus.
vsc, Vesica.
Z. S. I., Zoological Survey of India.

REVIEW OF THE TAXONOMY OF THE INDIAN COSSIDAE

(a) *Historical Account*

The word 'Cossida' was proposed by Leach (1815) for a group of those moths which included *Cossus cossus* (Linn.) and its allied species. Boisduval (1829) proposed *Zeuzeridi* for the genus *Zeuzera* Latreille and its allies but subsequently (1834) changed it to *Zeuzerides*. It was Newman (1832) who used the words *Cossidae* and *Zeuzeridae* for the first time and it is probably due to this reason that the family is assigned to Newman by several workers. Dalla-Torre (1923) and Dyar (1937) have, however, assigned the family to Leach (1815) because of the priority of *Cossida* Leach over *Cossidae* Newman. Besides as above, the family has also been referred in the literature under several other names, viz. *Cossides* Herr.-Sch., *Cossina* Heinemann, *Phalaenina Cossites* Newman, etc.

The family has a world-wide distribution of nearly all the genera that are not monotypical and, as Seitz (1929) refers, the global distribution is mainly due to the larvae which are wood-or pith-borers and are easily transportable. He recorded some 500 species from the world, but today the number of known species and subspecies is nearly 1000, increased mainly on account of the taxonomic work on the Cossidae of Palaeæctic (Daniel, 1940 to 1965), Australian (Turner, 1945), Neotropical (Clench, 1956, 1957), Ethiopian (Clench, 1959) and Oriental (Roepke, 1957 ; Arora, 1965, 1974) regions.

The first record of Cossidae from India appears to have been given by Donovan (1800), who recorded *Phalaena scalaris* (Fabricius) and *Phalaena mineus* (Cramer) from Bengal, originally described from China and Batavia, respectively. Eschscholtz (1821) described a new species, viz. *Zeuzera viridicans*, now a synonym of *Xyleutes mineus*, for the first time from India (Ganjam, Orissa). Subsequent additions to the Indian fauna were made in a series of papers by Herrich-Schäffer (1854), Walker (1856, 1865), Nietner (1861), Moore (1865-1883), Butler (1880), Swinhoe (1884, 1894), Hampson (1891-1905) and Dudgeon (1899).

Cotes & Swinhoe (1887) prepared a *Catalogue of Moths of India* and included 21 species in the family Cossidae. Kirby (1892) instead, recorded 22 species in the family because the species *Zeuzera asylas* (Cramer) was not recognised by him as a synonym of *Zeuzera scalaris* (Fabricius), as done by the former. Hampson (1892b), however, pointed out that *Zeuzera asylas* (Cramer) was a South African species and, therefore, he excluded it from the Indian Cossids. He also described five new species and synonymised some species to the already known ones, thus recognising only 23 species from the Indian region. Subsequent additions, which followed till the publication

of Dalla-Torre's (1923) catalogue, were by Swinhoe (1894), Hampson (1895-1905) and Dudgeon (1899), who added one, six and one species, respectively.

(b) *Recent Development and Present Position of the Indian Cossidae*

Since the publication of the catalogue of the world Cossidae by Dalla-Torre (1923) very little work has been done on the taxonomy of the Indian Cossidae. Although Dalla-Torre (1923) recorded 35 species from the Indian region under this family, the figure also included those species which were either not considered as belonging to this family, viz. *Cossus stigmatus* Moore (vide Hampson, 1892b; and Gaede, 1929) and *Dudgeonea leucosticta* Hampson (vide Berger, 1957), or not occurring in Indian region, viz. *Zeuzera asylas* (Cramer) (vide Hampson, 1892b), and *Z. crassicornis* (Fabr.) (vide Kirby, 1892), or not valid species, viz. *Duomitus pardalis* Dudgeon which was synonymised with *Zeuzera pardicolor* Moore (= *Xyleutes pardicolor*) (vide Gaede, 1933 and Roepke, 1957). Further additions to the Indian Cossidae were made by Fletcher (1928) from Pusa, Bihar, India, (2 species); Bryk (1950) from Burma (2 species); and by Arora (1965, 1974) from Sikkim and Bhutan (2 species).

Beeson (1941) recorded some 25 species of Cossidae from the different host-plants, but referred to a number of unidentified Cossidae attacking Indian plants.

Daniel (1940 to 1965) in a series of papers on the Palaearctic and Oriental Cossidae, revised the genera *Catopta* Staudinger, *Holcocerus* Staudinger, *Cossus* Fabricius, *Zeuzera* Latreille, and a few more, which are common to both Palaearctic and Oriental regions and also transferred several species of the genus *Cossus* to various other known or new genera.

Another significant work on the Cossidae is by Clench (1956-1959) who revised mainly the Neotropical (1956), Chilean (1957) and the African fauna (1959b). He (1958) also described a new species from Western-China, viz. *Sinicossus danieli*, which, he considered, possessed its closely related forms in India. He also studied (1959a) the unusual structure and affinities of the Madagascarian genus *Pseudocossus* Kenrick, and for the first time reported the presence of ocelli in this genus. Among the Indian Cossidae the ocelli were hitherto unknown and are being reported for the first time in the genus *Catopta* Staudinger, particularly in the two species which have been studied here, viz. *C. cashmirensis* (Moore) and *C. sikkimensis* (Arora). Clench's revision of the African fauna (1959b) is also of interest as far as the Indian Cossidae is concerned, since he revived the genus *Brachylia* Felder, which was till then generally considered as a synonym of the genus *Cossus*. In fact it was under this genus that

one of the Indian species was described as *Brachyilia acronyctoides* Moore, but now has been placed in the genus *Cossus*.

Roepke (1957) revised the Malaysian Cossidae and made a comprehensive study of the male genitalia in several species. Berger (1957) transferred a hitherto-known Cossid-genus *Dudgeonea* Hampson from India, into a distinct family Dudgeonidae due to the presence of tympanum in the latter.

In the present study two more new species and a subspecies have been described, respectively, from Ceylon, S. Andaman and Sangur (W.B.). One species viz., *Holcocerus arenicola* (Staudinger) has been recorded from India (Great Nicobar Island), for the first time, thus bringing the total number of known species and subspecies to 40.

III—MATERIAL AND METHODS

(a) Material

The material for the present study consists of about 400 specimens representing 32 species & subspecies belonging to eight genera, viz. *Catopta* Staudinger (2 species), *Cossus* Fabricius (3 species), *Holcocerus* Staudinger (2 species), *Paracossus* Hampson (1 species), *Azygophelps* Hampson (3 species), *Phragmataecia* Newman (10 species), *Xyleutes* Hübner (7 species) and *Zeuzera* Latreille (3 species and a subspecies). The material of the remaining eight species was not available for study and hence their original descriptions have been quoted so as to show the differences from their closely-related species. The material is mainly present, except otherwise stated, in the National Zoological Collections at the Zoological Survey of India, Calcutta, which also includes extensive collections of, E.E. Green from Ceylon; G. C. Dudgeon from Kangra valley, Sikkim and Bhutan; and of T. C. Jordan from Sikkim.

Several types were available for the study from various institutes and museums in India and abroad. These were: F Moore's species viz., *Cossus cashmirensis*, *Phragmataecia minor*, *Phragmataecia saccharum*, *Zeuzera stigmatica* (labelled as *Zenzera bistigma*), *Zeuzera albofasciata*, and *Zeuzera pardicolor* from the Berlin Museum; F. Bryk's species, viz. *Phragmataecia obliquifascia* and *Phragmataecia clara* from the Riksmuseum, Stockholm; T. B. Fletcher's species *Phragmataecia purpureus* and *Phragmataecia terebrifer* from the N.P.C. at I.A.R.I., New Delhi. The material for the species *Cossus pallidalae* Hampson [now *Phragmataecia pallidalae*], *Phragmataecia impura* Hampson and *Paracossus parve* Hampson, was available from the B.M. (N.H.), London. Some material both determined and undetermined was also available from F.R.I., Dehra Dun and I.A.R.I., New Delhi.

(b) Methods of Study

The material was studied dry. Special attention was paid to the study of head-appendages and wing-venation, the latter was studied from the under side by applying toluene with the help of a fine sable-hair brush.

The genitalia were studied by cutting a part of abdomen in the male and detaching the whole abdomen in the female. The same was kept in 10 % KOH overnight. This treatment was prolonged if the material did not soften. After washing with the distilled water the genitalia were passed through different grades of alcohol and mostly preserved in spirit.

The sketches were made with the help of camera lucida.

(c) Some Characters of Taxonomic Importance

Both the external as well as genitalic studies have been made with a view to present, as far as possible, the detailed taxonomic account of the Cossid fauna of the Indian region including India, Bangladesh, Pakistan, Burma and Ceylon.

The following characters have been studied in more detail :

Antennae.—Highly variable but taxonomically of great importance. These are either bipectinate upto the tip as in the case of *Catopta* (Text-fig. 1B) ; or unipectinate up to the tip as in *Cossus* (Text-fig. 3 A-B). The length of pectination decreases in several genera : In *Phragmataecia* it is three-fourths the length (Text-fig. 12 C-D) ; in *Xyleutes* and *Zeuzera* the pectination is in the basal half of the length (Text-fig. 25). The antennae are laterally flattened and simple in *Holcocerus* (Text-fig. 6A). In the female the antennae are variable, *i.e.*, either simple and ciliate, or shortly serrate or bipectinate (Text-fig. 12 E-F).

Ocelli.—All the Indian Cossidae are without ocelli except the two species of *Catopta* (Text-figs. 1B, 2B).

Labial palpi.—These are generally always present but are variable in shape and size.

Legs.—The legs have been found to be of considerable taxonomic importance, especially in differentiating the two subfamilies, *viz.* Cossinae and Zeuzerinae and the identity of genera. The former is generally characterised by having dilated hind tibiae, two pairs of hind tibial-spurs, tarsal spines and arolium. In the latter subfamily the hind tibiae are slender, with a single pair of spurs, the tarsal

spines may be present either on all the tarsal segments, or absent on one or more segments, and the arolium may be absent or present.

Venation.—The venation in both the wings is another character which helps in separating the two subfamilies and in determining the identity of the species, *e.g.* in Cossinae the veins R_s and M_1 are mostly connate in the hind wings unlike the case in Zeuzerinae where these veins are always wide separate. The position and origin of veins R_1 to R_3 and M_1 to M_3 , and median cell in the hind wing also offers an important diagnostic character for both the subfamilies.

Genitalia.—The male genitalia in case of Cossinae are characterised by the presence of gnathos which meet below the uncus, unlike in Zeuzerinae where they are free, if present, or completely absent. The shape and structure of uncus, clasper, juxta, aedeagus, etc., is of help in the identity of the different species.

The female genitalia have been studied, wherever available and have offered a good amount of help in the identity of various species, especially by the sclerotisation on dorsal or ventral, or both surfaces of the 8th segment, the shape and size of signum, if present, on the corpus bursae. However, it is observed that the female genitalic characters are quite variable.

IV—TAXONOMIC ACCOUNT

Family COSSIDAE Leach (1815)

- 1815. *Cossida* Leach, *Edinb. Encycl.*, 9 : 131.
- 1821. *Fodicantes teredines*, Hübner, *Verz. bek. Schmett.* : 195.
- 1829. *Zeuzeridi* Boisduval, *Eur. Lep. Index Meth.* : 51.
- 1832. *Zeuzeridae* Newman, *Ent. Mag.* : 68.
- 1832. *Cossidae* Newman, *Ent. Mag.* : 68.
- 1832. *Phalaenina cossites* Newman, *Ent. Mag.* : 68.
- 1834. *Zeuzerides* Boisduval, *Icon. Syst. Lep. Eur.*, 2 : 173.
- 1840. *Zeuzerides* Boisduval, *Gen. et. Index Meth. Eur. Lep.* : 75.
- 1843. *Cossides* Herrich-Schäffer, *Syst. Bearb. Schmett. Eur.* 2 : 14.
- 1854. *Cossina* Herrich-Schäffer, *Samml. Ausser. Schmett.* : 58.
- 1856. *Cossidae*, Walker, *List Lep. Brit. Mus.*, 7 : 1509.
- 1862. *Cossidae*, Walker, *J. Linn. Soc. (Zool.)*, 6 : 177.
- 1865. *Cossidae*, Walker, *List Lep. Brit. Mus.*, 32 : 582.
- 1865. *Cossidae*, Moore, *Proc. zool. Soc. Lond.* : 822.
- 1867. *Cossidae*, Moore, *Proc. zool. Soc. Lond.* : 886.
- 1877. *Cossidae*, Moore, *Ann. Mag. nat. Hist.*, (4) 20 : 348.
- 1879a. *Cossidae*, Moore, *Proc. zool. Soc. Lond.* : 411.
- 1879b. *Cossidae*, Moore, *Descr. Indian Lep. Atk.* : 85.
- 1880. *Cossidae*, Butler, *Ann. Mag. nat. Hist.*, (5) 6 : 68.
- 1881. *Cossidae*, Moore, *Proc. zool. Soc. Lond.* : 327.
- 1882. *Cossidae*, Butler, *Ann. Mag. nat. Hist.*, (5) 10 : 228.
- 1883. *Cossidae*, Moore, *Lep. Ceylon*, 2 : 153.

1884. *Cossidae*, Staudinger, In Romanoff *Memoir. Lep.*, 1 : 1.
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 1894. *Cossidae*, Swinhoe, *Ann. Mag. nat.-Hist.*, (6) 14 : 440.
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 1894a. *Cossidae*, Neumoegen & Dyar, *J. N. Y. ent. Soc.*, 1 : 97.
 1894b. *Cossidae*, Neumoegen & Dyar, *J. N. Y. ent. Soc.*, 2 : 1.
 1895. *Cossidae*, Swinhoe, *Trans. ent. Soc. Lond.* : 29.
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 1925. *Cossidae*, Handlirsch, *Handb. Ent.*, 3 : 893.
 1926. *Cossidae*, Tillyard, *The Insects of Australia and New Zealand* : 416.
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 472.
 1940. *Cossidae*, Daniel, *Mitt. münch. ent. Ges.*, 30 : 1004.
 1941. *Cossidae*, Beeson, *The Ecology and Control of Forest Insects of India
 and Neighbouring Countries* : 572.
 1945. *Cossidae*, Gardner, *J. Bombay nat. Hist. Soc.*, 45 (3) : 390.
 1945. *Cossidae*, Sevastopulo, *J. Beng. nat. Hist. Soc.*, 19 : 113.
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 1949. *Cossidae*, Daniel, *Mitt. münch. ent. Ges.*, 35-39 : 226.
 1951. *Cossidae*, Essig, *College Entomology* : 444.
 1951. *Zeuzeridae*, Essig, *College Entomology* : 445.
 1951b. *Cossidae*, Viette, *Lambillionea*, 51 (5-12) : 37.
 1954. *Cossidae*, Brues, Melander & Carpenter, *Bull. Mus. comp. Zool. Harv.*,
 128 : 232.

1955. *Cossidae*, Daniel, *Mitt. münch. ent. Ges.*, 44-45 : 159.
 1955. *Cossidae*, Roepke, *Trans. R. ent. Soc. Lond.*, 107 : 281.
 1956. *Cossidae*, Daniel, *Mitt. münch. ent. Ges.*, 46 : 243.
 1956. *Cossidae*, Clench, *Ann. Mag. nat. Hist.*, (12) 9 : 897.
 1957. *Cossidae*, Clench, *Mitt. münch. ent. Ges.*, 47 : 122.
 1957. *Cossidae*, Roepke, *Verh. k. ned. Akad. Wet. Afd. Nat.*, (2) 52 (1) : 1.
 1957. *Cossidae*, Imms, *A General Textbook of Entomology* : 543.
 1958. *Cossidae*, Clench, *Mitt. münch. ent. Ges.*, 48 : 82.
 1959a. *Cossidae*, Clench, *Revue fr. Ent.*, 26 : 44.
 1959b. *Cossidae*, Clench, *Veröff. zool. Stsamml. Münch.* 6 : 1.
 1959. *Cossidae*, Daniel, *Mitt. münch. ent. Ges.*, 49 : 102.
 1961. *Cossidae*, Daniel, *Mitt. münch. ent. Ges.*, 51 : 160.
 1962. *Cossidae*, Daniel, *Z. Arb. Gen. öst. Ent.*, 14 (1) : 6.
 1962. *Cossidae*, Comstock, *Introduction to Entomology* : 601.
 1962. *Cossidae*, Agrawal and Agrawal, *Curr. Sci.*, 29 (8) : 311.
 1965. *Cossidae*, Arora, *Bull. syst. Zool.*, 1 (1) : 25.
 1965. *Cossidae*, Daniel, *Mitt. münch. ent. Ges.*, 55 : 77.
 1965. *Cossidae*, Müller, *Dt. ent. Z.*, 12 (3) : 181.

(a) *Characters of the Family COSSIDAE* Leach

The main features of the family Cossidae are as follows :-

Moths of medium to large size. Frons smooth. Antennae in male usually bipectinate ; in female usually simple and minutely ciliate ; eyes generally smooth and large ; ocelli absent (except in *Catopta* and *Pseudocossus*) ; proboscis usually atrophied ; labial palpi variable in size, being well developed to obsolete ; maxillary palpi absent. Frenulum in male generally in the form of a single stout spine, sometimes short and functionless ; in female the number of frenulum spines generally vary from 2 to 3, sometimes up to 30.

Fore wings : Generally with an areole ; vein Sc free ; $R_4 + R_5$ stalked ; median vein strong and usually forked in the cell ; Cu_2 present ; two anal veins present, 2A forming a fork with 1A. Hind wings broad ; Sc either free or connected with Rs by a short cross bar ; median and Cu_2 as in fore wing ; three anal veins present, 2A forming a fork with 1A, 3A short and close to the anal margin.

(b) *General remarks on the classification of the Family COSSIDAE* Leach

Family Cossidae was subdivided for the first time, by Neumoegen and Dyar (1894), into two subfamilies, viz. Cossinae and Zeuserinae. The classification was followed by Tillyard (1926), Gaede (1933), Mehta (1933), Bryk (1937), Dyar (revised by Schaus) (1937), Clench (1959b), Comstock (1962) and Daniel (1962, 1965). Berger (1957), however, separated the Indian genus *Dudgeonea* Hampson into a distinct family Dudgeonidae on account of the presence of tympanic organ and proposed two subfamilies of the family Cossidae, viz.

Cossinae and Eulophonotinae. He obviously included whole of the Cossid fauna under the subfamily Cossinae. Handlirsch (1925), Janse (1932) and Brues, Melander and Carpenter (1954) went a step further by treating Cossidae in a very broad sense and included several families as its subfamilies, *viz.* *Argyrotypinae*, *Cossinae*, *Eulophonotinae*, and *Metarbelinae*, and further classified the subfamily Cossinae into several tribes, including Cossini and Zeuzerini. While Turner (1918) believed Cossidae as a compact group and considered rather impossible to divide it, for he commented (p. 166) "that this is a natural and compact family not divisible naturally even into subfamilies. There is, it is true, a considerable and very interesting degree of variation in several directions, but all these lines of development are linked together by forms of intermediate structure." Essig (1951), on the other hand, recognised both Cossidae and Zeuzeridae as distinct families under the superfamily Cossoidea, and not as subfamilies of Cossidae.

In the present work the earliest classification, as proposed by Neumoegen & Dyar (1894), has been followed, though the basis of classification has been modified in the light of present study, *i.e.*, several important characters have been taken into account, *e.g.* the antennae in male, the origin of veins Rs and M_1 in hind wing, the hind-tibiae, and in the male genitalia the gnathos, which define rather clearly both Cossinae and Zeuzerinae unlike the earlier system of classification based on more or less a single character.

(c) *Key to Subfamilies of the Family COSSIDAE*

Only two subfamilies of the family Cossidae are represented in the Indian subregion, and have been based on the following key :

Antennae in male pectinate up to the tip, sometimes simple and flattened ; veins Rs and M_1 generally connate or stalked, rarely separate ; hind tibiae dilated, usually with two pairs of tibial spurs ; gnathos in the male genitalia present, and meeting below the uncus

Cossinae Neumoegen & Dyar

Antennae in male pectinate only in basal half to three-fourths of length, never simple and flattened ; veins Rs and M_1 separate, never connate or stalked ; hind tibiae not dilated, with a single pair of tibial spurs ; gnathos either absent, or free, if present

Zeuzerinae Neumoegen & Dyar

Subfamily (i) COSSINAE Neumoegen & Dyar

- 1894a. *Cossinae* Neumoegen and Dyar, *J.N.Y. ent. Soc.*, 1 : 97.
 1894b. *Cossinae* Neumoegen and Dyar, *J.N.Y. ent. Soc.*, 2 : 1.
 1925. *Cossinae*, Handlirsch, *Handb. Ent.*, 3 : 893.
 1926. *Cossinae*, Tillyard, *The Insects of Australia and New Zealand* : 416.
 1929. *Cossinae*, Seitz, in *Seitz Macrolepidoptera of the World*, 14 : 539.
 1932. *Cossinae*, Janse, *The Moths of S. Africa* : 61.
 1933. *Cossinae*, Mehta, *Rec. Indian Mus.*, 35 : 231.
 1937. *Cossinae*, Bryk, *Lepid. Cat.*, 81 : 3.
 1937. *Cossinae*, Dyar, in *Seitz Macrolepidoptera of the World*, 6 : 1265.
 1954. *Cossinae*, Brues, Melander & Carpenter, *Bull. Mus. comp. Zool. Harv.*, 128 : 234.
 1955. *Cossinae*, Daniel, *Mitt. münch. ent. Ges.*, 44-45 : 159.
 1959b. *Cossinae*, Clench, *Veröff. zool. Stsamml. Münch*, 6 : 15.
 1962. *Cossinae*, Comstock, *Introduction to Entomology* : 601.
 1965. *Cossinae*, Daniel, *Mitt. münch. ent. Ges.*, 55 : 77.

Type-genus : *Cossus* Fabricius (1794).

(a) Characters of the Subfamily COSSINAE

Insects of medium size. Antennae in male 'pectinate up to tip or simple and laterally flattened ; in female generally simple, sometimes with short pectination. Labial palpi well developed, upturned and closely appressed to face, with the third segment short. Proboscis absent. Middle tibiae with a single pair of spurs ; hind tibiae having two pairs of spurs and dilated ; tarsal spines well developed and present on all segments ; tarsal claws with a distinct arolium. Frenulum in the form of a single bristle in the male and eight to ten bristles in the female ; retinaculum generally elongate and simple.

Fore wings with the areole usually small to moderately large, rarely absent ; vein R_1 arises from cell ; median vein usually forked in the cell ; M_2 and M_3 from above the lower angle of cell. Hind wings usually without cross bar between vein Sc and the cell ; Rs and M_1 connate or shortly stalked, rarely separate ; median as in fore wings.

Male genitalia with socii present ; gnathos present, arms fused below the uncus. Female genitalia variable.

(b) General remarks on the Indian COSSINAE

The present study is based on 12 species belonging to the following genera : *Catopta* Staudinger (two species), *Cossus* Fabricius (five species), *Eremocossus* Hampson (one species), *Holcocerus* Staudinger (two species) and *Paracossus* Hampson (two species).

The genus *Catopta* is mainly Palaearctic. Daniel (1940) transferred one of the Indian species, *Cossus cashmirensis* Moore, to this genus and later (1961) recorded the species from China. Another species described recently by the author (Arora, 1965) is transferred now to this genus. The genus *Cossus* is based on the study of five species, one of which, namely *Cossus greeni*, is new to science. The genus *Holcocerus*, like *Catopta*, was hitherto not reported from India till Daniel (1959) transferred one of the species of the genus *Cossus*, namely *C. rufidorsia* Hampson (from Sikkim), to this genus. In the present study this species from Assam (coll. S.K. Tandon and G. S. Arora, 1966) and another palaearctic species, viz. *Holcocerus arenicola* (Staudinger) from India (Great Nicobar Islands) are being reported for the first time. The genus *Paracossus* Hampson is represented by only two species, namely *P. furcata* Hampson and *P. parva* Hampson.

(c) Key to the Indian Genera of the subfamily COSSINAE

1. Ocelli generally present ; antennae in male always bipectinate ; claspers in the male genitalia short, simple, without any sclerotisation and spinabasis ; aedeagus short, slender and always with short spines *Catopta* Staudinger

- Ocelli absent ; antennae in male either bipectinate, or unipectinate or simple ; claspers short or long, usually with the inner side sclerotised and with spinabasis ; aedeagus short or long, and with or without spines 2

2. Antennae unipectinate in male. Clasper in male with generally L-shaped, or somewhat reduced, spinabasis *Cossus* Fabricius

- Antennae in male bipectinate or simple 3

3. Hind wing with veins Rs and M₁ stalked *Eremocossus* Hampson

- Hind wing with Rs and M₁ either connate or free 4

4. Antennae in male simple ; median vein forked in both wings ; clasper in the male genitalia with L-shaped spinabasis *Holcocerus* Staudinger.

Antennae in the male bipectinate ;
 median unforked in both wings ;
 claspers with inverted T-shaped
 spinabasalis

Paracossus Hampson

Genus *Catopta* Staudinger

1899. *Catopta*, Staudinger, *Dt. ent. Z. Lep.* : 157.
 1901. *Catopta*, Staudinger and Rebel, *Cat. Lep. Pal. Fngeb.*, 1 : 407.
 1912. *Catopta*, Seitz, in Seitz *Macrolepidoptera of the World*, 2 : 425.
 1923. *Catopta*, Dalla-Torre, *Lepid. Cat.*, 29 : 4.
 1940. *Catopta*, Daniel, *Mitt. münch. ent. Ges.*, 30 : 1015.
 1951. *Catopta*, Viette, *Lambillionea*, 51 (5-12) : 39.
 1961. *Catopta*, Daniel, *Mitt. münch. ent. Ges.*, 51 : 174.
 1965. *Catopta*, Müller, *Dt. ent. Z.*, 12 (3) : 189.

Type-species : *Cossus albonubilus* Graeser

(a) General

The genus *Catopta* was erected by Staudinger (1899) to include the palaeartic species *Cossus albonubilus* Graeser. Daniel (1940) transferred one of the Indian species of the genus *Cossus* Fabricius to this genus, and later (1951) included two more species, *viz.* *acronyctoides* (Moore) and *pallidalae* Hampson, on the basis of the long-hairy appearance of the insect, antennae bipectinate up to the tip, thin labial palpi, broad wings, and long abdomen. He also made the genitalic studies of *cashmirensis* and *albonubilus*. The present study, however, shows that both *acronyctoides* and *pallidalae* do not belong to this genus due to absence of all the above-mentioned characters and are placed in the genera *Cossus* Fabricius and *Phragmataecia* Newman, respectively.

(b) Characters of the Genus *Catopta* Staudinger

Antennae bipectinate up to the tip. Ocelli well developed. Labial palpi short and slender. Fore wings very broad. Hind wings with the retinaculum short, narrow and bar-shaped, curved at its tip. Legs with the tibiae dilated from near the base ; tarsal spines well developed, present on all the segments ; arolium well developed.

Fore wings with moderately long areole ; vein R_1 arises from cell ; R_2 from the distal one-third of the areole ; R_3 connate or connected by a short cross bar with the stalk of veins $R_4 + R_5$; M_1 either from angle or from below the angle of the cell ; M_2 and M_3 close and arise from above the lower angle ; Cu_{1a} from angle ; median vein forked in the cell and forming the median cell, with its branches ending between M_1-M_2 and M_2-M_3 ; other veins as described under the family. Hind wings with the vein Sc free ; Rs connate with M_1 ;

median forked, forming median cell ; the branches of median and other veins as in fore wing.

Claspers in male genitalia short, broad at the base and with a costal hump in the middle ; gnathos short, arms meeting mid-ventrally below uncus ; aedeagus simple and with a few distal spines. Female not known.

(c) *Relationships of the Genus Catopta with the other allied Genera*

The genus *Catopta* resembles other Cossinae genera, viz. *Cossus*, *Holcocerus* and *Paracossus* Hampson, by the presence of dilated hind-tibiae having two pairs of tibial spurs, but, however, differs in having well developed ocelli, bipectinate antennae having long rami, and well developed retinaculum. In the male genitalia the gnathos present, arms unite rather directly below uncus ; claspers small, each with a costal hump.

Other than Ethiopian genus *Pseudocossus* Kenrick, this is the only genus having ocelli. It, however, differs from *Pseudocossus* by the presence of stalked vein $R_4 + R_5$, forked median in both wings and in the uncus being not bifid, unlike in *Pseudocossus* where all the veins are free, median unforked and the uncus bifid.

(d) *Geographical distribution of the Genus Catopta*

The genus *Catopta* is distributed in the Palaearctic (mainly China, U.S.S.R., Iran, Afganistan, Algeria and Tibet) and Oriental (India) regions.

(e) *Key to the Indian Species of the Genus Catopta*

Antennae of male with 67 segments and long branches. Fore wing with the vein R_3 connate with the stalk of veins $R_4 + R_5$; M_1 arises from angle of cell. Uncus, in male genitalia, long and narrowly curved, about two-and-a-half times as long as its width in middle ; each clasper with a strong medial hump ; aedeagus with a few spines. Male 42 mm.

cashmirensis (Moore)

Antennae of male with 61-66 segments, the branches short. Fore wing with the vein R_3 separate from $R_4 + R_5$; M_1 arises from below the angle. Uncus short and rounded, about twice as long as its width ; each clasper with a weak medial hump ; aedeagus with numerous spines. Male 44-46 mm.

sikkimensis (Arora)

*(f) Descriptions of Species*1. *Catopta cashmirensis* (Moore)

(Plate I, fig. 1 ; Text-fig.1)

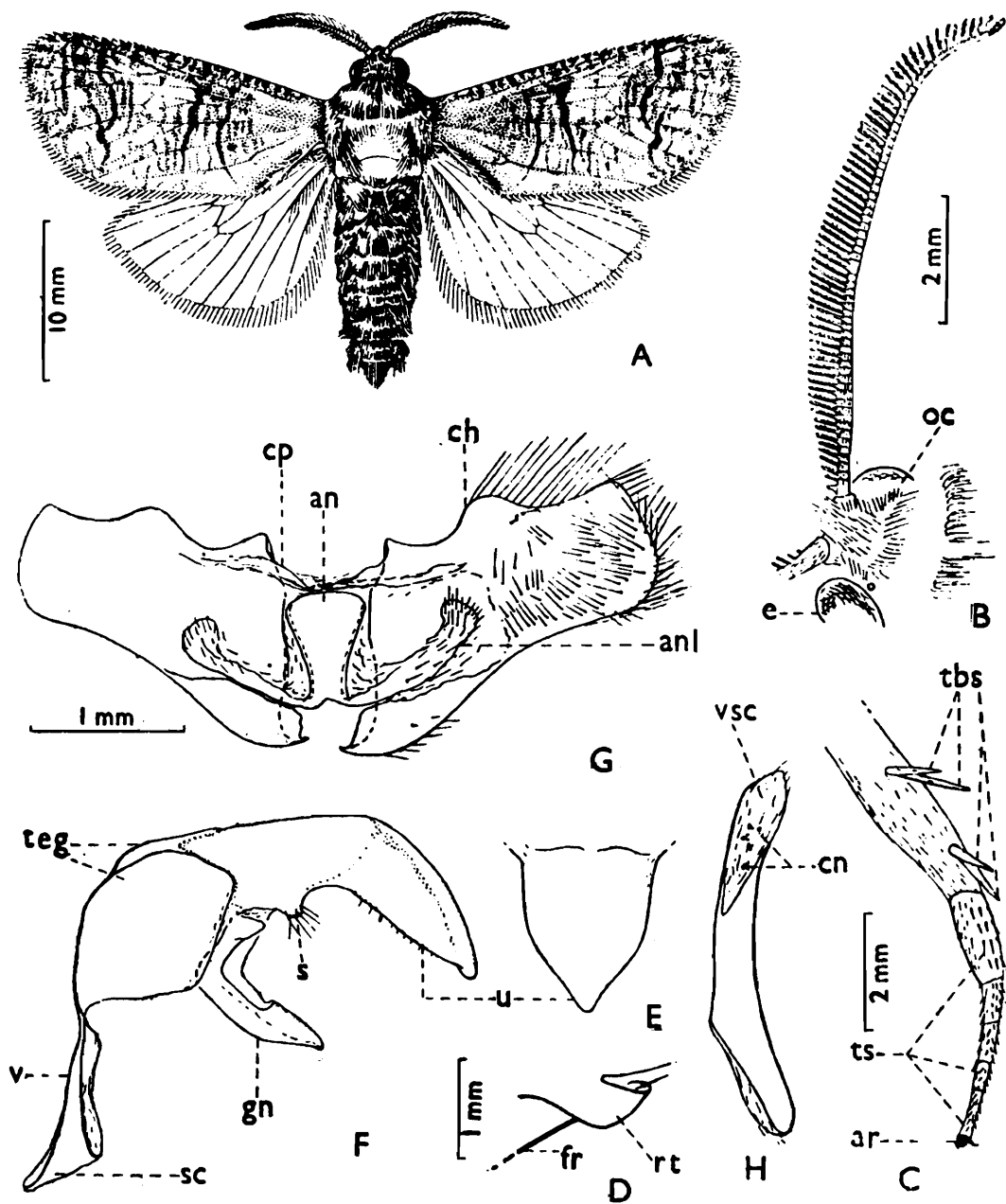
- 1879b. *Cossus cashmirensis* Moore, *Descr. Indian Lep. Atk.* : 87 (Type loc.-Tawi, Jammu & Kashmir, India)
1887. *Cossus cashmirensis*, Cotes and Swinhoe, *Cat. Moths of India*, 2: 232.
1892. *Trypanus cashmirensis*, Kirby, *Cat. Lep. Het.*, 1 : 862.
- 1892b. *Cossus cashmirensis*, Hampson, *Fauna Brit. India, Moths*, 1 : 305
1905. *Cossus cashmirensis*, Hampson, *J. Bombay nat. Hist. Soc.*, 16 : 194.
1940. *Catopta cashmirensis*, Daniel, *Mitt. münch. ent. Ges.*, 30 : 1015.
1961. *Catopta cashmirensis*, Daniel, *Mitt. münch. ent. Ges.*, 51 : 187.
1965. *Catopta cashmirensis*, Daniel, *Mitt. münch. ent. Ges.*, 55 : 105.

Type : A male in Ber. Mus.

Head with the frontal tufts and labial palpi blackish brown. Antennae brown beneath, with the branches cinerous grey above. Vertex cinerous grey. Thorax and fore wings on the upper side cinerous grey, the latter darker at base and paler medially. Fore wings (Pl. I, fig. 1, Text-fig. 1A) marked by several pale-greyish black, irregular, wavy lines across the length ; in the medial area striae coalesce into irregular lines, the prominently marked ones being between the cell and Cu_2 ; in the postmedial area also the striae coalesce to form wavy and irregular lines, the prominent one being between subapical margin and tornal angle at Cu_{1b} ; some scales along the discocellulars, up to the base of areole, pale brown. Hind wings and abdomen fuliginous brown above, with tufts of long hair. The former unmarked. Legs dark brown. Underside of wings pale brown, with dark brown reticulations and streaks, those on the hind wing prominent ; thorax and abdomen pale-cinerous grey.

Antennae (Text-fig. 1A, B) about 8 mm. long ; bipectinate up to tip, the rami short at base, increasing in length gradually up to the middle and thereafter decreasing, the longest ones as long as seven segments in middle ; the shaft with about 67 segments ; basal segments about twice as broad as their length, apical segments gradually becoming long and narrow towards the tip. Labial palpi short, about 1.5 mm. and porrect, not extending beyond the frontal tufts. Ocelli (Text-fig. 1B) and legs (Text-fig. 1C) as given for the genus.

Venation, in general, as described for the genus except that vein M_1 in the fore wing arises from upper angle of cell.



Text-fig. 1. *Catopta cashmirensis* (Moore): (A) An outline drawing of the male type. (B) Male antennae showing pectinations of one side. (C) A portion of the hind leg showing two pairs of tibial spurs and the tarsal spines. (D) Retinaculum, with a portion of frenulum. (E) Uncus in a dorsal view. (F) Male genitalia in a lateral view, without claspers. (G) Claspers in an inner view, with anellus. (H) Aedeagus. (E to H of the same magnifications).

Genitalia.—Male (Text-fig. 1 E-H); Uncus broadly triangular, about two-and-a-half times as long as its width in middle and strongly bent from middle downwards. Gnathos short, ribbon-like, bent strongly inwards, meet each other in middle and folded to enclose a small cavity. Tegumen short and broad; vinculum narrow and

ending in a very short saccus. Clasper short, not extending beyond uncus in a normal course, highly raised mid-dorsally into a hump and curved ventrally outwards at the distal end ; about three times as long as its width at the distal end. Juxta short and broadly conical, with two membranous lobes. Aedeagus short, with a few extremely short spines on vesica. Female : Not known.

Measurements.—Expanse : fore wing, 42 mm. Length : fore wing, 19.5 mm. ; hind wing, 15 mm. ; abdomen, 10.5 mm. ; whole body, 19 mm.

Material examined.—One male (holotype) labelled as “Original, Tawi, Kashmir (coll. Atkinson, coll. Staudinger)” (ex. colln. Ber. Mus.).

Distribution.—India (J. & K.). Also China.

Remarks.—Hampson (1892b) considered this species as a synonym of *Cossus acronyctoides*, treating it as latter's form, and stated (p.305): “The form *cashmirensis* has some of the striae of the fore wing coalescing into somewhat prominent lines, the best marked being one across end of cell, one beyond the cell from vein 6 to 3, and one from the costa before the apex, but these are somewhat variable” Later he (1905) revived the species *cashmirensis* by the following remarks (p. 194) “It is a distinct species from *acronyctoides*, the antennae bipectinate with branches long at the base while in the latter they are unipectinate with the branches short at the base, then increase in length before middle. The former is larger broad winged insect with markings dark” Daniel (1961), while studying *Catopta cashmirensis*, referred to Hampson (1892b), Seitz (1912) and Gaede (1933) but there is no reference to the revival of the species by Hampson (1905) which is quite important especially in the light of observations made by Daniel (1961), who, however, rightly transferred it to the genus *Catopta*. He figured the male genitalia of the species, collected from “North-Yuennan, Li-Kiang”, and “Nw-Karakorum ; Hunza Nagar, Kuto-Darukust”, and identified respectively as “*Catopta cashmirensis* Moore” and *Catopta cashmirensis* Mr. ssp.” The latter was differentiated from the former mainly by the presence of a well developed costal hump in the middle of the clasper. The male genitalia of the holotype of *Catopta cashmirensis* (Moore), however, shows that the clasper has a distinct hump in the middle (Text-fig. 1G), contrary to the observations by Daniel (1961), i.e. the undescribed subspecies of Daniel (1961) resembles the holotype in this respect. It is quite likely that the hump on the clasper is a variable character and not much reliance be given.

C. cashmirensis (Moore) is closely related to the other known species from India, viz. *C. sikkimensis* (Arora) mainly in respect of

the presence of well developed ocelli, the wing venation, and the male genitalia in general. The two species, however, differ in the number of antennal segments and the length of rami, in the wing pattern, and in the shape of uncus in the male genitalia. For detailed differences see under *sikkimensis*.

2. *Catopta sikkimensis* (Arora) comb. nov.

(Pl. I, fig. 2; Text-fig. 2)

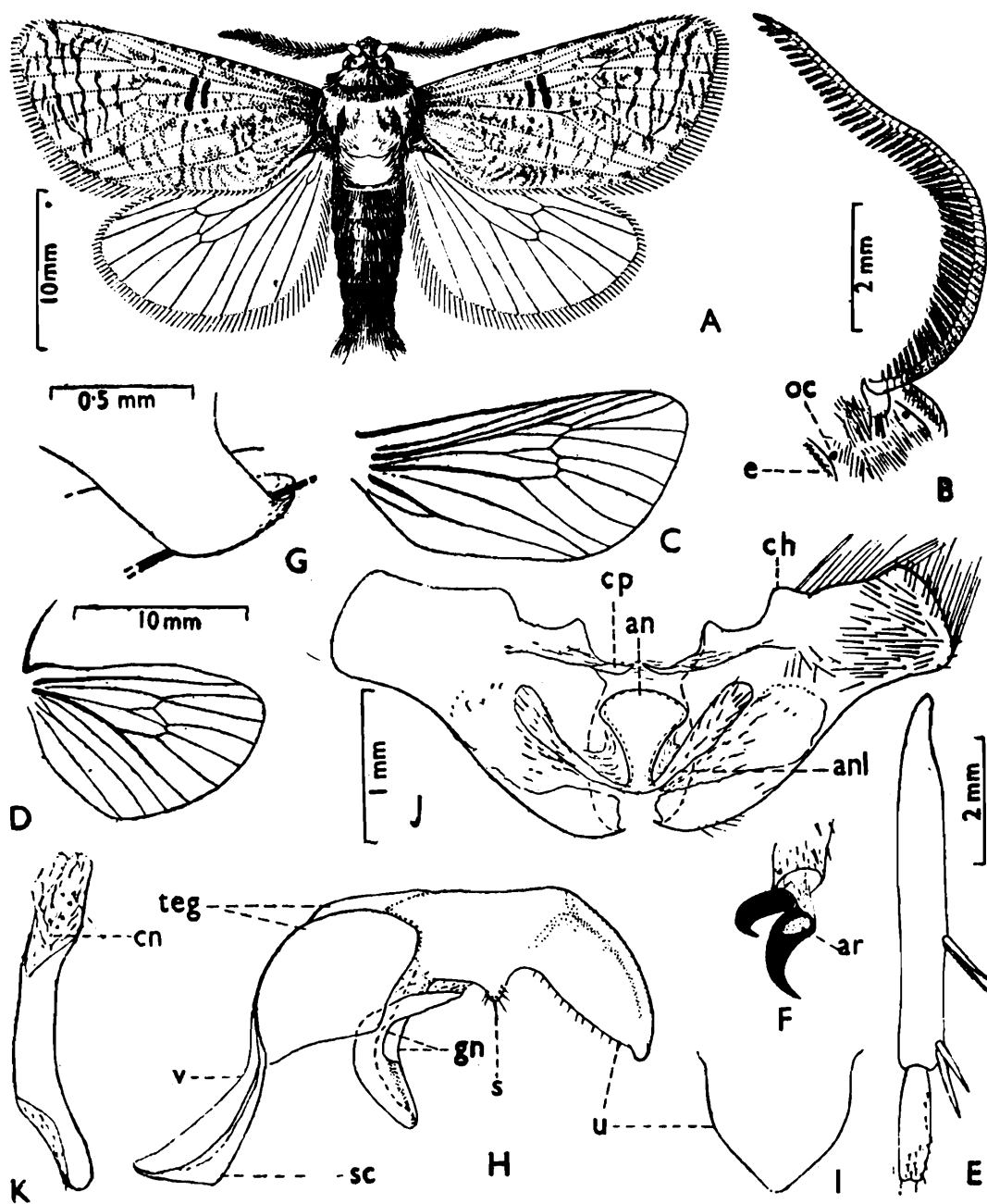
1965. *Cossus sikkimensis* Arora, *Bull. syst. Zool.*, **1** (1) : 25. (Type loc.-Sikkim : Northern Sikkim, Dambung, 298 mm.).

Type : A male in the N.Z.C. at Z.S.I.

Head and abdomen brown, the latter with tufts of scales at the base and extremity. Frontal tufts and labial palpi blackish brown. Antennae brown throughout, without prominent cinerous greyish scaling above. Fore wings brown, darker basally; marked (Text-fig. 2A) with several dark striae across the wing; striae mostly coalescent or partly so beyond the cell in the postmedial and submarginal areas, two striae across the middle of cell broader and darker in colour, one between areole and vein Cu_2 and the other confined to the cell itself; those beyond the cell and between veins R_4-Cu_{1b} prominent only at postmedial area; postmedial line double, with the inner line curved and ending at vein 1A at the inner margin and the outer one curved outwards and ending at vein Cu_{1b} at the tornal angle; subapical area with some prominent striae from the apex to vein M_2 , others forming very wavy, irregular and indistinct lines. Hind wings fuscous brown, with some shine on the costal border. Thorax and abdomen above slightly darker than the underside. Underside with prominent striae on the hind wing which is unmarked on the upperside. Legs at the base darker; tarsal segments with white scaling.

Antennae (Text-fig. 2B) bipectinate up to tip, shaft with 61-66 segments; the rami short and broad at the base, thereafter increasing in length gradually up to the middle and again decreasing in length apically, the longest rami as long as five to six segments in the middle, terminal segment without pectination. Labial palpi short, about 2 mm. long, slender and porrect, slightly reaching the frontal tufts. Wings broad. Fore wings deeply angled near the base; outer margin nearly straight. Ocelli (Text-fig. 2B), legs' spines, spurs, etc. (Text-fig. 2E), and frenulum and retinaculum (Text-fig. 2G) as for the genus.

Venation (Text-fig. 2 C-D) typically *Catopta*-type except that vein M_1 in fore wing arises from well below the angle of cell.



Text-fig. 2. *Catopta sikkimensis* (Arora): (A) An outline drawing of the male paratype. (B) Male antenna showing pectinations of one side. (C) and (D) Fore and hind wing venation, respectively. (E) A portion of the hind leg showing two pairs of tibial spurs and a few tarsal spines. (F) Tarsal claws showing arolium. (G) Retinaculum, with a portion of frenulum. (H) Male genitalia in a lateral view, without claspers. (I) Uncus in a dorsal view. (J) Claspers in an inner view, with anellus. (K) Aedeagus. (C—D; F—G; H to K of the same magnifications).

Genitalia.—Male (Text-fig. 2 H—K) : Uncus broadly triangular, about twice as long as its width in middle; broader in the middle,

and then narrowing distally and ending into a broadly pointed apex. Gnathos present, narrow ribbon-like and curved inwards, meeting each other by their inner margin. Tegumen short and broad; vinculum extremely narrow, continuous ventrally into a short saccus. Claspers as in *cashmirensis* but with a somewhat weaker mid-dorsal hump. Juxta narrowed at base; otherwise as in generic characters. Aedeagus short and slender as in *cashmirensis*, but with more spines on the vesica.

Measurements.—Expanse: fore wing, 44-46 mm. Length: fore wing, 20.5 mm.; hind wing, 16 mm., abdomen, 11 mm.; body, 19 mm.

Material examined.—2 ♂♂ : Sikkim : Dambung (Northern Sikkim) 298 m., 10.vii.1959 (A. G. K. Menon coll.). One holotype (Regd. no. 1098/H10) and one paratype (Regd. no. 1099/H10).

Distribution.—Sikkim.

Remarks.—This species resembles *Catopta cashmirensis* (Moore) in having well developed ocelli, a costal hump on the clasper in the male genitalia, and in general hairy-appearance. This species, however, differs from the other species in having less number of antennal segments, i.e., 61-66, by the origin of veins R_3 and M_1 in the fore wing, and by the shorter uncus in the male genitalia. The aedeagus, in the male genitalia, also has numerous spines (very few in *cashmirensis*).

Genus *Cossus* Fabricius

1794. *Cossus*, Fabricius, *Syst. Ent.*, 3 (2) : 3.
 1834. *Cossus*, Boisduval, *Icon. Hist. Lep. Nouv.*, 2 : 178.
 1840. *Cossus*, Boisduval, *Gen. et. Index Meth. Eur. Lep.* : 75.
 1856. *Cossus*, Walker, *List. Lep. Brit. Mus.*, 7 : 1510.
 1865. *Cossus*, Walker, *List. Lep. Brit. Mus.*, 32 : 582.
 1865. *Cossus*, Moore, *Proc. zool. Soc. Lond.* : 822.
 1866. *Trypanus*, Rambur, *Cat. Syst. Lep. Andal.*, 2 : 326.
 1877. *Cossus*, Piepers & Snellen, *Tijdschr. Ent.*, 20 : 22.
 1889. *Cossus*, Cotes and Swinhoe, *Cat. Moths of India* : 232.
 1892b. *Cossus*, Hampson, *Fauna Brit. India, Moths*, 1 : 305.
 1892. *Trypanus*, Kirby, *Cat. Lep. Het.*, 1 : 860.
 1892. *Cossus*, Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.*, 1 : 284.
 1899. *Cossus*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 : 645.
 1900. *Trypanus*, Piepers & Snellen, *Tijdschr. Ent.*, 43 : 37.
 1901. *Cossus*, Staudinger & Rebel, *Cat. Lep. Pal. Fnggeb.*, 1 : 406.
 1903. *Cossus*, Poujade, *Bull. Soc. ent. Fr.* : 122.
 1905. *Cossus*, Schaus, *Proc. U.S. Nat. Mus.*, 29 : 340.
 1909. *Cossus*, Lefroy, *Indian Insect Life* : 495.
 1912. *Cossus*, Seitz, in Seitz *Macrolepidoptera of the World*, 2 : 418.
 1914. *Cossus*, Bethune-Baker, *Trans. ent. Soc. Lond.* : 327.
 1917. *Cossus*, Chapman, *Ent. Rec.*, 29 (3) : 5.

1918. *Cossus*, Turner, *Trans. ent. Soc. Lond.*, **66** : 157, 158, 188.
 1923. *Cossus*, Dalla-Torre, *Lepid. Cat.*, **29** : 5.
 1929. *Cossus*, Gaede, in Seitz *Macrolepidoptera of the World*, **14** : 541.
 1933. *Cossus*, Gaede, in Seitz *Macrolepidoptera of the World*, **10** : 809.
 1941. *Cossus*, Beeson, *The Ecology and Control of Forest Insects in India and the Neighbouring Countries* : 572.
 1945. *Cossus*, Gardner, *J. Bombay nat. Hist. Soc.*, **45** (3) : 391.
 1951b. *Cossus*, Viette, *Lambillionea*, **51** (5-12) : 41.
 1956. *Cossus*, Daniel, *Mitt. münch. ent. Ges.*, **46** : 244.
 1957. *Cossus*, Roepke, *Verh. k. ned Akad. Wet. Afd. Nat.*, (2) **52** (1) : 6.
 1959b. *Cossus*, Clench, *Veröff. zool. St. Samml. Münch.*, **6** : 16.
 1965. *Cossus*, Müller, *Dt. ent. Z.*, **12** (3) : 193.
 1965. *Cossus*, Daniel, *Mitt. münch. ent. Ges.*, **55** : 84.

Type-species : *Phalaena Bombyx Cossus* Linn.

(a) General

Moore (1865) described for the first time one species from India (Calcutta), namely *Cossus cadambae* and added (1879b) another species, viz., *C. cashmirensis* from Kashmir, India. Hampson (1892b) considered the genus *Brachyilia* Felder as a synonym of *Cossus*. Viette (1951b) and Clench (1959b), however, do not agree with Hampson's synonymy. Hampson (*loc. cit.*) transferred *Brachyilia acronyctoides* Moore and *Zeuzera stigmatica* Moore to this genus, treated *cashmirensis* as a synonym of *acronyctoides*, and described three more species, viz., *nigromaculatus*, *pallidalae* and *parvipunctus*, from the Indian subregion. He further added (1895, 1905) a species each from Burma and Sikkim, respectively, and revived the species *cashmirensis* Moore, thus bringing the total number of species from the Indian region to nine. Turner (1918) transferred one of Hampson's species, viz. *Cossus parvipunctus* to the genus *Phragmataecia*. Dalla-Torre (1923), however, recorded eleven species, including *parvipunctus*, and two other species which are either not Indian or do not belong to this family. There was no addition to this genus till 1965, when a species, from Sikkim, was described by the author (*vide* Arora, 1965).

The present study of these species shows that two of these (10 species) belong to the genus *Catopta*, one to *Holcocerus* and three to *Phragmataecia*. Only four species, viz., *acronyctoides* (Moore), *cadambae* Moore, *nigromaculatus* Hampson and *fuscibasis* Hampson (*nec.* Gaede)*, are referred to the genus *Cossus*. Another new species, viz., *greeni*, is also described now.

*Gaede (1929) described a Cossid from Madagascar as *Cossus fuscibasis*. I have not been able to get the types of *fuscibasis* Hampson and *fuscibasis* Gaede, and therefore, cannot say whether these are two different species or not. But in case they are different, which is quite likely, *fuscibasis* Gaede should require a new name.

(b) Characters of the Genus Cossus Fabricius

Antennae in male pectinate up to the tip, in female pectination short, reduced and not up to tip. Proboscis absent. Labial palpi well developed, porrect, upturned and closely appressed to the face. Frenulum spine single in male, 8 to 10 in the female ; not held by the retinaculum. Tibiae and the spurs as in subfamily ; tarsi with three to four rows of spines ; arolium distinct.

Fore wing with a reduced areole ; median vein present in both wings and generally forked in cell, sometimes unforked in hind wings. Hind wing with the vein Sc free, rarely a cross bar present between Sc and the cell ; Rs and M₁ either connate or stalked, rarely separate.

Male genitalia with the gnathos fused below the uncus ; claspers generally with spinabasalis and well developed sclerotisation on the mesal side ; aedeagus long, narrow, with or without cornutus, and supported by the well developed anellus lobes.

(c) Relationships of the Genus Cossus with the other allied Genera

The genus *Cossus* resembles the other Cossid genera in respect of two pairs of tibial spurs, well developed tarsal spines, and gnathos, which meet in the middle below the uncus.

From *Catopta* it differs by the absence of ocelli and for having unipectinate antennae, and well-sclerotised claspers in the genitalia. From the genus *Eremocossus* it differs in veins Rs and M₁ in the hind wings being connate unlike in the *Eremocossus* where these are stalked ; from *Holcocerus* it differs in the unipectinate antennae, unlike simple and flattened in the latter ; and from the genus *Paracossus* for having a forked median vein in both the wings unlike unforked median in *Paracossus*.

(d) Geographical distribution of the Genus Cossus

The genus *Cossus* is universally distributed, with majority of the species are known from Ethiopian and Palaearctic regions. In the Indian subregion this genus is recorded from India (Kashmir, Delhi, Punjab, Madhya Pradesh, Bengal, Orissa, Maharashtra and Tamil Nadu), Sikkim, Pakistan, Burma and Ceylon. The genus is being recorded from Ceylon for the first time.

(e) Key to the Indian Species of the Genus Cossus

The following keys are given for only those species of which material was available for study.

1. Antennae, in male, with long and narrow branches, the longest rami, in the middle, about the size of three to four segments. Male genitalia with the uncus truncate and the aedeagus with cornuti *acronyctoides* (Moore)
- Antennae, in male, with short and broad branches and shortly bifurcate, the longest rami shorter than three segments. Male genitalia with the uncus rounded or truncate and the aedeagus with or without cornuti 2
2. Wings greyish-brown ; markings on the fore wing thin. Male genitalia with the uncus rounded apically and the aedeagus without cornuti *cadambae* (Moore)
- Wings dark-brown ; markings on the wings prominent and thick. Male genitalia with the uncus truncate and the aedeagus with cornuti *greeni* sp. n.

*(f) Description of Species*3. *Cossus acronyctoides* (Moore)

(Pl. I, fig. 3 ; Text-fig. 3)

1879. *Brachylia arconyctoides* Moore, *Proc. zool. Soc. Lond.* : 411 (Type loc.—Bombay, India).
1884. *Brachylia acronyctoides*, Swinhoe, *Proc. zool. Soc. Lond.* : 551.
1886. *Brachylia acronyctoides*, Swinhoe, *Proc. zool. Soc. Lond.* : 441.
1887. *Zeuzera acronyctoides*, Cotes & Swinhoe, *Cat. Moths of India* : 232.
- 1892b. *Cossus acronyctoides*, Hampson, *Fauna Brit. India, Moths*, 1 : 305.
1899. *Cossus acronyctoides*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 : 645.
1912. *Cossus acronyctoides*. Seitz, in *Seitz Macrolepidoptera of the World*, 2 : 420.
1923. *Cossus acronyctoides* Dalla-Torre, *Lepid. Cat.*, 29 : 6.
1938. *Cossus acronyctoides*, Gaede, in *Seitz Macrolepidoptera of the World*, 10.
1941. *Cossus acronyctoides*, Beeson, *The Ecology and the Control of Forest Insects in India and Neighbouring Countries* : 572.
1945. *Cossus acronyctoides*, Gardner, *J. Bombay nat. Hist. Soc.*, 45 (3) : 392.
1945. *Cossus acronyctoides*, Sevastopulo, *J. Beng. nat. Hist. Soc.*, 19 : 115
- 1961b. *Cossus acronyctoides*, Mathur & Singh, *Forest Bull. Dehra Dun*, 171 (9) : 5.
1961. *Catopta acronyctoides*, Daniel, *Mitt. münch. ent. Ges.*, 51 : 190.

Type : In B. M.

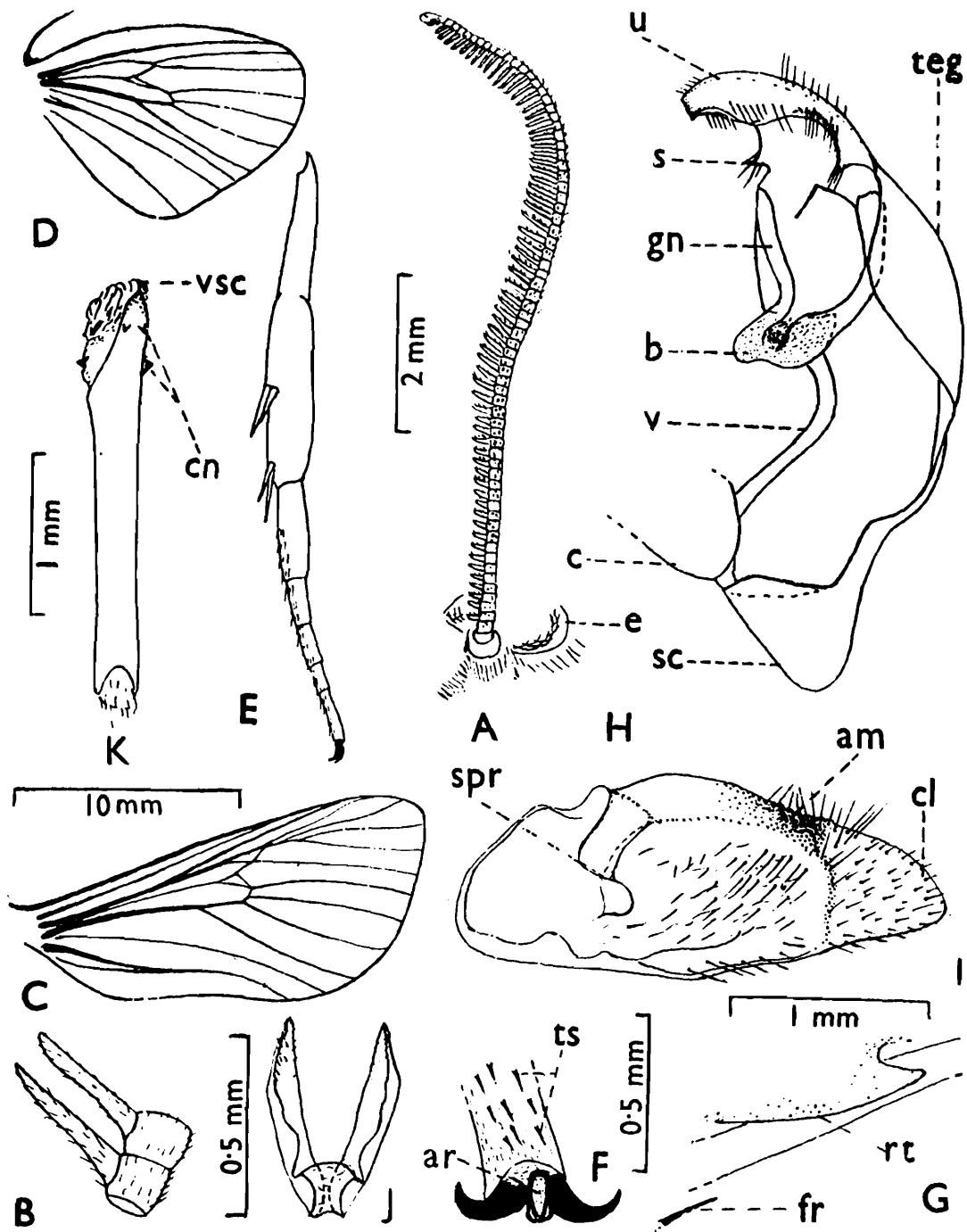
Hosts : *Tamarix articulata* (Punjab), Beeson (1941).

Head and abdomen dark brown. Frontal tufts and thorax greyish-brown. Vertex and antennae brown. Labial palpi greyish-brown beneath, darker on sides. Fore wings greyish-brown, darker in middle and greyish at apex; crossed by numerous short striae some of which coalesce into fine lines in the postmedial area, the most prominent being the subapical patch and the other between vein M_1 and Cu_{1b} . Hind wings brown; striae faint. Underside of wings dark brown, with more prominent striae.

Antennae (Text-fig. 3 A-B) unipectinate up to tip in male, uniseriate in the female; the shaft in male with 67 segments; rami short and broad at base, thereafter increasing in length up to the middle, the longest ones in the middle and as long as three to four segments. Labial palpi upturned, closely appressed to face and reaching beyond the frons; the third joint short. Wings broad (Text-figs. 3 C-D). Hind tibiae (Text-fig. 3E) with two pairs of spurs; tarsi with spines; arolium (Text-fig. 3F) about twice as long as its width in middle. Frenulum short and functionless (Text-fig. 3G); retinaculum short. Abdomen stout, longer than hind wings in both sexes.

Venation.—Fore wing (Text-fig. 3C) : Areole short, projecting about half its length out of the cell angle; R_3 stalked with $R_4 + R_5$ and as far from the areole as from R_4 ; M_1 arising from upper angle, sometimes from above it; median cell with its upper and lower branches ending between $M_1 - M_2$ and at M_2 , respectively; M_3 arising between Cu_{1a} and M_2 . Hind wing (Text-fig. 3D) ; Sc free; $R_s - M_1$ connate; median cell very short, with the branches ending between $M_1 - M_2$, the lower nearer M_2 ; M_3 nearer Cu_{1a} than to M_2 .

Genitalia.—Male (Text-figs. 3 H-K) : Uncus about twice as long as its width in the middle, broad at the base and narrowing distally; apex truncate and produced to an acuminate point directed downwards. Gnathos slender, curved and bent inwards and forwards to meet in the middle through a very fine spiny membrane (*bullu* of Roepke, 1957). Tegumen broad, indistinctly differentiated from uncus; vinculum slender; saccus broad. Claspers about two-and-a-half times as long as wide, with the inner side clearly differentiated into highly sclerotised and poorly dentate region, the ampulla, and membranous cucullus, the latter beset with fine setae; harpe poorly demarcated; costal prolongation short, with only a small lobe. Juxta formed of two short lobes, the latter open throughout on the outer side and with short blunt projection. Aedeagus long and narrow, with its distal portion broad and the apex pointed; distal portion with two short spines below the tip and one on each side. Female: Not studied.



Text-fig. 3. *Cossus acronyctoides* (Moore) : (A) Male antenna, with unipectinate branches. (B) Two antennal segments of (A) highly enlarged. (C) and (D) Fore and hind wing venation, respectively. (E) A portion of the hind leg, with two pairs of tibial spurs and the tarsal spines. (F) Tarsal claws with arolium. (G) Retinaculum, with a portion of frenulum. (H) Male genitalia in a latero-ventral view, without claspers. (I) A clasper in an inner view. (J) Anellus lobes. (K) Aedeagus. (A and E; C—D; and H to K of the same magnifications).

Measurements.—Wing expanse : Male, 43 mm. ; female, 51 mm. ; Length : Fore wing : Male, 18 mm. ; female, 22 mm. Hind wing : Male, 12 mm. ; female, 17 mm. Abdomen : Male, 16 mm. ; female, 15 mm. Whole body : Male, 23 mm. ; female, 22 mm.

Material examined.—Two examples : India : Maharashtra : Poona, 1 ♂, 15.x.1965 (B. S. Lamba coll.). Delhi, 1 ♂, 8.viii.1939 (Gullamullah coll.). At light (ex. colln. I.A.R.I.).

Distribution.—India (Kashmir, Madhya Pradesh, Orissa, Maharashtra, Tamil Nadu, Delhi, Punjab, Bengal, Sikkim) and Pakistan.

Remarks.—This was described as a species of the genus *Brachylia* Felder by Moore (1879b), but Hampson (1892b) considered it as a species of the genus *Cossus* Fabr., and referred it under the category (p. 305) "Fore wing with vein 6 from angle of cell ; the antennae of male bipectinate to tip", and synonymised *Cossus cashmirensis* Moore with it. Later he (1905) revived *cashmirensis* and differentiated *acronyctoides* on the basis of antennae, in males, which he stated as 'unipectinate with the branches short at the base' Daniel (1961), who studied a female from Bombay, however, transferred it to the genus *Catopta* mainly on the basis of published literature, specially that of Hampson (1892b), Seitz (1912) and Gaede (1933), but does not refer to Hampson's (1905) differentiation of *acronyctoides* from *cashmirensis*.

The male specimen, also from Bombay, which happens to be the type locality of this species, resembles in respect of its general appearance and genitalia with the photograph of the type received from B.M.

Cossus acronyctoides can be differentiated from *cadambae* by its antennae which are with long and narrow branches, whereas in the other species these are short and broad ; in respect of claspers in the male genitalia, it differs in having a smaller spinabasalis.

For differences from *greeni* sp. n., see under that species.

4. *Cossus cadambae* Moore

(Pl. I, fig. 4 ; Text-fig. 4).

1865. *Cossus cadambae*, Moore, *Proc. zool. Soc. Lond.* : 822 (Type loc.—Calcutta).
 1887. *Cossus cadambae*, Cotes & Swinhoe, *Cat. Moths of India*, 2 : 232.
 1892. *Cossus cadambae*, Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.*, 1 : 285.

1892. *Brachylia cadambae*, Kirby, *Cat. Lep. Het.*, 1 : 865.
 1892b. *Cossus cadambae*, Hampson, *Fauna Brit. India, Moths*, 1 : 306.
 1909. *Cossus cadambae*, Lefroy, *India Insect Life* : 405.
 1923. *Cossus cadambae*, Della-Torre, *Lepid. Cat.*, 29 : 6.
 1933. *Cossus cadambae*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 809.
 1941. *Cossus cadambae*, Beeson, *The Ecology and the Control of Forest Insects in India and Neighbouring Countries* : 572.
 1945. *Cossus cadambae*, Gardner, *J. Bombay nat. Hist. Soc.*, 45 (3) : 391.
 1945. *Cossus cadambae*, Sevastopulo, *J. Beng. nat. Hist. Soc.*, 19 : 115.
 1959. *Cossus cadambae*, Mathur & Singh, *Forest Bull. Dehra-Dun*, 171 (1) : 150.
 1961. *Cossus cadambae*, Mathur & Singh, *Forest Bull. Dehra-Dun*, 171 (9) : 16.

Type : In B.M.

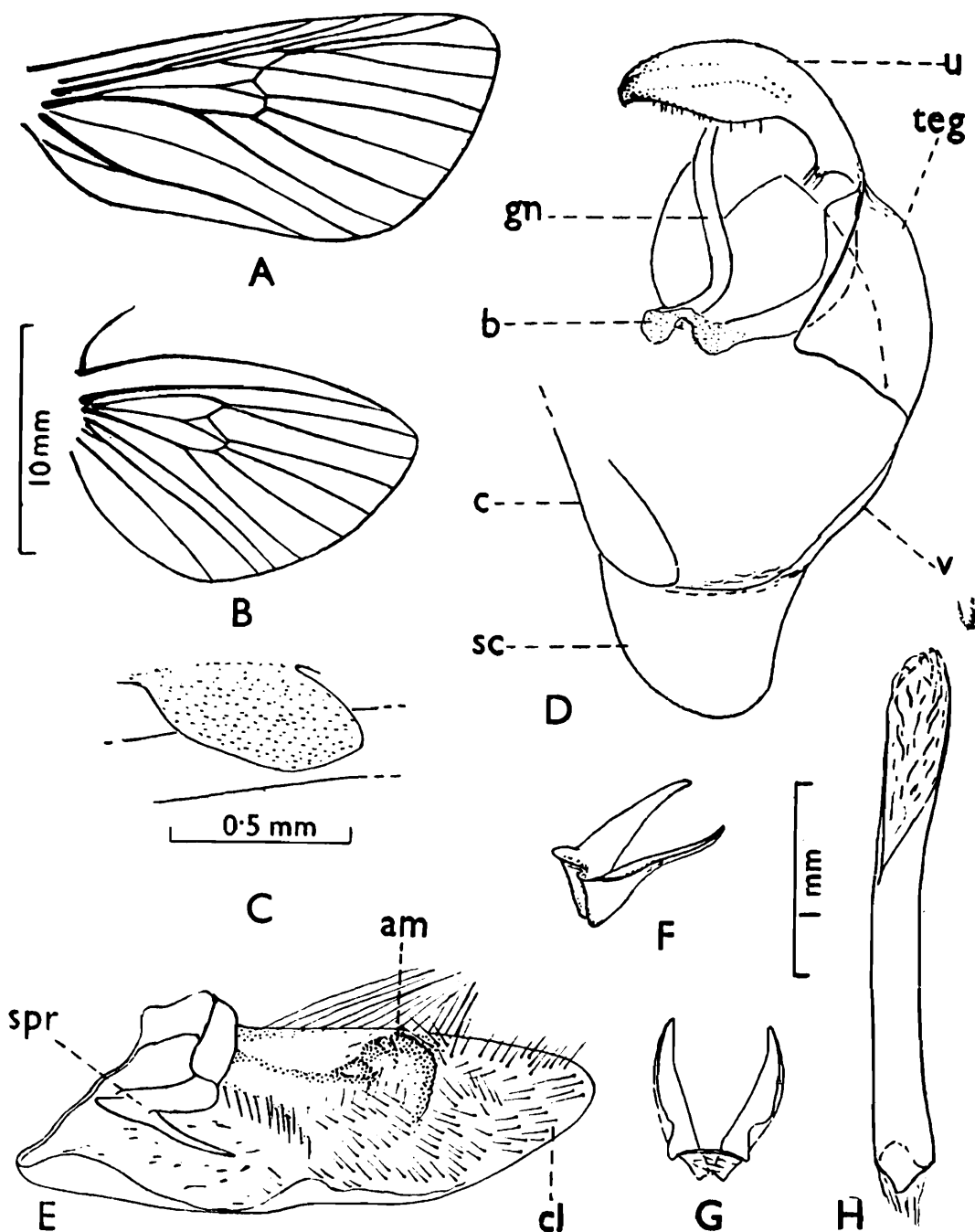
Host : *Ficus*. sp, *Nauclea cadamba* (Calcutta), Moore (1865) ; *Tectona grandis* (South India), Beeson (1941).

Head and thorax dark-greyish brown. Fore wings greyish brown and marked with several short, transverse, black striae and lines ; two lines across the wing, in middle, and two between the base of vein Cu_{1b} and inner margin, prominent ; postmedial line dark, running from costa to M_3 , thereafter incurved towards Cu_{1b} ; some dark, indistinct striae present beyond the postmedial line and excurved at M_3 ; submarginal lines also dark, with some indistinct striae. Hind wings pale-greyish brown, with some faint striae towards outer margin. Abdomen pale-greyish brown. Underside of both the wings pale-greyish brown and marked with numerous short brown striae.

Head with the labial palpi, though incomplete and damaged in the specimen available for study, appears to be well developed and closely appressed to face. Legs with the hind tibiae dilated and beset with two pairs of spurs. Wings broad (Text-figs. 4 A-B). Frenulum as in *acronyctoides*, retinaculum (Text-fig. 4C) short and broad.

Venation.—Fore wing (Text-fig. 4A) : Venation more or less as in *acronyctoides* ; areole, however, longer and projecting outside the cell angle by almost half, or more than its length ; R_3 weakly stalked with $R_4 + R_5$ at base ; M_1 arises from above the cell angle. Hind wing (Text-fig. 4B) : median vein generally forked in cell, forming a median cell, the upper and lower branches of which end between vein $M_1 - M_2$, and $M_2 - M_3$, respectively.

Genitalia.—Male (Text-figs. 4 D-H) : Uncus broad from base to distal one-third, narrowing gradually beyond it ; tip rounded, narrow and pointing downwards. Gnathos, tegumen and vinculum as in *acronyctoides*. Clasper about thrice as long as its width in middle ;



Text-fig. 4. *Cossus cadambae* Moore : (A) and (B) Fore and hind wing venation, respectively. (C) Retinaculum. (D) Male genitalia in a latero-ventral view, without claspers. (E) A clasper in an inner view. (F) and (G) Juxta of the anellus. (H) Aedeagus. (A and B ; and D to H of the same magnifications).

costa produced inwards and meeting with that of the other side and continued below with the highly sclerotised L-shaped spinabasis; mid-dorsal area highly sclerotised, denticulate and with a raised edge, running downwards across the claspers, thus clearly separating the distal membranous cucullus from rest of the portion; cucullus beset with long setae; harpe indistinct. Juxta with slender lobes, the anterior margin of which produced into short prolongations which along

with the spinabasalis support the aedeagus. Aedeagus simple, slender and without differentiation into base and the apex, the latter without spines. Female.—Not known.

Measurements.—Wing expanse : 41 mm. Length : Fore wing, 18 mm. ; hind wing, 12 mm.

Material examined.—Two examples as follows : India : West Bengal ; Calcutta, 1 ♂ (Bred in laboratory) (no other data).

Ceylon : Haragama, 1 ♂, -iv.1900, (*E. F. Green* coll.)

Distribution.—India : West Bengal (Calcutta) ; Travancore ; Bombay ; Mhow ; Nilgiris Hills ; and Ceylon.

Remarks.—This species is recorded here from Ceylon for the first time.

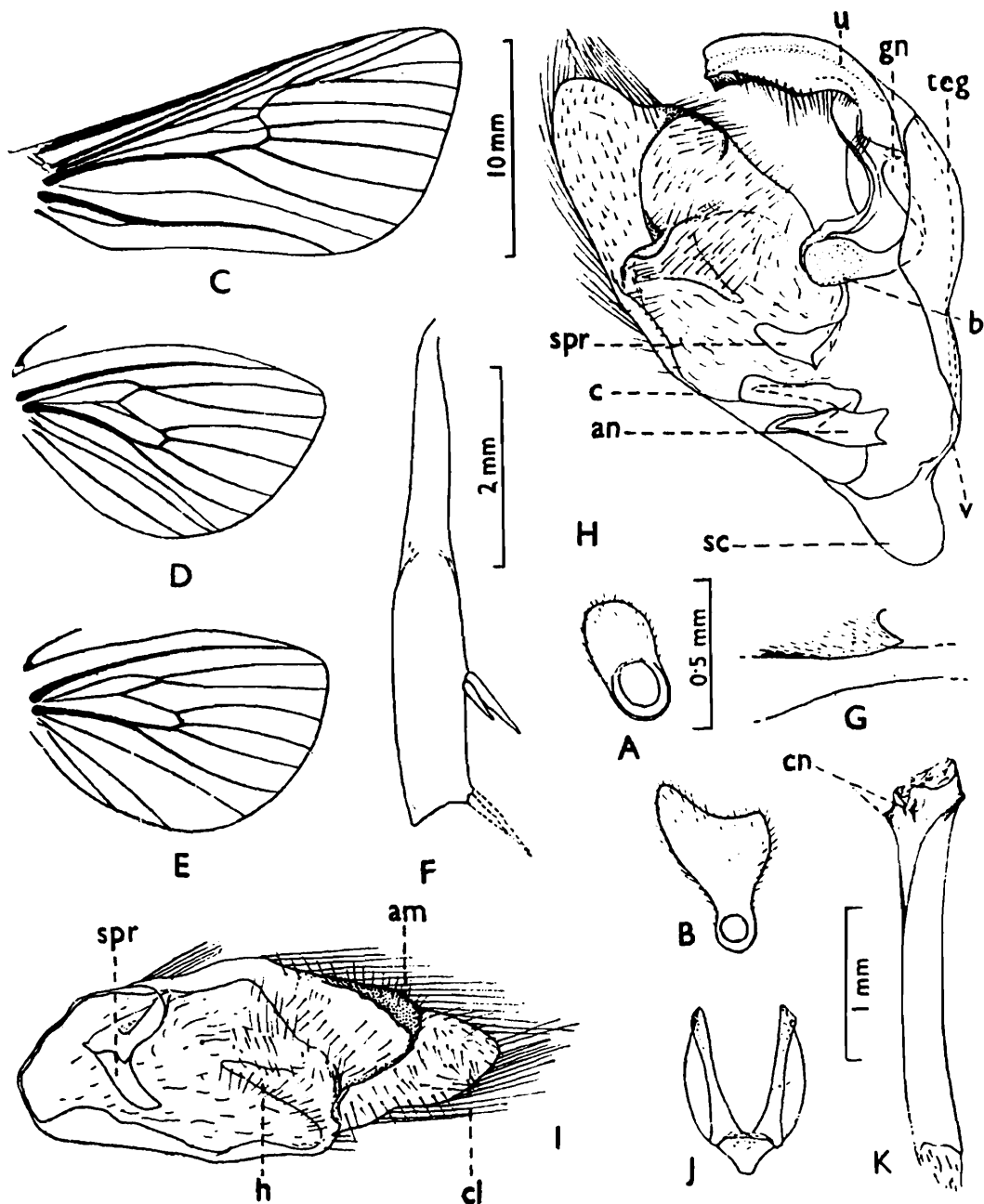
For differences from *acronyetoides* (Moore), see under that species.

5. *Cossus greeni* sp. n.

(Pl. I, fig. 5 ; Text-fig. 5).

Head antennae, thorax and abdomen dark brown. Labial palpi pale brown beneath, darker on the inner and outer sides. Fore wings (Pl. I, fig. 5) brown ; darker at base and medial area ; greyish at the antemedial and apex ; marked with several prominent striae across the wings, some coalescing to form thick lines ; the most prominent lines being one below the cell between Cu_{1a} and inner margin, and the other beyond the cell running between costa and M_3 , and thereafter incurved ; the postmedial series of striae oblique and parallel to the last-mentioned line up to M_3 , thereafter excurved and coming close to another prominent and oblique submarginal line, thus making a characteristic 'V'—shape ; striae beyond the submarginal not forming any definite lines ; the submarginal not forming any definite lines ; the subapical patch indistinct. Hind wings dark fuscous, without or with a few faint striae. Underside of both the wings dark fuscous, with a few markings on the fore wing but with the V-shaped marking prominent.

Antennae unipectinate, the shaft with 63 segments ; the rami short and broad from base to the middle (Text-fig. 5A), thereafter increasing in length towards the tip, indistinctly bifurcate (Text-fig. 5B), with the outer part smaller than the inner one. Labial palpi closely appressed to face, upturned and reaching beyond frons. Wings narrow at base than at the broad apical area (Text-fig. 5C). Legs with spurs,



Text-fig. 5. *Cossus greeni* sp.n. : (A) and (B) Antennal segments showing unipectinate branches. (C) Fore wing venation. (D) and (E) Hind wing venation, without median cell in 'E'. (F) A Portion of the hind leg, with two pairs of tibial spurs. (G) Retinaculum. (H) Male genitalia in a latero-ventral view, without clasper of one side. (I) A clasper in a inner view. (J) Juxta of the anellus. (K) Aedeagus. (A—B; C to E; and G to K of the same magnifications).

spines and arolium (Text-fig. 5F) as in genus. Frenulum short and functionless; retinaculum (Text-fig 5G) short and narrowly pointed.

Venation.—Fore wing (Text-fig. 5C) : Areole small, projecting about two-thirds outside the cell angle; vein R_1 arises from cell;

R_2 from areole ; R_3 either stalked or connate with $R_4 + R_5$; M_1 from above the cell angle ; median cell with its lower branch ending at M_2 . Hind wing (Text-figs. 5 D-E) : venation as in *C. cadambae*, except that the median cell is either reduced, with its branches lying between M_1 and M_2 , or absent.

Genitalia.—Male (Text-figs. 5H-K) : Uncus broad at base ; apical part narrow and ending in a truncate tip, the latter pointed downwards ; when seen from above, uncus appears slightly depressed. Clasper about two-and-a-half times as long as its width in middle, the latter broader ; harpe distinct ; spinabasis L-shaped and stout. Juxta well developed, the two lobes not separate at their bases. Aedeagus long and narrow, distal end broad and ending in a narrow tip and beset with four spines, *i.e.*, two ventrally, on the vesica, and one on each side.

Measurements.—Wing expanse : fore wing, 42 mm. Length : fore wing, 19.5 mm. ; hind wing, 14.5 mm.

Holotype : A male : Ceylon : Kandy, —.xi.1906 (*E. E. Green* coll.). Paratype : A male, —.x.1907 (*E. E. Green* coll.). Both deposited in the Z.S.I.

Remarks.—*Cossus greeni* is close to *C. cadambae* Moore in coloration and, to some extent, in the wing pattern except that the submarginal lines in *cadambae* are not prominent as in *greeni* ; the markings in *greeni* are thicker and form a characteristic V-shape mark on the fore wing whereas in *cadambae* the markings are thinner and do not form any clear V-mark on the fore wing. In respect of male genitalia the two species differ as follows : in *greeni* the uncus is truncate at the tip and aedeagus is with cornuti, whereas in *cadambae* the uncus is narrowly rounded at the tip and the aedeagus is without cornuti.

In respect of the genital structure, especially the shape of uncus and presence of cornutal spines on aedeagus it is close to *C. acronyctoides* (Moore) but differs in having shorter rami on the antennae and a well developed spinabasis on the claspers of male genitalia.

6. *Cossus nigromaculatus* Hampson

1892. *Cossus nigromaculatus* Hampson, *Fauna Brit. India, Moths*, 1 : 305 (Type loc.—Nilgiris).
 1923. *Cossus nigromaculatus*, Dalla-Toore, *Lepid. Cat.*, 29 : 12.
 1933. *Cossus nigromaculatus*, Gaede, in Seitz, *Macrolepidoptera of the World*, 10 : 809.

Type ; In B.M.

As no specimen of this species was available, the original description is reproduced here : “♀” Head, thorax, and abdomen blackish brown. Fore wing with the inner margin deeply angled near the base ; colour brown, greyish towards the costa ; a black blotch on the costa near the base ; a small blotch above centre of cell ; a large, very irregular, black blotch beyond the cell from the costa to vein 1c extending along vein 3 towards outer margin ; an apical black blotch ; the outer half of wing reticulated with fine black lines. Hind wing pale.

Hab. Nilgiris, 8000 ft. (*Minchin*). Exp. 66 millim. “Type in coll. Elwes.”

Distribution.—India : Nilgiris Hills.

Remarks.—Hampson (1892b) grouped this species with *acronyctoides* and *cadambae*, under the category of Cossids having bipectinate antennae. Later he (1905) stated that the antennae of *acronyctoides* are unipectinate, but did not mention anything about the antennae of *cadambae* and *nigromaculatus*—probably he had no males of these two species available to him. Gaede (1933) also described the antennae of *nigromaculatus* as bipectinate. I have males of *cadambae* which have unipectinate antennae, and as I did not have access to any material of *nigromaculatus* I am placing this species under the genus *Cossus*, as referred in literature.

7. *Cossus fuscibasis* Hampson

1895. *Cossus fuscibasis* Hampson (nec. Gaede)*, *Trans. ent. Soc. Lond.* : 287 (Type loc.—N. Chin Hills, Burma).
 1896a. *Cossus fuscibasis* Hampson, *Fauna Brit. India, Moths*, 4 : 473.
 1905. *Cossus fuscibasis* Hampson, *J. Bombay nat. Hist. Soc.*, 16 : 194.
 1923. *Cossus fuscibasis* Dalla-Torre, *Lepid. cat.*, 29 : 12.
 1933. *Cossus fuscibasis*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 808.

Type ; In B.M.

No specimen of this species was available, therefore the original description is reproduced here : “♀” Head, thorax and abdomen dark brown, the last greyish towards extremity. Fore wings with vein 6 from angle of cell ; the basal two-thirds brown irrorated with fuscous, a paler patch between median nervure and vein 1, bounded by an irregular black postmedian line highly angled at vein 4 and sending a streak inwards above vein 1 ; outer area grey striated and

*See foot-note on page 23.

reticulated with black. Hind wing with the basal half fuscous ; the outer area grey striated and reticulated with fuscous.

Hab. N. Chin Hills, Burma (*Watson*). Exp. 50 millim. Type B.M."

Distribution.—Burma.

Remarks.—This species differs from other species of the genus *Cossus* in having thick and dentate antennae in the male. Material of this species was not available to me for study, hence the species is referred to the genus *Cossus* as mentioned in literature.

Genus *Eremocossus* Hampson

- 1892b. *Eremocossus* Hampson, *Fauna Brit. India, Moths*, 1 : 313.
 1896b. *Eremocossus* Hampson, *Proc. zool. Soc. Lond.* : 276.
 1923. *Eremocossus*, Della-Torre, *Lepid. cat.*, 29 : 48.
 1929. *Eremocossus*, Gaede, in Seitz *Macrolepidoptera of the World*, 14 : 544.
 1933. *Eremocossus*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 811.
 1951b. *Eremocossus*, Viette, *Lambillionea*, 51 (5-12) : 42.
 1952. *Eremocossus*, Viette, *Bull. Mus. Hist. nat.*, (2) 24 : 555.

Type-species : *Phragmataecia foeda* Swinhoe

(a) General

The genus *Eremocossus* Hampson was erected to include *Phragmataecia foeda* Swinhoe, from Karachi, mainly on the basis of external characters, of the antennae, the labial palpi, venation, etc.

Hampson (1896) described one species, viz. *E. proleuca*, from Aden, and Le Cerf (1919) added yet another, viz. *E. senegalensis* from Senegal. The latter, however, was synonymised to *Hypopta saharae* Lucas, by Viette (1952). Thus, there are only two species of this genus known from the world, i.e., *foedus* from Karachi and *proleuca* from Aden.

(b) Characters of the Genus *Eremocossus* Hampson

Antennae in male bipectinate to tips, the branches short. Labial palpi large, the third segment rounded. Legs without spurs on the hind tibiae ; femora hairy. Wings long and narrow. Fore wing with the costal margin weakly concave and the inner one evenly curved ; vein R_1 arising from the cell. Hind wing with the veins R_s and M_1 stalked ; M_2 and M_3 close to each other at base.

(c) Relationships of the Genus *Eremocossus* with the other allied Genera

The genus *Eremocossus* Hampson is characterised by the absence of tibial spurs and having stalked Rs and M_1 in the hind wing which separate it from the other Indian Cossinae. It, however, resembles the other genera in respect of the pectination of antennae in the male and the fore wing venation.

(d) Geographical distribution of the Genus *Eremocossus*

The genus is known only from Pakistan (Karachi) in the Oriental and Arabia (Aden) in the Palaearctic regions.

(e) Description of Species

8. *Eremocossus foedus* (Swinhoe)

1884. *Phragmataecia foede* Swinhoe, *Proc. zool. Soc. Lond.* : 515, pl. XLVII, fig. 1 (Type loc.—Karachi, Pakistan).
 1887. *Phragmataecia foeda*, Cotes & Swinhoe, *Cat. Moths of India*, 2 : 234.
 1892. *Phragmataecia foeda*, Kirby, *Cat. Lep. Het.*, 1 : 876.
 1892b. *Eremocossus foedus* Hampson, *Fauna Brit. India, Moths*, 1 : 314.
 1918. *Eremocossus foedus*, Turner, *Trans. ent. Soc. Lond.*, 66 : 158.
 1923. *Eremocossus foedus*, Dalla-Torke, *Lepid. cat.*, 29 : 48.
 1929. *Eremocossus foedus*, Gaede, in Seitz *Macrolepidoptera of the World*, 14 : 544.
 1933. *Eremocossus foedus*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 811.

Type : In B.M

As no specimen of this species was available, the original description is produced here : "*Phragmataecia foeda*, n.sp. (Pl. XLVII, fig.1). Kurrachee, January and February. Colour ashy grey ; thorax and abdomen covered with long grey hairs, the latter conical, extending far beyond the wings. Antennae of the male moderately pectinate throughout, of the female simple. Fore wings with a reddish testaceous band along the costa, extending along the outer border and inner margin, making a complete circle of the wings, and a band of the same colour from the base extending under, and up to the end of the discoidal cell, and then continuing upwards to the costa near the apex. Hind wing immaculate.

Expanse of wings, ♂ $9\frac{1}{10}$, ♀ $1\frac{4}{10}$ inches.

Remarks.—Only two species of the genus *Eremocossus* Hampson, i.e. *E. foedus* (Swinhoe) and *E. proleuca* Hampson, from Karachi,

Pakistan and Aden, respectively, are hitherto known. From the literature I cannot make out any definite difference between the above-mentioned two species.

Genus *Holcocerus* Staudinger

1884. *Holcocerus* Staudinger, in Romanoff *Memoir. Lep.*, 1 : 139.
 1901. *Holcocerus*. Staudinger & Rebel, *Cat. Lep. Pal. Fnggeb.*, 1 : 407.
 1912. *Holcocerus*, Seitz, in Seitz *Macrolepidoptera of the World*, 2 : 421.
 1923. *Holcocerus*, Dalla-Torre, *Lepid. Cat.*, 29 : 16.
 1959. *Holcocerus*, Daniel, *Mitt. munch. ent. Ges.*, 49 : 102.
 1965. *Holcocerus*, Daniel, *Mitt. munch. ent. Ges.*, 55 : 75.
 1965. *Holcocerus*, Müller, *Dt. ent. Z.*, 12 (3) : 264.

Type-species : *Cossus nobilis* Staudinger

(a) *General*

The genus *Holcocerus* Staudinger (1884) was erected for the palaeartic species *Cossus nobilis* Staudinger from Ashkabad (Turkestan, U.S.S.R.). Dalla-Torre (1923) recorded some 40 species and subspecies, many of which have since been revised. Daniel (1959), while working on the palaeartic *Holcocerus*, recognised only 26 species of the Dalla Torre's Catalogue, and the remaining were either transferred to other genera or synonymised with other species. He also (*loc. cit.*) transferred several species of the genera *Cossus* Fabricius and *Paropta* Staudinger (including *Cossus rufidorsia* Hampson, from Sikkim) to this genus, bringing the total number, thus, to thirty five. There had been no further additions to this genus since then.

The present study includes two species, *viz.* *Holcocerus arenicola* Staudinger, and *H. rufidorsia* (Hampson) the former being a new record from India.

(b) *Characters of the Genus Holcocerus* Staudinger

Antennae simple and flattened. Labial palpi present. Legs with the hind tibiae dilated and beset with two pairs of spurs ; tarsi with spines. Frenulum and retinaculum short.

Venation.—Fore wing : Areole short ; R_1 arises from cell ; R_2 usually from areole ; $R_4 + R_5$ stalked ; median vein forked in the cell, forming the medial cell, the latter reduced. Hind wing : Cross bar between Sc and cell absent ; R_s and M_1 connate ; median vein forked in the cell and forming a short median cell.

Male genitalia.—Gnathos present and meeting in the middle below the uncus ; clasper with spinabasis ; juxta present.

(c) *Relationships of the Genus Holcocerus with the other allied Genera*

The genus *Holcocerus* is characterised by the presence of dilated hind tibiae, which are beset with two pairs of tibial spurs, and by the gnathos in the male genitalia which meet in the middle below the uncus. These characters bring the genus close to the other Indian Cossinae genera, especially the genus *Cossus* Fabricious, but differs from latter by the simple and flat antennal shafts. Seitz (1912) comments on the antennae, especially in relation to those in *Holcocerus* and *Cossus*, as (p. 419) : "The absence of woods, the ubiquity of the foodplants, the uniformity of the locality may considerably assists the function of the antennae as an organ of search, and thus organs which were originally complicated may become simplified. We are, therefore, loth to keep *Cossus* and *Holcocerus* separate, and only do so in order to avoid anything in our essentially practical work which would disturb the previous arrangements in collections and literatures and render the work more difficult to use"

Thus, according to above statement, by Seitz (1912), these two genera were kept separate to avoid difficulties but since the antennae, which are flattened and simple in *Holcocerus*, are a good character for differentiating it from the genus *Cossus*, where these are pectinate, and have been used in the identity of different genera, it would be better to keep these separate for the time being.

(d) *Geographical distribution of the Genus Holcocerus*

The genus *Holcocerus* is known from the Oriental (India, Sikkim) and the Palaearctic (China, Japan, U.S.S.R., Afganistan, Iran, Iraq, Israel, Algeria and Tunisia), regions.

(e) *Key to the Indian species of the Genus Holcocerus*

- Areole in fore wing moderately large, vein R_2 arising from it ; lower branch of median cell in fore wing ending between M_2 and M_3 ; uncus broadly rounded at tip and weakly depressed dorsally ; spinabasis short and stout, with equally long and narrow stems *arenicola* (Staudinger)
- Areole in fore wing small, R_2 arising from beyond it and stalked with R_3 ; lower branch of median cell in fore wing end at M_2 ; uncus rather pointed at tip and not depressed dorsally ; spinabasis long, with lower stem about twice as long as upper *rufidorsia* (Hampson)

(f) *Description of Species*9. *Holcocerus arenicola* (Staudinger)

(Pl. I, fig. 6 ; Text-fig. 6)

1879. *Cossus arenicola* Staudinger, *Stett. ent. Ztg.*, **40** : 317 (Type loc.—Ashkabad, Turkestan, U.S.S.R.)
 1892. *Holcocerus arenicola*, Kirby, *Cat. Lep. Het.* : 862.
 1901. *Holcocerus arenicola*, Staudinger and Rebel, *Cat. Lep. Fngeb.*, **1** : 408.
 1912. *Holcocerus arenicola*, Seitz, in Seitz *Macrolepidoptera of the World*, **2** : 421.
 1923. *Holcocerus arenicola*, Dalla-Torre, *Lepid. Cat.*, **29** : 16.
 1959. *Holcocerus arenicola*, Daniel, *Mitt. münch. ent. Ges.*, **49** : 114.
 1965. *Holcocerus arenicola*, Daniel, *Mitt. münch. ent. Ges.*, **55** : 93.
 1965. *Holcocerus arenicola*, Müller, *Dt. ent. Z.*, **12** (3) : 212.

Type : Repository not known.

Antennae and eyes dark brown. Vertex, thorax and basal half of abdomen greyish. Fore wings greyish, marked with numerous blackish brown striae some of which coalescing into fine lines across the wings ; the prominent lines being the one at the outer side of subapical patch, running from apical margin to vein R_5 and continued below as a fine line up to vein Cu_{1b} , and another from costa is interrupted at veins Sc and R_1 and runs down as a double line between R_5 and R_2 , thereafter the lines diverge, the inner line bending inwards and up to Cu_{1b} and the outer line reduced to several striae one of which, *i.e.* between M_3 and Cu_2 , prominent and incurved at vein Cu_{1a} ; the medial area irrorated with blackish scales, with the medial line prominent from costa to the anal vein. Hind wings brown, unmarked and with tufts of scale-hairs on anal veins at the inner margin ; costal half pale-greyish brown at the base. Underside of the wings fuscous, marked with prominent striae in fore wing and faint ones in hind wings ; the inner area of the fore wing near the base, and costa of hind wing greyish brown and unmarked. Body greyish.

Antennae about half the length of costa ; shaft with 53 laterally-flattened, simple and minutely ciliate segments (Text-fig. 6A) ; basal segments short and broad, distal ones long and narrow ; the apical one about twice the length of its width. Labial palpi appressed to face and upturned ; the third segment short and blunt, extending beyond fronts. Legs (Text-figs. 6 B-C) as described in generic characters. Retinaculum (Text-fig. 6D) minute, rounded at the tip and partly covering vein R_1 . Abdomen with tufts of scales.

Fore wing (Text-fig. 6E) : Areole large, projecting by about half its length from cell end ; vein R_2 arises from areole ; R_3 connate with

the stalk of $R_4 + R_5$ and running close to vein R_4 for half way and then diverging rapidly towards the apical margin ; M_1 arising from the cell angle ; median cell with the branches ending between $M_1 - M_2$, and $M_2 - M_3$; M_2 and M_3 above the cell end, M_3 nearer M_2 than Cu_{1a} ; the latter arising from angle whereas the vein Cu_{1b} from before the cell angle. Hind wing (Text-fig. 6F) ; with a short veinlet arising from vein Sc and ending abruptly ; median cell with its branches ending between $M_1 - M_2$, and at M_3 ; otherwise as in fore wing.

Genitalia.—Male (Text-fig. 6 G-M) : Uncus uniformly broad from base to near the tip ; about twice as long as its width in the middle and with a slight dorsal depression near the distal end ; the latter ending in a fine point. Gnathos meeting through a fine membrane, the latter beset with spines. Tegumen short, broadest in middle. Saccus long, broadly quadrangular. Clasper about three times as long as its width in middle ; costal margin produced inwards and meet each other in the middle ; spinabasis L-shaped, short and with its lower stem as long as the upper verticle one ; the mid dorsal area highly sclerotised, denticulate and with numerous short spines, setae and several short parallel ridges which do not reach half way ; distal part membranous. Juxta with long and narrow lobes. Aedeagus simple, not differentiated into base and apex and about twelve to thirteen times as long as its width in middle ; cornuti absent.

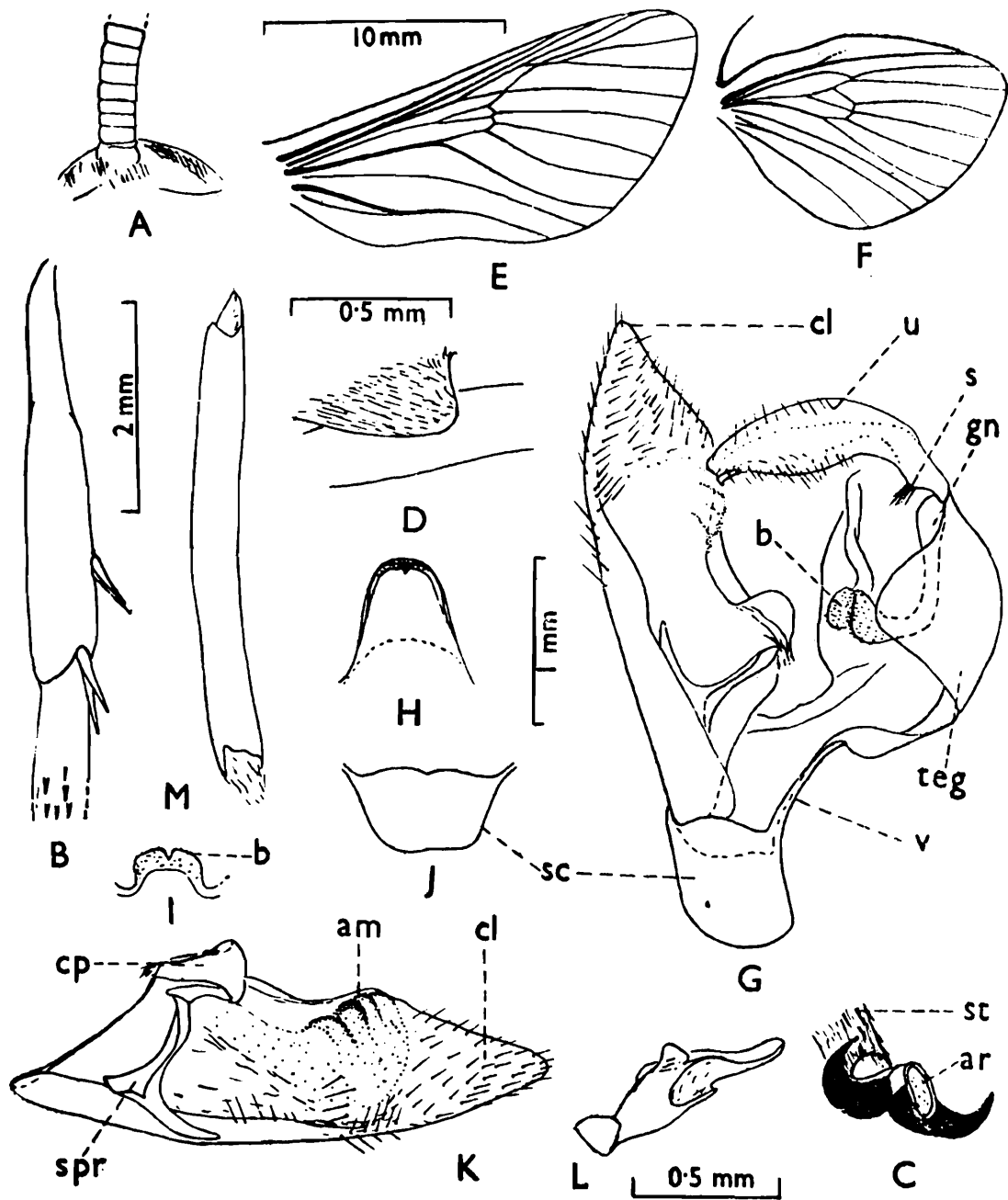
Measurements.—Expanse : fore wing, 40 mm. Length : fore wing, 18 mm. ; hind wing, 12 mm. ; abdomen, 12.5 mm. ; whole body, 22.5 mm.

Material examined.—India : Great Nicobar Islands, Bankol Camp, Bellabay, 1 ♂, 3.iii.1966 (Daniel and Bhowmick coll.).

Distribution.—This species is hitherto known from Pakistan (Baluchistan), Afganistan, China and Russia (Central Asia, Turkestan). The present record from India (Great Nicobar Islands) is being reported for the first time.

Remarks.—*H arenicola* differs from the other oriental species, viz. *H rufidorsia* (Hampson) for its larger size, and for having a dark medial patch on the fore wing (absent in *rufidorsia*). In respect of the male genitalia, it differs in having a short and stout spinabasis, where as in *rufidorsia* it is long and narrow.

It is also close to the palaeartic species *H consobrinus* Püng but can be differentiated by its larger size, shorter antennae and the greyish colour of the body (brownish grey in *consobrinus*).



Text-fig. 6. *Holcocerus arenicola* (Staudinger) : (A) Male antenna showing a few basal segments. (B) A portion of the hind leg, with two pairs of tibial spurs and a few tarsal spines. (C) Tarsal claws, with arolium. (D) Retinaculum. (E) and (F) Fore and hind wing venation, respectively. (G) Male genitalia in a latero-ventral view, without clasper of one side. (H), (I) and (J) Uncus, bulla and saccus, respectively, in a ventral view. (K) A clasper in an inner view. (L) Juxta of the anellus. (M) Aedeagus. (A—B; C—D; E—F; G to K and M, of the same magnifications).

10. *Holcocerus rufidorsia* (Hampson)

(Pl. I, fig. 7 ; Text-fig. 7)

1905. *Cossus rufidorsia* Hampson, *J. Bombay nat. Hist. Soc.*, **16** : 194. (Type loc.—Sikkim).
 1923. *Cossus rufidorsia*, Dalla-Torre, *Lepid. Cat.*, **29** : 13.
 1933. *Cossus rufidorsia*, Gaede, in Seitz *Macrolepidoptera of the World*, **10** : 810.
 1965. *Holcocerus rufidorsia*, Daniel, *Mitt. münch. ent. Ges.*, **55** : 95.

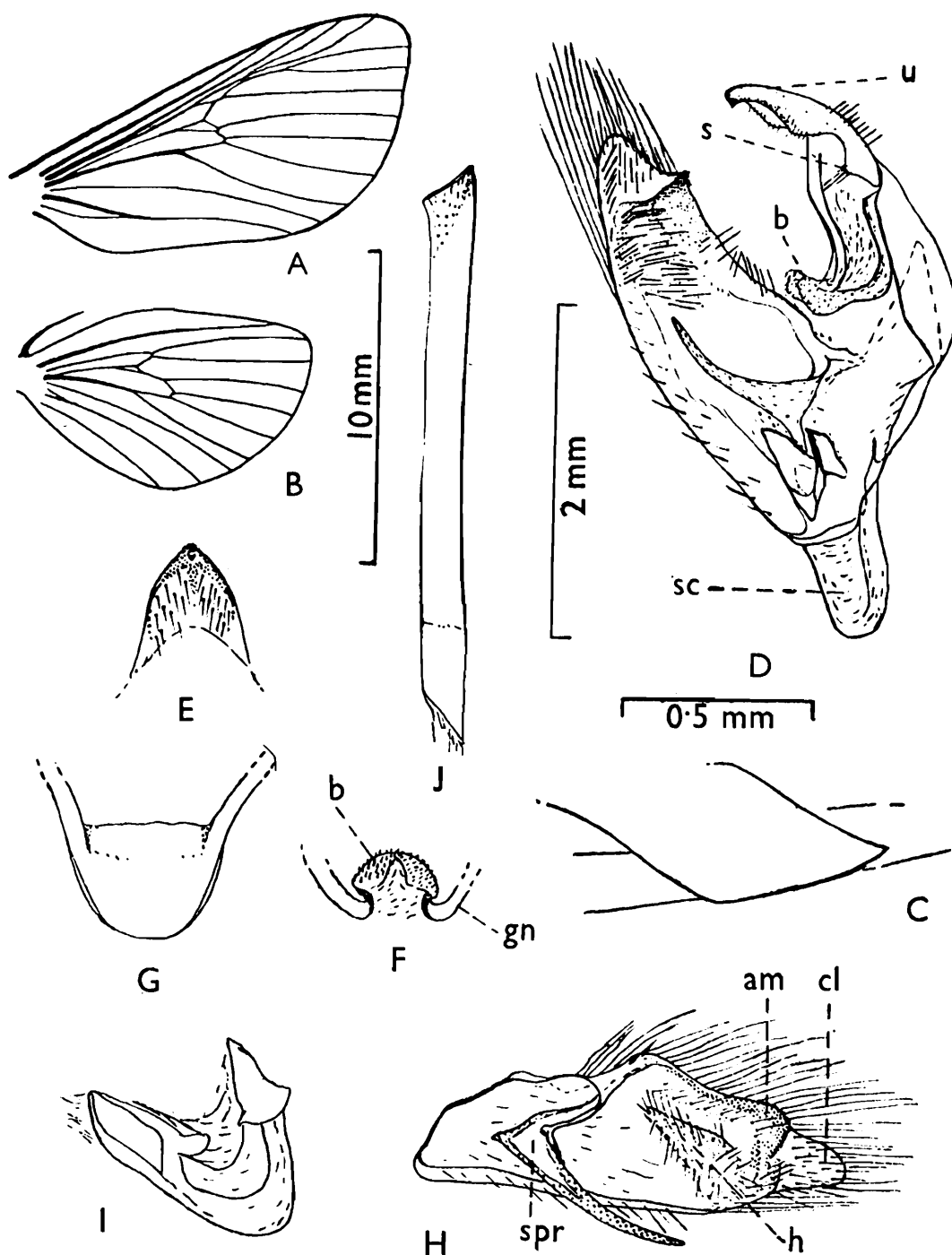
Type : In B.M.

Head, thorax and abdomen dark brown. Antennae and labial palpi paler. Fore wing greyish brown, somewhat paler beyond the middle ; striae blackish brown, faint before the middle but well marked beyond it, some of which coalesce into fine lines across the wings ; the postmedial line double, running from costa to inner margin, with the inner line bifurcating at Cu_{1b} ; the two parallel and narrow lines prominent between costa and M_1 , thereafter faint and diffused ; submarginal line connected with marginal line through short and faint striae. Hind wing blackish brown, unmarked but irrorated with black scales throughout uniformly. Underside of the wings dark brown, marked with faint striae, the striae on the fore wings prominent. Abdomen and abdominal tufts greyish.

Antennae half the length of costa ; the shaft composed of 53 simple, laterally-flattened and minutely ciliate segments ; each segment slightly half or more than its width, a few distal ones longer than wide. Labial palpi closely appressed to face and upturned ; the third segment short, blunt and reaching up to the frontal tufts. Legs with arolium, spurs and spines as given in the generic characters. Retinaculum (Text-fig. 7C) short.

Venation.—Fore wing (Text-fig. 7A) : Areole small, projecting about two-thirds outside the cell ; R_2 stalked with R_3 , the common stem either connate with the base of $R_4 + R_5$ or anastomosing to enclose an areole ; R_3 running close to $R_4 + R_5$, as in *arenicola* ; M_1 arises from above the cell angle ; median cell short, with its branches ending between M_1-M_2 , and M_2-M_3 . Hind wing (Text-fig. 7B) : Median cell with both the branches ending between M_2-M_3 ; otherwise typically *Holcocerus*-type.

Genitalia.—Male (Text-fig. 7 D-J) : Uncus broad from base to middle, thereafter narrowing gradually towards distal end. Tegumen long and narrow. Claspers with the mid-dorsal area sclerotised, not denticulate ; distal part reduced and membranous ; the costal margin not much produced ; spinabasis, especially the lower



Text-fig. 7. *Holcocerus rufidorsia* (Hampson) : (A) and (B) Fore and hind wing venation, respectively. (C) Retinaculum. (D) Male genitalia in a latero-ventral view, without clasper of one side. (E), (F) and (G) Uncus, bulla and saccus, respectively, in a ventral view. (H) A clasper in an inner view. (I) Juxta of the anellus. (J) Aedeagus (A—B; C and I; D to H & J of the same magnifications).

horizontal stem, well developed. Juxta with short lobes. Aedeagus as in *arenicola*. Female : Not known.

Measurements.—Expanse : fore wing, 29 mm. Length : fore wing, 13 mm. ; hind wing, 9 mm. ; abdomen, 9 mm. ; whole body, 29 mm.

Material examined.—1 ex, India : Assam : N. Lakhimpur, 1 ♂ 3.x.1966 (S. K. Tandon and G. S. Arora coll.).

Distribution.—India (Assam, Sikkim).

Remarks.—*Holcocerus rufidorsia* (Hampson), which was hitherto known only from Sikkim, is now being reported here from Assam for the first time.

For differences from *H arenicola*, see under the latter.

Genus *Paracossus* Hampson

1905. *Paracossus* Hampson. *J. Bombay nat. Hist. Soc.*, **16** : 194.
 1918. *Paracossus*, Turner, *Trans. ent. Soc. Lond* **66** : 178.
 1923. *Paracossus* Dalla-Torre, *Lepid. Cat.*, **29** : 15.
 1933. *Paracossus* Gaede, in Seitz *Macrolepidoptera of the World*, **10** : 810.

Type Species : *Paracossus furcata* Hampson

(a) *General*

The genus *Paracossus* is endemic to the Indian subregion and was erected by Hampson (1905) to include his two species, viz. *furcata* from Burma (type), and *parva* from Ceylon. Since then, there have been no further additions to this genus. It is referable to the subfamily Cossinae on account of pectination of antennae, the presence of two pairs of tibial spurs, tarsal spines, and gnathos in the male genitalia which is united below the uncus.

(b) *Characters of the Genus Paracossus* Hampson

Antennae of male bipectinate, rami short and gradually decreasing in size towards the apex. Labial palpi slender, upturned and not quite reaching up to vertex of head. Legs with two pairs of spurs on hind tibiae ; tarsal spines present ; claws with arolium.

Fore wings without areole ; veins R_2 to R_5 stalked, R_5 arising before the origin of R_2 ; median vein unforked in the cell. Hind wings with the veins R_s and M_1 separate ; median. as in fore wing.

Uncus in male genitalia narrowed distally and not ending into a point ; gnathos present, meeting medially below the uncus ; claspers with a sclerotised mid-dorsal area ; juxta well developed.

(c) *Relationships of the Genus Paracossus with the other allied Genera*

The genus *Paracossus* Hampson, both taxonomically and phylogenetically, is very important because of the absence of areole, the stalking of veins R_2 to R_5 in the fore wing and for the unforked median vein in both wings. By briefly reviewing the venation of the Indian genera, namely *Catopta*, *Cossus*, *Ereimocossus* and *Holcocerus*, it appears that the absence of areole and the median cell in this genus has come about or evolved gradually, the intermediate stages are traceable in certain species of the genus *Cossus* Fabricius; similarly, the genus *Holcocerus* also presents a stage where the areole is not closed by usual anastomosis between vein R_3 and $R_4 + R_5$, but by the anastomosis of the stalks of $R_2 + R_3$ and $R_4 + R_5$. This is very significant since only a small areole is formed in the species *H. rufidorsia* (Text-fig. 7A), the condition which, probably, leads to the complete anastomosis of the stalks of $R_2 + R_3$ and $R_4 + R_5$, resulting in the absence of areole which is a characteristic feature of the genus *Paracossus* Hampson.

(d) *Geographical distribution of the Genus Paracossus*

The genus *Paracossus* Hampson is purely an oriental genus and is known from Ceylon and Burma.

(e) *Key to the species of the Genus Paracossus*

- M_1 in the fore wing arising from angle of cell *parva* Hampson
 M_1 in the fore wing arising from below the angle of cell *furcata* Hampson

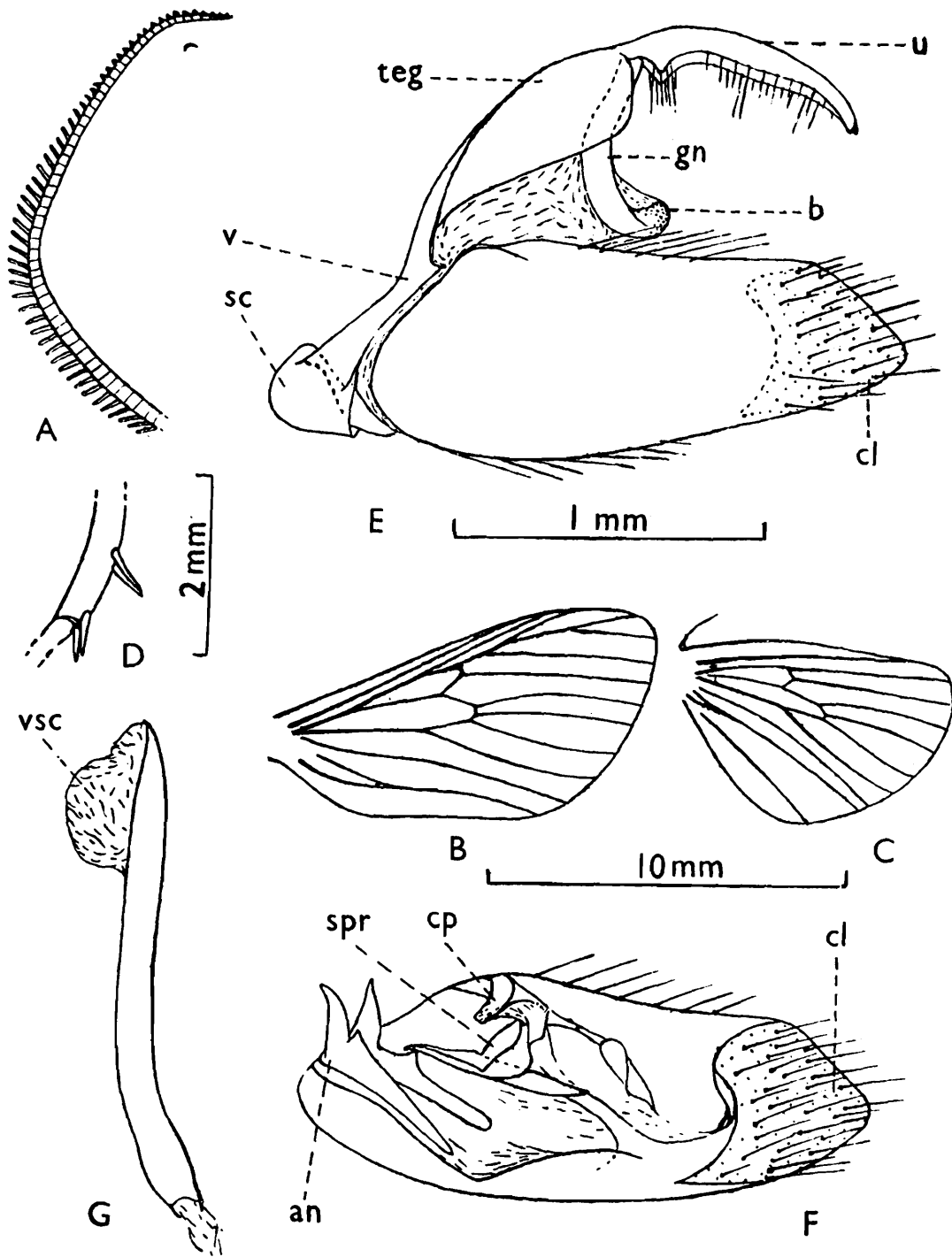
(f) *Description of Species*11. *Paracossus parva* Hampson

(Pl. I, fig. 8; Text-fig. 8)

1905. *Paracossus parva* Hampson, *J. Bombay nat. Hist. Soc.*, **16** : 194 (Type loc.—Ceylon, Matale (*Pole*)).
 1918. *Paracossus parva*, Turner, *Trans. ent. Soc. Lond.*, **66** : 178.
 1923. *Paracossus parva*, Dalla-Torre, *Lepid. Cat* **29** : 15.
 1933. *Paracossus parva*, Gaede, in Seitz *Macrolepidoptera of the World*, **10** : 810.

Type : In B.M

Body pale-greyish brown; abdomen darker dorsally. Fore wing greyish brown, with fine dark striae and lines; the inner area reddish



Text-fig. 8. *Paracossus parva* Hampson : (A) A portion of male antenna showing pectination of one side. (B) and (C) Fore and hind wing venation, respectively. (D) A portion of the hind leg, with two pairs of tibial spurs. (E) Male genitalia in a lateral view. (F) A clasper in an inner view. (G) Aedeagus. (A & D ; B & C ; and E to G of the same magnifications).

brown ; medial line black and slightly bent outwards at median nervure ; an oblique line running from costa to the upper angle of cell, thereafter following the discocellulars with a slight fork on the outer side and bending inwards on median nervure to angle outwards on

vein Cu_{1b} and then incurving ; a postmedial incurved line from costa to vein M_3 where it angles outwards and then is incurved, and connected at vein M_3 by an oblique streak with the irregularly waved subterminal line. Hind wing semihyaline, fuscous brown and with darker veins.

Antennae (Text-fig. 8A) bipectinate nearly up to five-sixths of the length from base ; the distal part with short and uniserrate branches. Labial palpi short and slender, not quite reaching vertex. Wings broad (Text-fig. 8 B-C). Legs with the spurs (Text-fig. 8D), spines and claws as in generic characters. Venation typically *Paracossus*-type.

Genitalia.—Male (Text-fig. 8 E-G) : Uncus broad, distally narrower ; apex slightly notched and not ending into a fine point. Tegumen long and narrow, more so at its base than at the upper broader part ; saccus short and subrounded. Claspers with the costal process produced inwards to meet with that of the other side ; spinabasis '└' -shaped (not L-shaped as in other genera), with the lower horizontal stem running on both sides, *i.e.*, towards distal as well as basal end of claspers. Juxta with well developed lobes, and with short basal prolongations. Aedeagus simple and without cornuti.

Measurements.—Expanse ; fore wing, 25 mm. Length : fore wing, 11.5 mm. ; hind wing, 8.5 mm.

Material examined.—1 example. Ceylon : Mirigama, 1♂, .xii.— (Joicey coll.) (colln. G. C. Altson) (ex. colln. B. M.).

Distribution.—Ceylon.

Remarks.—This species differs from the other species, *viz.* *P. furcata*, in the origin of vein M_1 in the fore wing being from angle of cell.

12. *Paracossus furcata* Hampson

1905. *Paracossus furcata* Hampson, *J. Bombay nat. Hist. Soc.*, **16** : 195 (Type loc.—Pegu, Burma).
 1918. *Paracossus furcata*, Turner, *Trans. ent. Soc. Lond.*, **66** : 178.
 1923. *Paracossus furcata*, Dalla-Torre, *Lepid. Cat.*, **29** : 15.
 1933. *Paracossus furcata*, Gaede, in Seitz *Macrolepidoptera of the World*, **10** : 810.
 1951b. *Paracossus furcata*, Viette, *Lambillionea*, **51** (5-12) : 66.

Type : In B.M.

As no example of this species was available, the original description is reproduced here : u♂. Brownish-grey. Fore wing with

dark striae, an indistinct oblique brown antemedial line bifurcating and enclosing an elliptical spot in the middle; a medial line bent obliquely outwards from median nervure to submedian fold where it is connected by a streak with the post-medial line which is strongly incurved below vein 4 where it is connected by an oblique spur with irregularly waved subterminal line which is obscurely furcate in places. Hind wing pale fuscous brown.

Habitat—Pegu, Magene.

Exp.—34 milim.

Remarks.—For differences from *parva* see the latter.

Subfamily (ii) ZEUZERINAE

- 1894a. *Zeuzerinae* Neumoegen and Dyar, *J. N. Y. Ent. Soc.*, 1 : 97.
 1894b. *Zeuzerinae* Neumoegen and Dyar, *J. N. Y. Ent. Soc.*, 2 : 1.
 1926. *Zeuzerinae*, Tillyard, *The Insects of Australia and New Zealand* : 417.
 1929. *Zeuzerinae*, Seitz, in Seitz *Macrolepidoptera of the World*, 14 : 539.
 1937. *Zeuzerinae*, Dyar, in Seitz *Macrolepidoptera of the World*. 6 : 1264
 1948. *Zeuzerinae*. Toxopeus, *Treubia*, 19 : 167.
 1955. *Zeuzerinae*, Daniel, *Mitt. münch. ent. Ges.*, 44—45 : 174.
 1959b. *Zeuzerinae*, Clench, *Veröff. zool. StSamml. Münch.*, 6 : 9.
 1962. *Zeuzerinae*, Comstock, *Introduction to Entomology* : 601.

Type-genus : *Zeuzera* Latreille

(a) Characters of the Subfamily ZEUZERINAE

Insects of variable size, varying from 2 cm. to 20 cm. Antennae of male bipectinate for a portion of length, the distal part usually serrate. Proboscis either poorly developed or absent. Labial palpi obsolete or moderately developed. Legs with a single pair of minute spurs in hind tibiae, the latter normal, not dilated; tarsi with or without spines; arolium either present or absent. Frenulum in male one; in female usually from two to three, rarely as many as 30, bristles; retinaculum elongate.

Fore wing always with areole, the latter usually normal and moderate to hypertrophied in size; vein R_1 generally arising from the areole, rarely from cell; R_2 from areole; median forked; M_1 usually arising from well below the upper angle of cell, rarely from above. Hind wing with vein Sc usually free and without cross bar, rarely with cross bar; R_s and M_1 separate; median vein as in fore wing.

The male genitalia considerably variable; with or without gnathos. The female genitalia also variable.

(b) *General remarks on the Indian ZEUZERINAE*

The Indian Zeuzerinae includes *Azygophelps* Hampson, *Phragmataecia* Newman, *Xyleutes* Hübner and *Zeuzera* Latreille.

The genus *Azygophelps* Hampson is mainly Ethiopian, and includes four species from the Indian subregion. The genus *Phragmataecia* Newman is a widely distributed genus and is represented by ten species, including four species, viz. *Cossus pallidalae* Hampson, *Xyleutes obliquifascia* Bryk, *X. clara* Bryk, and *Zeuzera stigmatica* Moore, which have been assigned now to this genus in the present study. The genus *Xyleutes* Hübner is well represented in the Indo-Australian region and has eight species (including a new species from S. Andamans) in the Indian subregion. The genus *Zeuzera* Latreille is also a widely distributed one, and is represented by 6 species and a new subspecies.

Thus, in all, 28 species, including a new species and a subspecies, under subfamily Zeuzerinae, are known from the Indian subregion.

(c) *Key to the Indian Genera of the Subfamily ZEUZERINAE*

1. Antennae in male bipectinate beyond the basal half, minutely pectinate in female. Arolium present. Wings with the veins M_2 and M_3 arising separately or from a point. Gnathos present or absent 2

Antennae in male not bipectinate beyond the basal half, simple in female. Arolium absent. Wings with the veins M_2 — M_3 always arising separately. Gnathos present 3

2. Labial palpi well developed. Fore wing with a long areole ; M_2 and M_3 arising from a point in both the wings. Gnathos present, but weak. Aedeagus with well developed cornutal process

Azygophelps Hampson

Labial palpi weak or obsolete. Fore wing with a moderately long areole ; M_2 and M_3 arising separately. Gnathos

absent. Aedeagus without
cornutal process .. *Phragmataecia* Newman

3. Areole in fore wing hypertrophied, projecting much beyond the cell angle. Hind wing without cross bar between Sc and Rs. Abdomen generally shorter than hind wings in the male. Gnathos well developed; juxta weak. Aedeagus stout and with a cornutal process *Xyleutes* Hübner

Areole in fore wing not much hypertrophied, projecting a little beyond the cell. Hind wing with a cross bar between Sc and Rs. Abdomen longer than hind wings in the male. Gnathos well developed or weak; juxta well developed. Aedeagus either simple and slender or stout, with or without cornutal process *Zeuzera* Latreille

Genus *Azygophelps* Hampson

- 1892b. *Azygophelps* Hampson, *Fauna Brit. India, Moths*, 1 : 309.
 1894. *Azygophelps*, Swinhoe, *Ann. Mag. nat. Hist.*, (6) 14 : 440.
 1895. *Azygophelps*, Swinhoe, *Trans. ent. Soc. Lond.* : 29.
 1896a. *Azygophelps* Hampson, *Fauna Brit. India, Moths*, 4 : 473.
 1899. *Azygophelps*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 (4) : 646.
 1905. *Azygophelps*, Schaus, *Proc. U.S. nat. Mus.*, 29 : 339.
 1909. *Azygophelps*, Lefroy, *Indian Insect Life* : 496.
 1918. *Azygophelps*, Turner, *Trans. ent. Soc. Lond.*, 66 : 162 [Synonymised to *Xyleutes* Hübner.]
 1923. *Azygophelps*, Dalla-Torre, *Lepid. Cat.*, 29 : 43.
 1929. *Azygophelps*, Gaede, in Seitz *Macrolepidoptera of the World*, 14 : 545.
 1933. *Azygophelps*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 821.
 1940. *Azygophelps*, Ayyar, *Handbook of Economic Entomology for South India* : 378, 472.
 1945. *Azygophelps*, Gardner, *J. Bombay nat. Hist. Soc.*, 45 (3) : 391, 392.
 1951b. *Azygophelps*, Viette, *Lambillionea*, 51 (5—12) : 39.
 1957. *Azygophelps*, Roepke, *Verh. K. ned. Akad. Wet. Afd. Nat.*, (2) 52 (1) : 19.

Type-species ; *Hepialis scalaris* Fabricius.

(a) General

The genus *Azygophelps* was erected by Hampson (1892b) for an Asian species *Hepialis scalaris* Fabricius as the type and two other

Indian species, viz., *Zeuzera albofasciata* Moore and *Z. pusilla* Walker. Later one more species, namely *A. nurella*, from Cherrapunji, was added to this genus by Swinhoe (1894). Thus, there are only four species of this genus known from the Indian subregion.

The present study of the Indian species, is based on the material of three well known species, viz. *albofasciata* (Moore), *pusilla* (Walker) and *scalaris* (Fabr.), including the holotype of *albofasciata*. The material of *A. nurella* Swinhoe was, however, not available.

(b) *Characters of the Genus Azygophelps* Hampson

Antennae bipectinate in both the sexes, shorter in female than in the male. Labial palpi short and porrect. Frenulum in female in the form of three bristles. Legs with a single pair of minute spurs in the hind tibiae, tarsal spines weakly developed; tarsal claw with a well developed arolium. Abdomen generally longer than hind wing in both sexes.

Fore wing with a large areole; veins R_1 and R_2 arising from areole, R_1 from the basal one-third and R_2 from near the distal end; M_1 from well below the angle of cell; median with the upper branch ending between M_1 — M_2 and the lower one either between M_3 — Cu_{1a} , or at M_3 ; M_2 — M_3 from a point in both the wings.

Gnathos in the male genitalia present and free at their distal end; aedeagus also well developed and with a sclerotised cornital process. Female genitalia variable.

(c) *Relationships of the Genus Azygophelps with the other allied Genera*

The genus *Azygophelps* Hampson is close to the genus *Zeuzera* Latreille. In fact most of the Indian species, including the type, were generally treated as the species of the genus *Zeuzera* at the time when Hampson (1892b) erected the genus. It is, however, separable from *Zeuzera* by the presence of arolium and absence of a cross bar between the veins Sc and Rs in the hind wing.

From *Xyleutes*, the genus differs by the presence of arolium and by the antennae which are bipectinate in both sexes, whereas in *Xyleutes* the arolium is absent and antennae bipectinate in the male but simple in the female.

It is close to the genus *Phragmataecia* in respect of antennae which are bipectinate in both sexes, and in the presence of arolium. The two, however, differ from each other as follows: In *Azygophelps* the veins M_2 and M_3 arise from a point in both the wings and gnathos

is present, unlike in *Phragmataecia* where M_2 and M_3 arise separately and gnathos is absent.

(d) *Geographical distribution of the Genus Azygophelps*

The genus *Azygophelps* is known from the Ethiopian (East, West and Central Africa, Madagascar, Transvaal, Uganda, Rhodesia), Oriental (India, Pakistan, Burma, Ceylon, Indo-China, Indonesia, Southern China), and Australian (Australia), regions.

(e) *Key to the Indian species of the Genus Azygophelps*

The following key includes three Indian species of which the material was available for study.

1. Antennae similar in both sexes, the branches long ; frontal tufts and the stripes on thorax orange ; fore wing with the cell area marked, the area below the cell unmarked. Tegumen shorter, vinculum and aedeagus long in male genitalia ; genital plate in female genitalia with a ventral sclerotised patch

scalaris (Fabricius)

Antennae dissimilar in both sexes, branches shorter in female than in the male ; frontal tufts either brown or blackish brown and thorax without any stripes ; fore wing with the cell area unmarked, the area below the cell marked. Tegumen longer, or as long as the vinculum, and aedeagus short ; genital plate without ventral sclerotisation

2

2. Fore wing with the median area unmarked throughout. Hind wing marked. Juxta in male genitalia without median lobes ; corpus bursae, in female genitalia, with a signum

albofasciata (Moore)

Fore wing with the median area unmarked only up to disco-cellular. Hind wing unmarked. Juxta with a median lobe ; corpus bursae without signum .

pusilla (Walker)

(f) Descriptions of Species

13. *Azygophelps scalaris* (Fabricius)

(Pl. I, fig. 9 ; Pl. II, fig. 13 ; Text-fig. 9).

1775. *Hepialis scalaris* Fabricius, *Syst. Ent. Ins.* : 590 (Type loc.—China).
 1794. *Cossus scalaris* Fabricius, *Ent. Syst.*, 3(2) : 5.
 1800. *Phalaena scalaris*, Donovan, *An Epitome of the Natural History of the Insects of India and the Islands in the Indian seas* : 82.
 1822. *Morpheis scalaris*, Hübner, *Verz. bek. Schmett.* : 196.
 1838. *Zeuzera scalaris*, Westwood, *Nat. Hist. Ins. India* : 83.
 1865. *Zeuzera bivittata* Walker, *List Lep. Brit. Mus.*, 32 : 586 (Type loc.—N. India).
 1887. *Zeuzera bivittata*, Cotes and Swinhoe, *Cat. Moths of India* : 232, (Karachi).
 1892. *Zeuzera scalaris*, Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.*, 1 : 281.
 1892. *Zeuzera scalaris*, Kirby, *Cat. Lep. Het.* : 871
 1892b *Azygophelps scalaris*, Hampson, *Fauna Brit. India, Moths*, 1 : 310.
 1909. *Azygophelps scalaris*, Lefroy, *Indian Insect Life* : 496.
 1914. *Azygophelps scalaris*, Fletcher, *Some South Indian Insects and other Animals of Importance* : 446.
 1917. *Azygophelps scalaris*, Fletcher, *Rept. Proc. 2nd. Ent. Mtg.* : 73,75,76.
 1918. *Azygophelps scalaris*, Fletcher, *Sci. ent. Rep. agric. Res. Inst. Pusa* : 100.
 1923. *Azygophelps scalaris*, Dalla-Torre, *Lepid. Cat.*, 29 : 44.
 1929. *Azygophelps scalaris*, Gaede, in Seitz *Macrolepidoptera of the World*, 14 : 545.
 1933. *Azygophelps scalaris*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 821.
 1939. *Azygophelps scalaris*, Hutson, *Adm. Rept. Agric. Ceylon* : D37—42.
 1940. *Azygophelps scalaris*, Ayyar, *Handbook of Economic Entomology for South India* : 378,379.
 1945. *Azygophelps scalaris*, Gardner *J. Bombay nat. Hist. Soc.*, 45 (3) : 392.
 1945. *Azygophelps scalaris*, Sevastopulo, *J. Beng. nat. Hist. Soc.*, 19 : 115.
 1960. *Azygophelps scalaris*, Agrawal and Agrawal, *Curr. Sci.*, 29 (8) : 311.

Type : In the cabinet of Emperor of Austria (*vide* Westwood, 1838).

Hosts : *Sesbania aculeata* (Bengal) ; *S. grandiflora* ; *S. speciosa* (Ceylon) ; *S. aegyptiaca* ; and Sunnhemp.

Head, thorax, wings and abdomen cinerous white. Head with the frontal tufts and the area around the base of antennae beset with orange scales ; the area in between the antennae with black scales. Antennae cinerous white above. Labial palpi and an area immediately below it, on the underside, blackish. Collar whitish or cinerous white, with a line of black scales across it. Thorax with two

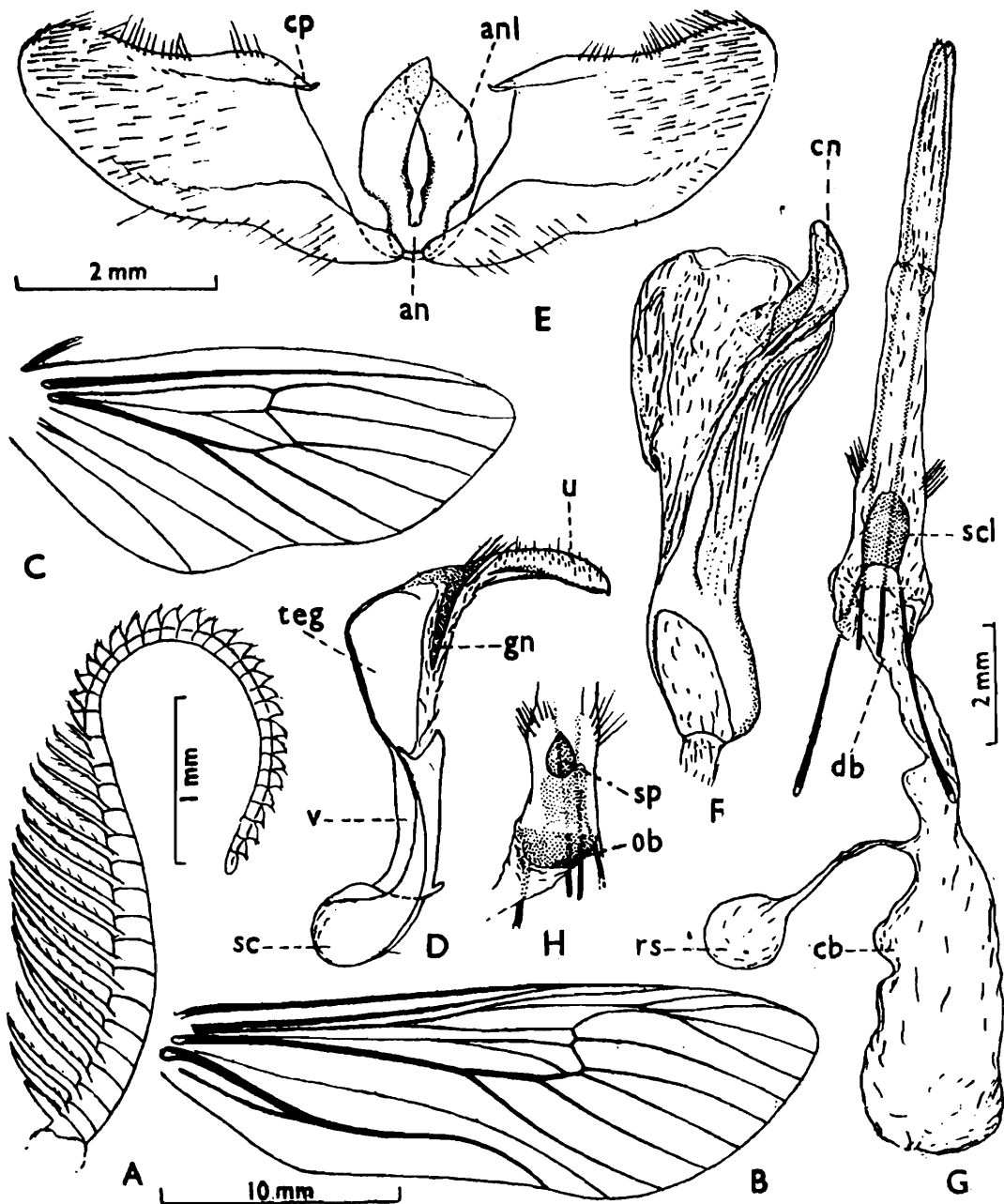
orange stripes dorsally and one each laterally at the base of fore wing, those on the lateral side continuous on the wings and make longitudinal orange markings up to the postmedial area ; orange markings also present on inner margin from base to the end of vein 1A ; several black striae present on the fore wings in and beyond the cell, on costal margin and along the inner margin, and interrupting the orange markings more densely inside the cell ; the area immediately below the cell whitish and without any marking. Hind wings whitish, unmarked. Underside white, except for the thoracical sternite, fore femora, middle and hind tarsi, which are black.

Antennae (Text-fig. 9A) bipectinate up to the basal half in both sexes, pectination much shorter in female than in the male ; the longest rami as long as four to five segments in the male and three to four in the female ; the shaft with 44-54 segments in male, with the pectinate branches up to 16-19 segments, the distal part of antennae, in both sexes, serrate, the tip simple. Labial palpi minute, not projecting beyond the frontal tufts. Wings with a single stout frenulum spine in male and three in female ; retinaculum in the male in the form of an elongate lobe. Claws with a well developed arolium.

Venation (Text-fig. 9 B-C).—Generally as for the genus. Lower branch of median in the fore wing ending between M_3 and Cu_{1a} .

Genitalia.—Male (Text-fig. 9 D-F) : Uncus sclerotised, about four times as long as its width in the middle, the distal portion narrow and ending into a downwardly-pointed acuminate tip. Gnathos weakly developed, slender and free. Tegumen subtriangular, shorter than vinculum ; saccus large and subrounded. Claspers short and broad, only about twice as long as the width in middle ; the distal part narrow and rounded. Juxta semicircular, without median lobe ; lateral lobes broad basally, narrowing gradually towards the apex. Aedeagus with the basal portion smaller than the apical part, the former more sclerotised than the latter which is membranous and striated ; a hard cornutal process, as described in the generic character, present. Female (Text-fig. 9 G-H) : Ostium bursae weakly sclerotised ; ductus bursae unsclerotised, long and tubular ; corpus bursae large sac like, without signum ; receptaculum seminalis almost rounded, connected with the corpus bursae by a fine duct, ductus spermathecus ; the genital plate sclerotised dorsally, the ventral side with a small oval-shaped sclerotised patch.

Measurements.—Wing expanse : Male, 37-44 mm. ; female, 37-60 mm. Length : fore wing ; Male, 18-22 mm. ; female, 18-28 mm. Hind wing : Male, 12-17 mm. ; female, 12-20 mm. Body : Male, 20-27 mm. ; female, 20-35 mm. Abdomen : Male, 15-20 mm. ; female, 14-26 mm.



Text-fig. 9. *Azygophleps scalaris* (Fabricius) : (A) A portion of male antenna showing pectination of one side. (B) and (C) Fore and hind wing venation, respectively. (D) Male genitalia in a lateral view, without claspers. (E) Inner view of the claspers, with juxta. (F) Aedeagus. (G) Female genitalia in a dorsal view. (H) A portion of the female genitalia in a ventral view. (B-C ; D to F ; and G-H of the same magnifications).

Material examined.—26 examples as follows : India : Punjab : Bhuin, 1 ♀, 7.vi.1953 (*E. Venugopalan* coll.) (ex. colln. F.R.I.). Bihar : Pusa, 1 ♂, 1 ♀, 26.v.1917 (*N. P. Nandi* coll.) ; 1 ♀, 15.vi.1918, "Boring Daincha Stem" ; 1 ♀, 9.ix.1926 (*Pillai* coll.) at light ;

1 ♂, 20.x.1927 (*Fletcher* coll.); 1 ♂, 6.ix.1929 (*A. Miyatake* coll.). Bengal : 1 ♀, "Daincha borer attack Bengal", (No further data). Tamil Nadu : Madras, 1 ♀, from stem of *Sesbania grandiflora* (No further data), Coimbatore, 1 ♂, 15.viii.1914, in Daincha stem (*T.B.R. Rao* coll.), 1 ♀, 20.vi.1918 (*S.R.S. Coll.*), 1 ♀ (*M.S. Pillai* coll.) (No further data) (ex. colln. I.A.R.I.). Andhra Pradesh : Bapatla, 5 ♂ ♂, 9 ♀ ♀, -ii.1965 (on sunnhemp) (no further data).

Distribution.—This species is very widely distributed in India and is also known from Burma, Pakistan, Ceylon, Indochina, Indonesia and China.

Remarks.—*Azygophelps scalaris* has been sometimes confused as a species of the genus *Xyleutes* because of the nature of pectination in the male antennae. It can, however, be differentiated by the presence of well developed arolium, which is absent in *Xyleutes*. This species can be separated from the other species by the conspicuous orange frontal tufts, orange markings or stripes on thorax and for having an unmarked area below the cell in fore wings, whereas in the other species, namely *albofasciata* and *pusilla*, the frontal tufts are either brown or blackish brown, the thorax is immaculate and the area below the cell is marked. In the genitalia the saccus in the male is large and the corpus bursae in the female is without signum, whereas the saccus is small and the corpus bursae with a signum in *albofasciata*. From *pusilla* (Walker) it differs in the absence of medial lobe in the male.

14. *Azygophelps albofasciata* (Moore)

(Pl. I, fig. 10 ; Text-fig. 10)

- 1879 b. *Zenzera albofasciata* Moore, *Descr. Indian Lep. Atk.* : 87 (Type loc.—Darjeeling, India).
 1887. *Zeuzera albofasciata* Cotes & Swinhoe, *Cat. Moths of India* : 232 (Darjeeling).
 1892. *Zeuzera albofasciata*, Kirby, *Cat. Lep. Het.* 872.
 1892 b. *Azygophelps albofasciata*, Hampson, *Fauna Brit. India, Moths*, 1 : 309.
 1899. *Azygophelps albofasciata*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12(4) : 646.
 1923. *Azygophelps albofasciata*, Dalla-Torre, *Lepid. Cat.*, 29 : 43.
 1933. *Azygophelps albofasciata*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 821.
 1934. *Azygophelps albofasciata*, Gaede, in Seitz *Macrolepidoptera of the World*, Suppl. 2 : 244.

Type : In Ber. Mus.

Head with blackish brown frontal tufts and antennae. Labial palpi blackish on sides, paler beneath. Vertex blackish. Collar and

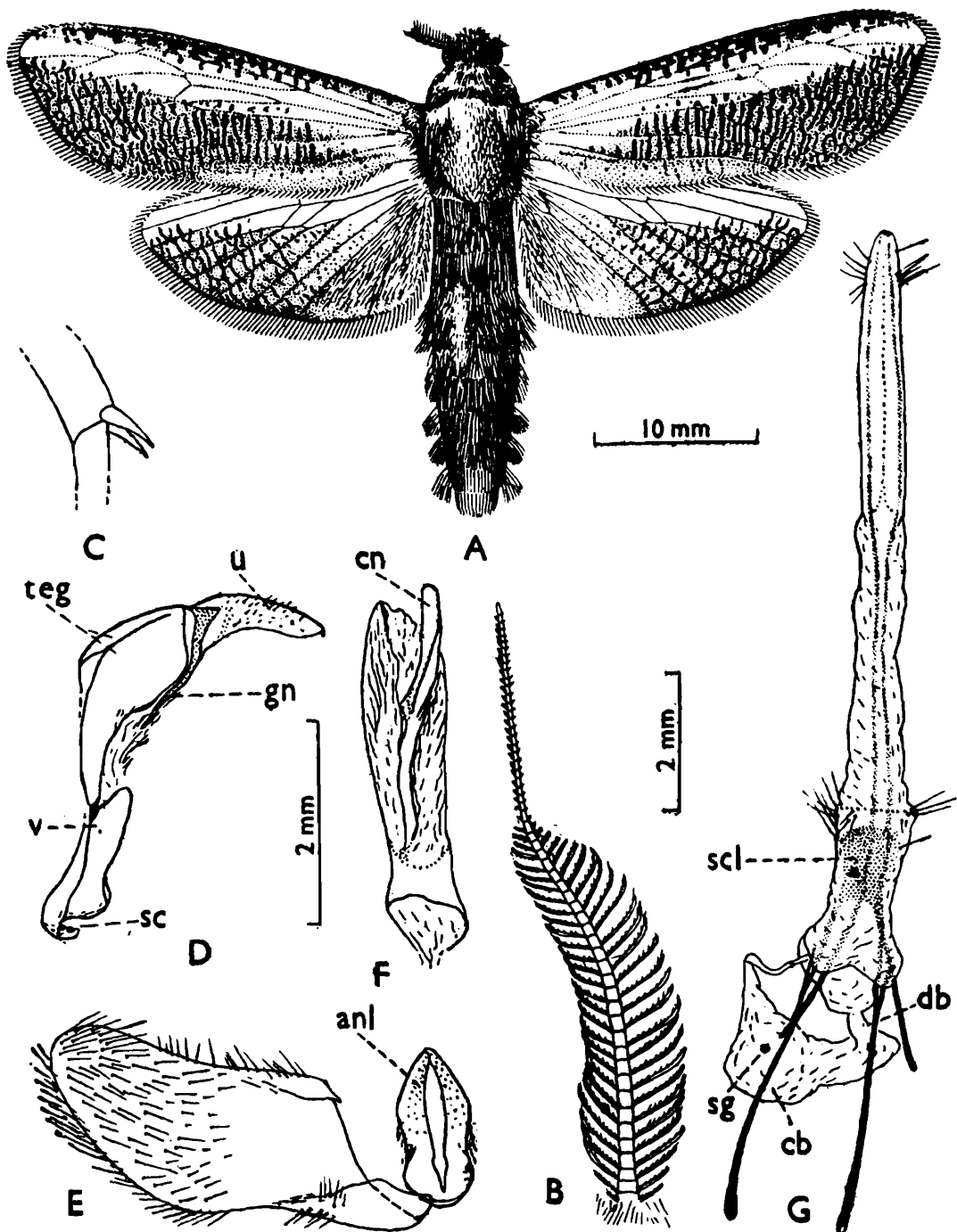
some anterior portion of thorax pale ochreous, the remaining portion of thorax dark-greyish brown. Fore wings greyish-white above the cell, and crossed by several black, confluent striae in the costal area, medial area unmarked, the area below the cell greyish brown and crossed by several black, confluent lines. Hind wings pale greyish; crossed by several delicate and confluent lines below the cell extending from near the middle of vein Cu_2 to the outer margin up to vein Rs; the area below and above the cell unmarked. Abdomen dark greyish brown, darker apically. Underside of both wings marked as on the upper side, but not so prominently; that of abdomen darker and with dark brown lateral tufts. Legs brownish black above, pale beneath.

Antennae (Text-fig. 10B) with 57 segments; bipectinate from base to about two-thirds (up to 32 segments) of length (antennae of the type broken and have only 16 basal segments which have the pectination); pectination nearly of equal length, except at base and the tip, the longest rami about the length of five segments of shaft; the distal one-third part serrate, the last segment simple and conical. Labial palpi short, nearly porrect. Frenulum and retinaculum as given in generic characters. Tibial spurs (Text-fig. 10C) and tarsal spines in the hind legs weakly developed; arolium distinct. Abdomen with lateral tufts.

Venation (Text-fig. 10A).—As given in the generic characters; areole, however, projecting out of the cell angle by about one-third of its length.

Genitalia.—Male (Text-fig. 10D-F): Uncus about two and a half times as long as its width in middle; broad at base and gradually narrowing apically into a downwardly directed acuminate tip. Gnathos very short and narrow, joined to the tegumen on sides. Tegumen broad at apex and narrowing basally. Vinculum short and broad, ending into a short flattened saccus. Clasper short and broad, a little more than two and a half times as long as its width in middle; ventral margin sharply curved inwards at base. Juxta horse-shoe shaped, with long and narrow anellus lobes. Aedeagus short at base; distal portion membranous and weakly striated but with a hard sclerotised process. Female (Text-fig. 10 G): Ostium bursae leading into ductus bursae through a sclerotised pouch; corpus bursae more or less quadrangular and membranous, a short signum present, with a shallow cavity and minute black spines on it; a fine duct arises from the corpus bursae and entering into genital tube to open distally at the ovopore; papilla anales of ovipositor beset with long setae.

Measurements.—Type material.—Expanse: fore wing, 55.5 mm. Length: fore wing, 25 mm.; hind wing, 18.5 mm.; abdomen, 20.5 mm.; whole body, 29 mm.



Text-fig. 10. *Azygophelps albofasciata* (Moore) : (A) An outline drawing of the male type (B) A male antenna showing pectination. (C) A portion of the hind leg with a single pair of tibial spurs. (D) Male genitalia in a lateral view, without claspers. (E) A clasper in inner view, with juxta. (F) Aedeagus. (G) Female genitalia, in a dorsal view. (B, C and G ; and D to F of the same magnifications).

Other material.—Expanse : fore wing, 54-55 mm. Length : fore wing, 25 mm. ; hind wing, 18-19 mm. ; abdomen, 15-20 mm. ; whole body, 25-29 mm.

Material examined.—Five examples as follows : India : West Bengal : Darjeeling : labelled as “Darjeeling 1870”, “*Zenzera albofasciata* type ♂ Moore”, “Original”, “Coll. *Staudinger*”, “Colln. *Atkinson*” (ex. colln. Ber. Mus.) ; Punjeet Valley, 2 ♂♂, 13. iv. 1879, -v.1879 (*C. Z. Peters* coll.). Punjab : 1 ♀ (no further data). Burma : Zibingyi, Maymyi, 1 ♂, 2. iv. 1937, (*P. F. Garthwaite* coll.) (ex. colln. F.R.I.).

Distribution.—India, (Kashmir, Punjab, West Bengal and Sikkim).

Remarks.—Referable to the genus *Azygophelps* it is characterised by the presence of a well developed arolium between the claws, spines on tarsi and well developed labial palpi. This species can be confused as a species of the genus *Phragmataecia* for having the antennal-pectination up to the basal two-thirds but is distinctly separable by the above characters.

It can be differentiated from the other species of the genus by the unmarked median area, whereas in the other species, except *nurella*, the median area is marked either completely or partly.

In respect of female genitalia it is also characterised by the presence of signum on corpus bursae unlike in *pusilla* (Walker) and *scalaris* (Fabricius), where it is absent.

15. *Azygophelps pusilla* (Walker)

(Pl. I, figs. 11, 12; Text-fig. 11)

1856. *Zeuzera pusilla* Walker, *List. Lep. Brit. Mus.*, 7 : 1538 (Type loc.—N. India).
 1886. *Zenzera pusilla*, Butler, *Ill. Lep. Het.*, 6 : 28, pl. cvii, fig. 9.
 1887. *Zeuzera pusilla*, Cotes & Swinhoe, *Cat. Moths of India* : 234.
 1892. *Zeuzera pusilla*, Swinhoe, *Cat. East. & Aust. Lep. Ox. Univ. Mus.*, 1 : 281.
 1892. *Zeuzera pusilla*, Kirby, *Cat. Lep. Het.* : 872.
 1892 b. *Azygophelps pusilla*, Hampson, *Fauna Brit. India, Moths*, 1 : 310.
 1909. *Azygophelps pusilla*, Lefroy, *Indian Insect Life* : 496.
 1923. *Azygophelps pusilla*, Dalla-Torre, *Lepid. Cat.*, 29 : 43.
 1933. *Azygophelps pusilla*, Gaede, in *Seitz Macrolepidoptera of the World*, 10 : 821.

Type : In B. M

Head, thorax, abdomen and wings brownish or whitish to pale brown. Antennae, labial palpi and frontal tufts brown. Fore wing marked with several dark brown striae all along its length except in the cell ; some striae beyond the cell, coalescing into fine lines, marginal spots dark brown and prominent. Hind wings whitish, without

any markings. Underside of the fore wings pale brown, markings as on the upper side; hind wings pale brown; abdomen brown or dark brown beneath. Legs blackish above and somewhat paler on the underside; with a prominent segmental band on tarsi.

Antennae with 43-45 segments and bipectinate in the basal 20-23 segments in both the sexes; the distal half with uniserrate branches, rami longer in male than in the female, the longest rami as long as four to five segments. Labial palpi short and porrect. Frenulum bristle single in male and three in female; retinaculum in the male reduced to a small elongate lobe. Legs with a single pair of short spurs on the hind tibia; tarsal spines rather poorly developed; claws with a well developed arolium.

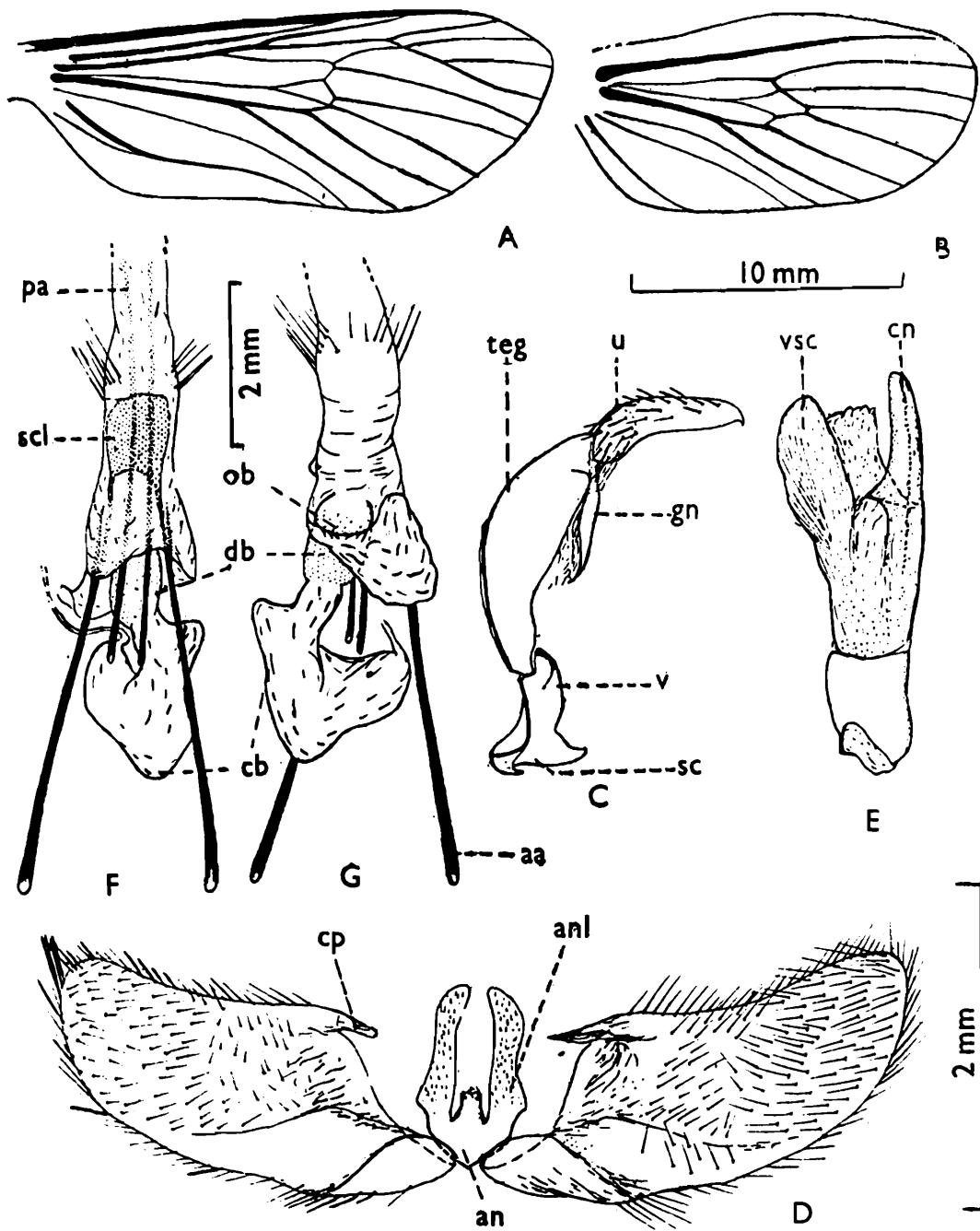
Venation (Text-fig. 11 A-B).—As for the genus. The lower branch of median in fore wing, however, ending at M_3 ; areole projecting half its length, or slightly more, outside the cell.

Genitalia.—Male (Text-fig. 11 C-E): Uncus about two-and-a-half times as long as its width in the middle, broad at base and gradually narrowing distally to a shortly acuminate, downwardly pointed tip. Gnathos short, narrow and attached to tegumen on sides. Tegumen long and narrow, somewhat broader apically; saccus very small. Clasper short and broad, about twice as long as the width in middle; costa produced inside into a costal prolongation. Juxta short, with a median and two lateral lobes. Aedeagus well built; the base short and more sclerotised than the large, rather membranous and striated distal part; with hard sclerotised process on one side from the middle. Female (Text-fig. 11 F-G): Ostium bursae simple, weakly sclerotised; ductus bursae short and broad, sclerotised in its basal half; corpus bursae more or less triangular, without signum and receptaculum seminalis; a fine duct arises from the corpus bursae directly and enters into the genital tube to open at the ovopore. Other features as in *albofasciata*.

Measurements.—Expanse: fore wing; Male, 29-31 mm.; female, 35-38 mm. Length: Fore wing: Male, 12-13.5 mm.; female, 15 mm. Hind wing: Male, 8.5-10 mm.; female, incomplete and damaged in the material. Whole body: Male, 14 mm.; female, incomplete and damaged.

Material examined.—India: Mysore: Bangalore, 1 ♀ (no further data), 1 ♂, 17.vii.1912 (*Fletcher* coll.); Bababundin Hills, 1219.2m.—1524 m., 1 ♂, 2-12.xi.1942 (*Fletcher* coll.). Bihar: Pusa, 1 ♂, 7.vii.1926 (*G. P. Pillai* coll.); Chapra, 3 ♂ ♂, 1 ♀ (*Mackenzie* coll.) (no date) (all, ex. colln. I.A.R.I.).

Distribution.—India (N. India, Bengal, Bihar, Mysore, Deccan, Tamil Nadu).



Text-fig. 11. *Azygophelps pusilla* (Walker) : (A) and (B) Fore and hind wing venation, respectively. (C) Male genitalia in a lateral view, without claspers. (D) Inner view of the claspers, with juxta. (E) Aedeagus. (F) A portion of the female genitalia in a dorsal view. (G) A portion of the female genitalia in a ventral view. (A-B ; C to E ; and F-G of the same magnifications).

Remarks.—Referable to the genus *Azygophelps*, it is close to the other Indian species in respect of its bipectinate antennae and the male genitalia. It, however, can be easily differentiated for having the fore wings marked with dark brown striae throughout their length except in the cell. For detailed differences see under *scalaris* and *albofasciata*.

16. *Azygophelps nurella* Swinhoe

1894. *Azygophelps nurella* Swinhoe, *Ann. Mag. nat. Hist.*, (6) 14 : 440 (Type loc.—Cherrapunji, Assam) (Now Meghalaya, India).
 1895. *Azygophelps nurella* Swinhoe, *Trans. ent. Soc. Lond.* : 29.
 1896a. *Azygophelps nurella*, Hampson, *Fauna Brit. India, Moths*, 4 : 473.
 1923. *Azygophelps nurella*, Dalla-Torre, *Lepid. Cat.*, 29 : 43.
 1933. *Azygophelps nurella*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 821.

Type : In B.M

As specimens of this species were not available for study, the original description of the species is reproduced here. “♂ Palpi and Frons black ; top of head, thorax, abdomen, and both wings, grey, tinged with ochreous ; a brown band behind the head ; abdomen with grey bands. Fore wing with a grey costal border, the inner portion of the wing suffused with darker ochreous ; both wings without markings. Below, of the same uniform colour, without markings, except the legs, which have black bands on the tarsi.

Expanse of wings $2 \frac{1}{10}$ inches.

Cherrapunji, “One example.”

Distribution.—India (Meghalaya, Assam).

Remarks.—From the above description it can be differentiated from the other species of *Azygophelps* by the complete absence of markings on the wings, unlike other species where the wings are marked by striae, either in cell or outside.

Genus *Phragmataecia* Newman

1822. *Zeuzera* Hübner [*nec* Lat.], *Verz. bek. Schmett.* : 196 (Type *Bombyx arundinis* Hübner) [generic name preoccupied].
 1836. *Macrogaster* Duponchel, *Hist. Nat. Lep. Fr.* : 136 (Type *Bombyx arundinis* Hübner) [generic name preoccupied].
 1844. *Macrogaster* Duponchel, *Cat. Lep. d' Eur.* : 81.
 1850. *Phragmataecia* Newman, *Zoologist*, 8 : 2931 (Type *Bombyx castaneae* Hübner from Europe)
 1854. *Rhizoma* Herrich-Schäffer, *Samml. Ausser. Schmett.* : 7 (Type *R. pallens* Herr.—Sch.)
 1854. *Phragmataecia*, Herrich-Schäffer, *Samml. Ausser. Schmett.* : 58.
 1856. *Phragmataecia*, Walker, *List Lep. Brit. Mus.*, 7 : 1549.
 1865. *Phragmataecia*, Walker, *List Lep. Brit. Mus.*, 32 : 590.
 1879b. *Phragmataecia*, Moore, *Descr. Indian Lep. Atk.* : 87.
 1880. *Phragmataecia*, Snellen, in Veth *Midden Sumatra Lep.* : 39.

1884. *Phragmataecia*, Swinhoe, *Proc. zool. Soc. Lond.* : 515.
 1886. *Phragmataecia*, Swinhoe, *Proc. zool. Soc. Lond.* : 441.
 1887. *Phragmataecia*, Cotes & Swinhoe, *Cat. Moths of India* : 234.
 1890. *Phragmataecia*, Swinhoe, *Trans. ent. Soc. Lond.* : 199.
 1891. *Phragmataecia*, Hampson, *Ill. Lep. Het. Brit. Mus.*, 8 : 11, 16.
 1892. *Phragmataecia*, Swinhoe, *Cat. East & Aust. Lep. Het. Ox. Univ. Mus.* : 285.
 1892b. *Phragmataecia*, Hampson, *Fauna Brit. India, Moths*, 1 : 312.
 1892. *Phragmataecia*, Kirby, *Cat. Lep. Het.*, 1 : 876.
 1899. *Phragmataecia*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 (4) : 646.
 1900. *Phragmataecia*, Piepers & Snellen, *Tijdschr. Ent.*, 43 : 37, 43.
 1901. *Phragmataecia*, Staudinger & Rebel, *Cat. Lep. Pal. Fnggeb.*, 1 : 409.
 1912. *Phragmataecia*, Seitz, in *Seitz Macrolepidoptera of the World*, 2 : 429.
 1918. *Phragmataecia*, Turner, *Trans. ent. Soc. Lond.*, 66 : 160, 163, 179.
 1923. *Phragmataecia*, Dalla-Torre, *Lepid. Cat.*, 29 : 45.
 1929. *Phragmataecia*, Gaede, in *Seitz Macrolepidoptera of the World*, 14 : 541.
 1933. *Phragmataecia*, Gaede, in *Seitz Macrolepidoptera of the World*, 10 : 821.
 1933. *Phragmataecia*, Mehta, *Rec. Indian Mus.*, 35 : 232.
 1940. *Phragmataecia*, Daniel, *Mitt. münch. ent. Ges.*, 30 : 1017.
 1951b. *Phragmataecia*, Viette, *Lambillionea*, 51 (11—12) : 68.
 1957. *Phragmataecia*, Roepke, *Verh. K. ned. Akad. Wet. Afd. Nat.*, (2) 52 (1) : 39.
 1959b. *Phragmataecia*, Clench, *Veröff. Zool. StSamml. Münch.*, 6 : 9.
 1965. *Phragmataecia*, Müller, *Dt. ent. Z.*, 12 (3) : 240.

Type-species : *Bombyx castaneae* Hübner

(a) *General*

The genus *Phragmataecia* was erected by Newman (1850) to include an European species *Bombyx castaneae* Hübner which is also known from the Indian subregion. Hampson (1892b) in his '*Fauna of British India*' recognised only two species, viz. *P. castaneae* Hübner and *P. impura* Hampson. The species *P. saccharum* Moore from Darjeeling (India), *P. minor* Moore from Sylhet (Bangladesh) and *P. minima* Hampson, from Nilgiris (India), described earlier, were treated by him (*loc. cit.*) as synonyms of the species *castaneae*. Piepers and Snellen (1900), however, recognised *P. minima* as a synonym of *P. sumatrensis* Snellen. Turner (1918) transferred *Cossus parvipunctus* Hampson to this genus. Fletcher (1928) added two species by describing *P. terebrifer* and *P. purpureus*, from Pusa (Bihar) and Arora (1974) added another species, i.e., *P. dudgeoni* from Bhutan. Thus, so far only six species were known from the Indian subregion.

During the present study of the Indian Cossidae a few more species, viz. *Zeuzera stigmatica* Moore, *Cossus pallidalae* Hampson, *Xyleutes clara* Bryk and *X. obliquifascia* Bryk have also been transferred to the genus *Phragmataecia* Newman. All the ten species,

thus recorded, are redescribed here and adequately figured from the actual specimens. Types of the species *stigmaticus* (Moore), *clara* (Bryk), *obliquifascia* (Bryk), *terebrifer* Fletcher, *purpureus* Fletcher, *saccharum* Moore and *minor* Moore, of which the latter two are synonymised with *P. castaneae*, have been examined and figured.

(b) *Characters of the Genus Phragmataecia* Newman

Antennae bipectinate, nearly up to three-fourths of their length in male and up to the basal half in female ; distal part serrate and the tip simple. Labial palpi short and either porrect or slightly directed downwards. Wings long and narrow in female, somewhat broader in male. Frenulum spines single in male, 3 to 4 in female ; retinaculum in male in the form of a short or elongate lobe. Legs without tarsal spines ; hind tibiae with a single pair of minute spurs ; claws with a distinct arolium.

Fore wing with a small to moderately long areole ; the latter projecting outside the cell by about one-fifth to half its length and either normal or distorted by the union of upper branch of median with chorda ; veins R_1 and R_2 arise from areole ; R_3 generally connate with $R_4 + R_5$ or stalked ; M_1 either from above the upper angle, or from angle or from below the angle of cell ; M_2 and M_3 close to one another ; median cell with the lower branch ending variably between veins M_1 and Cu_{1b} . Hind wings with the vein Sc free ; veins $Rs - M_1$ wide apart ; the upper and lower branches of median vein ending between $M_1 - M_2$ and $Cu_{1b} - M_3$, respectively. Male genitalia simple : Uncus either pointed into a hook-like apex (*castaneae*, *impura*, *pallidalae* and *purpureus*) or simply narrowed (*stigmaticus*, *clara* and *obliquifascia*) or blunt and rounded (*parvipunctus*, *tetebrifer* and *dudgeoni*). Gnathos absent. Claspers simple, without any chitinization. Juxta present. Aedeagus usually simple, long and slender.

Female genitalia short and stout ; genital plate generally sclerotised on both dorsal and ventral sides.

(c) *Relationships of the genus Phragmataecia*
with the other allied Genera

The genus *Phragmataecia* Newman can be well differentiated from other Zeuserinae genera by the antennae which are bipectinate up to two-thirds or three-fourths of length in the male, and slightly less so in the female. By this character and by the presence of arolium in between the claws, it comes close to the genus *Azygophelps*, but differs from the latter in the absence of tarsal spines and gnathos in the male genitalia. From *Xyleutes* and *Zeuzera*, it differs in the antennae which are bipectinate up to two-thirds or three-fourths, whereas

in the other two genera the pectination is up to the basal half, and by the absence of tarsal spines which are present in *Xyleutes* and *Zeuzera*. It can also be differentiated from *Xyleutes* by the presence of arolium which is absent in the latter.

In respect of the wing venation the genus is very important. On one hand it resembles the Cossinae group of genera due to the ending of the lower branch of the median veins between veins M_1-M_3 or at M_3 in the fore wing, and on the other hand it resembles the other Zeuzerinae group of genera where the lower branch of the median ends either at the vein M_3 or between the veins Cu_{1a} and M_3 . In the male genitalia too it shows an interesting change in the shape of the uncus which is either rounded apically (*P. dudgeoni*, *P. parvipunctus* and *P. terebrifer*), resembling species of the genus *Catopta*, viz. *cashmirensis* (Moore) and *sikkimensis* (Arora), or acuminate as in most of the other Zeuzerinae genera. Gnathos is also absent which brings it close to some of the *Zeuzera* species, in this respect.

(d) *Geographical distribution of the Genus Phragmataecia*

The genus *Phragmataecia* Newman is widely distributed and is known from the Oriental, Australian, Palaearctic, Ethiopian and Neotropical regions.

In the Indian subregion it is known from India (Bihar, West Bengal, Assam, Arunachal Pradesh, Tamil Nadu, Sikkim), Bhutan, Bangladesh, Burma and Ceylon.

(e) *Key to the Indian species of the Genus Phragmataecia*

- | | |
|--|---|
| 1. Fore wing without stigmata | 2 |
| Fore wing with stigmata | 8 |
| 2. Uncus in male genitalia ending apically in a hooked tip; aedeagus simple and not differentiated. Lower branch of median in fore wing ending either between $Cu_{1a}-M_3$ or between M_2-M_3 or beyond M_3 | 3 |
| Uncus ending apically in a rounded tip; aedeagus differentiated into basal and apical portion. Lower branch of median always ending between M_2-M_3 | 6 |
| 3. Areole in fore wing distorted | 4 |
| Areole in fore wing normal | 5 |

4. Lower branch of median in fore wing ending at discocellular near M_2 , and that of hind wing between Cu_{1a} — M_3 but nearer Cu_{1a} . Uncus in male genitalia long and narrow

castaneae (Hübner)

Lower branch of median in fore wing ending at M_3 , and that of hind wing between Cu_{1a} — M_3 but nearer M_3 . Uncus short and stout..

impura Hampson

5. Areole in fore wing large, projecting outside the cell by more than half its length; vein M_1 arises from above the cell angle. Tegumen broadly quadrangular. Claspers slightly and narrowly produced at the costal end

purpureus Fletcher

Areole in fore wing small, projecting outside the cell angle by about one-third its length; vein M_1 arises from below the cell angle. Tegumen long and narrow. Claspers strongly and broadly produced into a large fold at the costal end

pallidulae (Hampson) comb.nov.

6. Areole in fore wing projecting outside the cell angle by about one-fifth of its length. Aedeagus small, apical portion narrower than base

terebrifer Fletcher

Areole in fore wing projecting by one-third or half its length. Aedeagus large, apical portion broader than base

7

7. Fore wing without any oblique row of striae in postmedial area; vein 1A in fore wing with a row of three prominent spots. Uncus long, about thrice its width in middle and with straight lateral margins; juxta with oblique margins

parvipunctus (Hampson)

Fore wing with an oblique row of some prominent striae in post-medial area; vein 1A in fore wing

- without any row of distinct spots.
 Uncus short, about one-and-a-half times its width in middle and with excurved sides ; juxta with rounded margins *dudgeoni* Arora
8. Fore wing without any coloured band. Juxta horse-shoe shaped, not produced medially *clara* (Bryk) comb.nov.
- Fore wing with an oblique dark brown band from apex to vein Cu_2 . Juxta rounded and weakly produced medially 9
9. Antennal branches whitish at tips. Oblique band on fore wing ill-defined. Abdomen golden yellow below. Legs with black segmental bands *stigmaticus* (Moore) comb.nov.
- Antennal branches dark brown at tips. Oblique band well defined and prominent. Abdomen blackish below. Legs with whitish bands *obliquifascia* (Bryk) comb. nov.

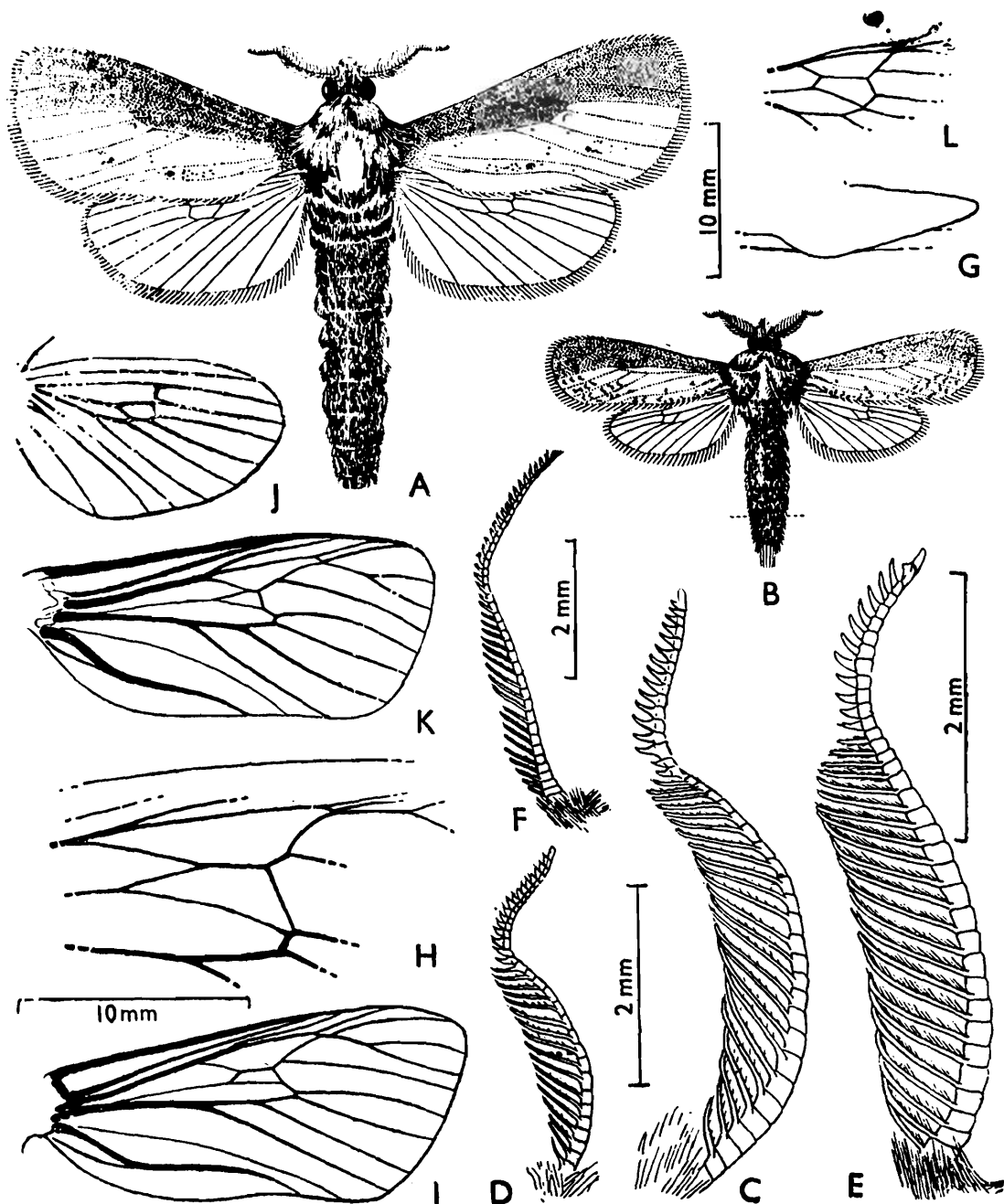
(f) *Description of Species*17. *Phragmataecia castaneae* (Hübner)

(Pl. I, figs. 14-16 ; Text-figs. 12-13)

1790. *Bombyx castaneae* Hübner, *Beitr. Ges. Schmett.*, 2 (1) : 9 (Type loc.— Europe).
1803. *Bombyx arundinis* Hübner, *Samml. Eur. Schmett.* : 151 (Type loc.— Europe).
1807. *Cossus castaneae*, Esper, *Schmett.*, 3 : 97.
1822. *Zeuzera arundinis*, Hübner, *Verz. beck. Schmett.* : 196.
1834. *Zeuzera arundinis*, Boisduval, *Icon. Syst. Lep. Eur.*, 2 : 183.
1836. *Macrogaster arundinis* Duponchel, *Hist. Nat. Lep. Fr.* : 136.
1840. *Zeuzera castaneae*, Boisduval, *Gen. et. Index Meth.* : 76.
1844. *Macrogaster arundinis*, Duponchel, *Cat. Lep. d' Eur.* : 81.
1850. *Zeuzera arundinis*, Harding, *Zoologist*, 8 : 2931.
1850. *Phragmataecia arundinis*, Newman, *Zoologist*, 8 : 2931.
1856. *Phragmataecia arundinis*, Walker, *List Lep. Brit. Mus.*, 7 : 1543.
1865. *Zeuzera innotata* Walker, *List Lep. Brit. Mus.*, 32 : 587 (Type loc.— Shanghai, China) (*syn.* Hampson, 1892b).
- 1879b. *Phragmataecia minor* Moore, *Descr. Indian Lep. Atk.* : 87 (Type loc.— Sylhet, Bangladesh) (*syn.* Hampson, 1892b).

- 1879b. *Phragmataecia saccharum* Moore, *Descr. Indian Lep. Atk.* : 87 (Type loc.—Darjeeling, India) (*syn.* Hampson, 1892b).
1880. *Phragmataecia sumatrensis*, Snellen, in Veth *Midden Sumatra Lep.* : 39 (Type loc.—Sumatra) (*syn.* Seitz, 1912)
1886. *Phragmataecia minor*, Swinhoe, *Proc. zool. Soc. Lond.*, 441 (Mhow).
1887. *Phragmataecia saccharum*, Cotes & Swinhoe, *Cat. Moths of India* : 234.
1887. *Phragmataecia minor*, Cotes & Swinhoe, *Cat. Moths of India* : 234.
1890. *Phragmataecia minor*, Swinhoe, *Trans. ent. Soc. Lond.* : 199.
1891. *Phragmataecia minima* Hampson, *Ill. Lep. Brit. Het. Mus.*, 8 : 11 (Type loc.—Nilgiris) (*syn.* Hampson, 1892b, Piepers & Snellen, 1900).
1891. *Phragmataecia castaneae*, Hampson, *Ill. Lep. Het. Brit. Mus.*, 8 : 11.
- 1892b. *Phragmataecia castaneae*, Hampson, *Fauna Brit. India Moths*, 1 : 313.
1892. *Phragmataecia castaneae*, Swinhoe, *Cat. East. & Aust. Lep. Ox. Univ. Mus.* : 285.
1892. *Phragmataecia castaneae*, Kirby, *Cat. Lep. Het.* : 876.
1892. *Phragmataecia saccharum*, Kirby, *Cat. Lep. Het.* : 876.
1892. *Phragmataecia minor*, Kirby, *Cat. Lep. Het.* : 876.
1892. *Phragmataecia innotata*, Kirby, *Cat. Lep. Het.* : 876.
1892. *Phragmataecia minima*, Kirby, *Cat. Lep. Het.* : 876.
1899. *Phragmataecia castaneae*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 (4) : 646.
1900. *Phragmataecia sumatrensis*, Piepers & Snellen, *Tijdschr. Ent.*, 43 : 43-44.
1901. *Phragmataecia castaneae*, Staudinger and Rebel, *Cat. Lep. Pal. Fnggeb.* : 409.
1912. *Phragmataecia castaneae*, Seitz, in Seitz *Macrolepidoptera of the World*, 2 : 429—430.
1917. *Phragmataecia castaneae*, Fletcher, *Rept. 2nd. Ent. Mtg.* : 152.
1918. *Phragmataecia castaneae*, Turner, *Trans. Ent. Soc. Lond.*, 66 : 160, 180.
1923. *Phragmataecia castaneae*, Dalla-Torre, *Lepid. Cat.*, 29 : 45.
1929. *Phragmataecia castaneae*, Gaede, in Seitz *Macrolepidoptera of the World*, 14 : 548.
1933. *Phragmataecia castaneae*, Mehta, *Rec. Indian Mus.*, 35 : 232.
1933. *Phragmataecia castaneae*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 821.
1934. *Phragmataecia castaneae*, Gaede, in Seitz *Macrolepidoptera of the World*, Suppl. 2 : 244.
1940. *Phragmataecia castaneae*, Daniel, *Mitt. münch. ent. Ges.*, 30 : 1017.
1951. *Phragmataecia castaneae*, Viette, *Lambillionea*, 51 (11—12) : 68.
1957. *Phragmataecia castaneae*, Roepke, *Verh. K. ned. Akad. Wet. Afd. Nad.*, (2) 52 (1) : 39.
- 1959b. *Phragmataecia castaneae*, Clench, *Veröff. Zool. St.Samml. Münch.*, 6 : 9.
1965. *Phragmataecia castaneae*, Müller, *Dt. ent. Z.*, 12 (3) : 240.

Types : *castaneae* (Hübner).—repository not known; *innotata* (Walker) and *minima* Hampson—in B.M.; *saccharum* Moore and *minor*—in Ber. Mus.



Text-fig. 12. *Phragmataecia castaneae* (Hübner) : (A) and (B) Outline drawings of the male types of *saccharum* and *minor*, respectively. (C) and (D) Antennae of the type specimens 'A' and 'B', respectively, showing pectinations of one side. (E) and (F) Male and female antennae, respectively, of other specimens. (G) Retinaculum in *saccharum*. (H) A portion of fore wing in *saccharum* showing venation. (I) and (J) Fore and hind wing venation, respectively in other specimens. (K) and (L) Portions of fore wing of two different specimens showing some variations in venation. (A-B ; C-D and G-H ; and I to L of the same magnifications).

Hosts : *Arundo phragmites* and *Saccharum spontaneum*.

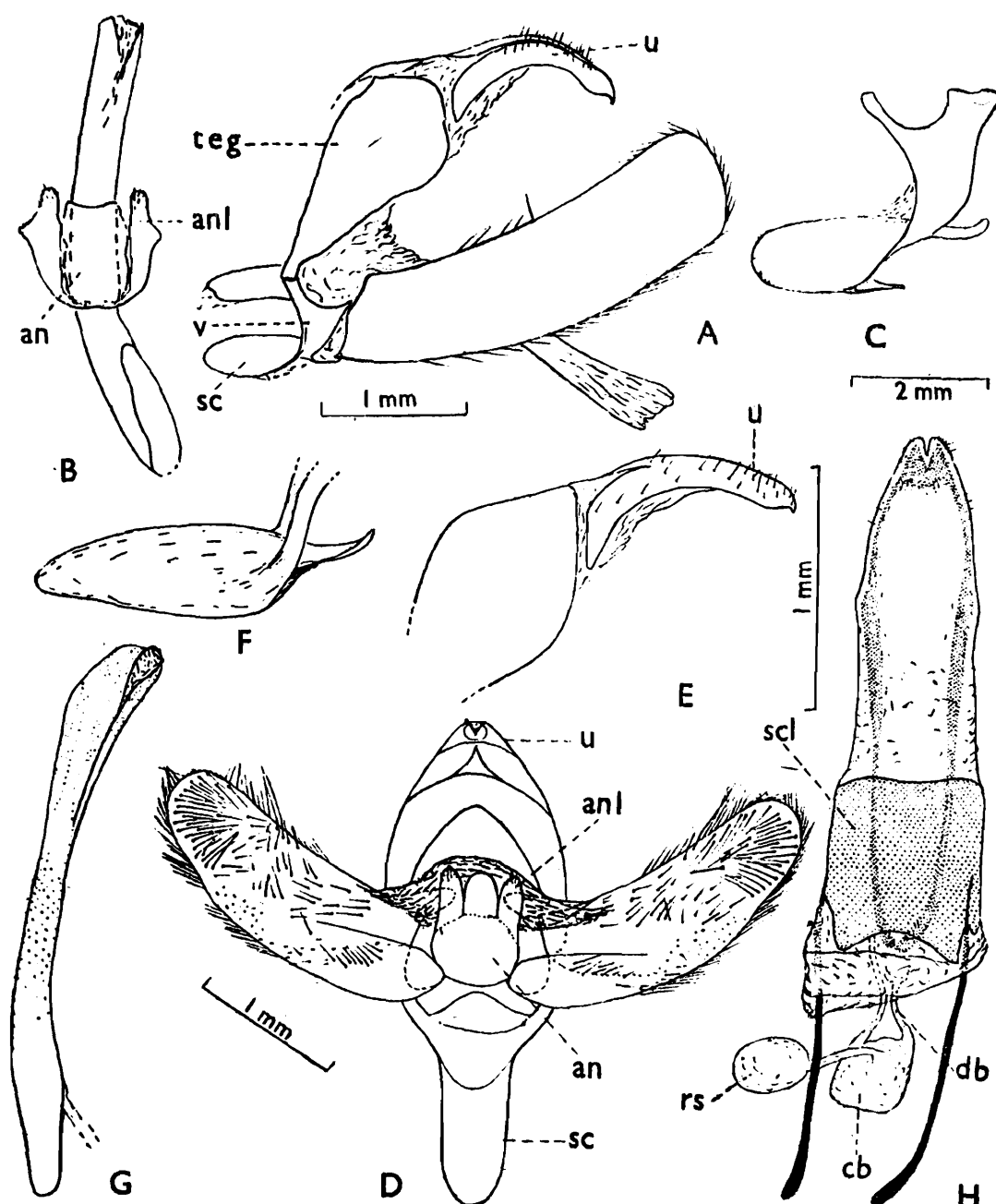
Head and thorax ochreous brown. Frontal tufts brownish ochreous. Antennae with shafts and branches ochreous above and brown beneath. Labial palpi greyish ochreous beneath, brownish ochreous above. Fore wings brownish ochreous in upper half and a part of the inner margin; with an indistinct brownish spot above the submedian; striae forming an indistinct brownish patch in the inner area and a spot at the lower angle of cell. Hind wings ochreous. Abdomen greyish ochreous. Underside, immediately behind the head, blackish brown. Legs and thoracical sternites brownish ochreous.

Antennae (Text-fig. 12C-F) with 36-41 segments; bipectinate up to basal half or two-thirds its length, the distal part serrate; the tip simple; branches or the rami longest in middle, and gradually decreasing both towards the base and the apex, the longest ones as long as six middle segments in male and four in the female. Labial/palpi short. Wings about twice the width in the middle; frenulum bristle single in male and four in female; retinaculum (Text-fig. 12G) elongate. Hind tibiae with a pair of minute tibial spurs; tarsal spines wanting; claws with a well developed arolium. Abdomen longer than hind wings and about as long as the fore wings.

Venation.—Fore wing (Text-fig. 12H-I, K-L) : Areole moderately large; projecting outside the cell angle by one-third its length and distorted by the union of chorda with upper median branch; vein R_1 arises from areole, near its origin, and in line with the origin of the median cell; R_2 from near the tip of areole; R_3 shortly anastomosed with $R_4 + R_5$; M_1 from above the upper angle and M_2 from above the lower angle of cell; Cu_{1a} from the lower angle and close to M_3 ; lower median ending at M_2 or between M_1-M_2 . Hind wings (Text-fig. 12J) : the venation as given in generic characters.

In certain examples, the upper median in fore wing ends at the upper angle of cell or rarely below it, the lower median ending at Cu_{1a} ; and Cu_{1a} and M_3 separate at bases in fore wings.

Genitalia.—Male (Text-fig. 13 A-G) : Uncus sclerotised on sides; about three times as long as its width in middle; distal half narrow and curved at about right angle to the lower half from the middle; the basal portion broad; the apex pointing downwards. Tegumen broadly conical. Saccus cylindrical and variable in size. Clasper simple, about three times as long as its width and either uniformly broad or weakly narrowed distally; costa produced inwards into a short prolongation. Juxta with a reduced median lobe, and two lateral blunt elongations (in one example with a distinct median lobe



Text-fig. 13. *Phragmataecia castaneae* (Hübner) : (A) Male genitalia in a lateral view, of the type of *saccharum*. (B) Aedeagus and anellus of 'A'. (C) Vinculum and saccus of another specimen. (D) Male genitalia in an inner view, with claspers. (E) and (F) Uncus and saccus, respectively, of 'D'. (G) Aedeagus of 'D'. (H) Female genitalia in a dorsal view. (A-B; C, E & F; D & G of the same magnifications).

and two shorter lateral ones), the latter with short and fine setae. Aedeagus simple, slender, elongate and not differentiated into base and apex. Female (Text-fig. 13H) : Ostium bursae simple ; ductus bursae weakly sclerotised ; corpus bursae membranous, more or less rectangular in shape and without signum ; receptaculum seminale connected with the former by a fine duct , posterior apodemes slightly extending beyond the genital plates.

Measurements.—Type material.—Expanse : fore wing, 26 mm. (*minor*) and 42 mm. (*saccharum*). Length : fore wing, 11 mm. (*minor*) and 19 mm. (*saccharum*) ; hind wing, 8 mm. (*minor*) and 15 mm. (*saccharum*) ; abdomen, 19 mm. (*saccharum*) whole body, 27 mm. (*saccharum*).

Other material.—Expanse : male, 26-42 mm.; female, 31-57 mm. Length : Fore wing ; male, 11-19 mm., female, 14-25 mm. Hind wing : male, 8-15 mm. ; female, 10.5-19 mm. Abdomen : male, 9-19 mm. ; female, 11-21 mm. Body : male, 12-27 mm., female, 15-32 mm.

Material examined.—19 examples as follows : India : West Bengal : Darjeeling, 1 ♂, labelled as “Darjeeling, 1870 coll. *Staudinger*, coll. *Atkinson*”, (Type of *saccharum* Moore ; ex. colln. Ber. Mus.). Assam : Kaziranga, 1 ♀, 6.x.1961 (*R. N. Katiyar* coll.) ; Gauhati, 1 ♂, (labelled as *P. minor*) (*Fletcher* coll.). Bihar : Pusa, 1 ♀, 10.x.1933 (*H. N. Batri* coll.), 1 ♀, 11.xi.1923 (*Peries* coll.) (ex. colln. I.A.R.I.). Sikkim : 1 ♂, -.vi.1896 ; 2 ♂ ♂, -.vii.1896 ; 1 ♂, -.ix.1897 ; 1 ♂, 2 ♀ ♀, -.x.1897 ; (all *G. C. Dudgeon* coll.). Burma : Mohnyin R., Katha Burma, 1 ♂, 1 ♀, 20.v.1919 (*C.F.C. Beeson* coll.) (ex. colln. F.R.I.). Ceylon : Tangla, 2 ♂ ♂, -.iii.1902 ; Eppawala, 1 ♂, -.ix.1905 ; Kandy, 1 ♂, -.v.1911 (all *E. E. Green* coll.). Bangladesh : Sylhet 1 ♂, labelled as “Sylhet Jheels, Sept., 1867, coll. *Staudinger*, coll. *Atkinson*”, (Type of *P. minor* ; ex. colln. Ber. Mus.).

Distribution.—It is mainly a Palaearctic species and is known from north and middle Europe, northern Asia, from Turkistan to China and Japan. In Oriental region, it is known from India (West Bengal, Assam, Madhya Pradesh, Tamil Nadu and Sikkim), Bhutan, Bangladesh (Sylhet), Burma, Ceylon and Indonesia.

Remarks.—The species is very variable and it is one of the reasons that it has been described under several different names. The types of *P. saccharum* Moore and *P. minor* Moore, received from Berlin Museum, were examined. They were found to be generally identical with the other material of the species available to me for study. The size, however, is very variable and the measurements of the types of both species fall in the range of variations.

It can be differentiated from *P. impura*, by the colouration of fore wing which is brownish ochreous (blackish brown in *P. impura*) ; from *P. clara*, *P. stigmaticus* and *P. obliquifascia* by the absence of stigmata ; from *P. parvipunctus* and *P. dudgeoni* by the absence of strigae on fore wings, and *P. pallidalae*, *P. purpureus* and *P. terebrifer* by the distorted areole in the fore wings.

In respect of male genitalia the species is characterised by the presence of hooked-tip of uncus. By this character it comes close to the species *impura*, *purpureus* and *pallidalae*, but can be easily separated for its long and narrow uncus from *impura*; by its broadly conical tegumen, which is broadly quadrate in *purpureus* and long and sharply conical in *pallidalae*.

18. *Phragmataecia impura* Hampson

(Pl. II, figs. 17-18; Text-fig. 14)

1891. *Phragmataecia impura* Hampson, *Ill. Lep. Het. Brit. Mus.*, 8 : 66 (Type loc.—Nilgiris, India).
 1892b. *Phragmataecia impura* Hampson, *Fauna Brit. India, Moths*, 1 : 313.
 1892. *Phragmataecia impura*, Kirby, *Cat. Lep. Het.* : 876.
 1892. *Phragmataecia gummata* Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.*, : 285 (Type loc.—Java).
 1900. *Phragmataecia impura*, Piepers and Snellen, *Tijdsch. Ent.*, 43 : 44, 45.
 1918. *Phragmataecia impura*, Turner, *Trans. ent. Soc. Lond.*, 66 : 161.
 1923. *Phragmataecia impura*, Dalla-Torre, *Lepid. Cat.*, 29 : 47.

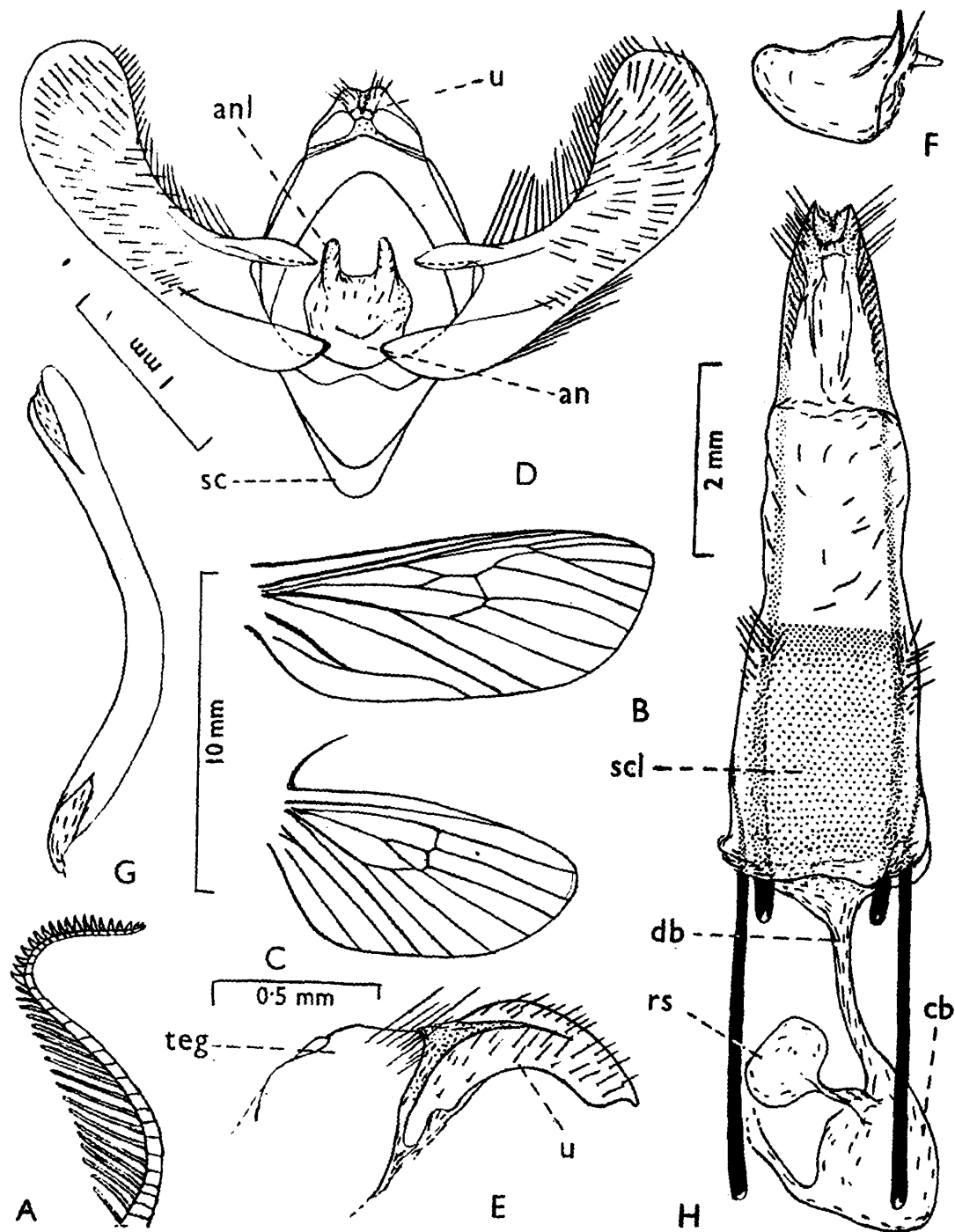
Type : In B.M

Head, thorax and fore wings dark smoky-black. Antennae and frontal tufts dark brown, the latter with some blackish scales; labial palpi dark brown. Hind wing pale fuscous. Underside pale fuscous throughout, the area near the head irrorated with dark scales.

Antennae (Text-fig. 14A) with 36 shaft-segments; bipectinate in both sexes; pectination longer and up to 22 basal segments in male, shorter and up to 19 segments in female; the longest rami as long as four segments in male, and three in female; the distal part minutely, but distinctly serrate; the tip simple. Labial palpi short, nearly porrect. Wings with a single frenulum spine in male and four spines in female; retinaculum in male reduced to a small elongate lobe. Legs with a single pair of short spurs on hind tibiae; tarsi without spines; claws with well developed arolium. Abdomen longer than hind wings.

Venation.—Fore wing (Text-fig. 14B) : Areole distorted by the union of upper branch of median with chorda and projecting outside the cell angle by a little less than half the length; vein R_1 near the origin of areole and arising in line with the origin of median cell; R_2 from near the tip of areole; R_3 free and connate in male, shortly stalked with $R_4 + R_5$ in female; M_1 from angle, or from above the angle if areole distorted; median cell with the upper branch ending at chorda and distorting the shape of areole, the lower branch ending at

vein M_2 in male, and M_2 or M_3 in female ; M_2 — M_3 close but separate. Hind wing (Text-fig. 14C) : Vein M_1 arises from well below the cell angle ; median cell with the upper and lower branches ending, respectively, between M_1 — M_2 and Cu_{1a} — M_3 .



Text-fig. 14. *Phragmataecia impura* Hampson : (A) Male antenna showing pectination of one side. (B) and (C) Fore and hind wing venation, respectively. (D) Male genitalia in inner view, with claspers and juxta. (E) Uncus and a portion of tegumen. (F) Saccus. (G) Aedeagus. (H) Female genitalia in a dorsal view. (A & H ; B-C ; D & G ; and E-F of the same magnifications).

Genitalia.—Male (Text-fig. 14D-G) : Uncus about two-and-a-half to three times as long as its width in middle ; distal end hooked and produced into a fine, downwardly directed tip. Tegumen broadly triangular. Saccus short and conical. Claspers simple and undifferentiated ; costal margin produced inwardly. Juxta short, almost semicircular and with short lobes, the latter with fine setae. Aedeagus simple, weakly curved and undifferentiated. Female (Text-fig. 14H) : Short. Genital plates and the tube rather heavily sclerotised, the former sclerotised both dorsally and ventrally, the latter short ; ostium bursae simple and unsclerotised ; ductus bursae short and slender ; corpus bursae irregularly shaped and with a fine duct ; receptaculum seminalis present.

Measurements.—Expanse : Fore wing ; male, 28.5 mm. ; female, 34-39 mm. Length : Fore wing : male, 12.5 mm. (approx.) ; female, 17 mm. Hind wing : male, 9.5 mm. ; female, 13-14 mm. Abdomen : male, 11 mm. ; female, 15-19 mm. Body : male, 15 mm. ; female, 21-23 mm.

Material examined.—Two examples as follows : India : Kerala ; Trivandrum, 1 ♂, (no other data) (ex. colln. B.M.). Bihar ; Pusa, 1 ♀, 7.vii.1926 (G. P. Pillai coll.) (ex. colln. I.A.R.I.) (no. L41/23 ; det W.H.T. Tams).

Distribution.—India (Bihar ; Pusa ; Tamil Nadu ; Nilgiris ; Kerala, Trivandrum) and Java.

Remarks.—*P. impura* is characterised by dark smoky-black wings in both the sexes and by the uncus, in male genitalia, which is of uniform width beyond the middle and has a downwardly pointing hook-like tip. It resembles, in respect of the latter character, with the other species of the genus *Phragmataecia*, viz. *castaneae*, *pallidulae* and *purpureus*, but differs from these all in having smoky black wings and a short uncus in the male genitalia.

19. *Phragmataecia purpureus* Fletcher

(Pl. II, fig. 19 , Text-fig. 15)

1920. *Phragmataecia* sp. Fletcher and Ghosh, *Rep. 3rd. Ent. Mtg.*, 1 : 374.
 1928. *Phragmataecia purpureus* Fletcher, *Scient. Rep. agric. Res. Inst. Pusa*, 1926—27 : 58, pl. I, figs. 1a-c (Type loc.—Pusa, Bihar, India).
 1930. *Phragmataecia purpureus* Fletcher, *Scient. Rep. agric. Res. Inst. Pusa*, 1928—29 : 68.

Type : In I. A. R. I.

Hosts : *Andropogon sorghum*, *Saccharum arundinaceum* roots, *Saccharum spontaneum*, Maize and Jowar (Fletcher, 1928).

Fletcher (1928) described the species from larvae and pupae. Although he figured the adult he did not give any description of it. The following description is based on the type specimens present in the I. A. R. I., New Delhi. The specimens were extremely oily in appearance and had probably lost their natural coloration.

Head, thorax and abdomen appear brown to blackish brown. Frontal tufts and labial palpi blackish. Antennae brown. Wings blackish brown; fore wings darker than hind wings. Legs brown to blackish brown. Male generally somewhat paler than female.

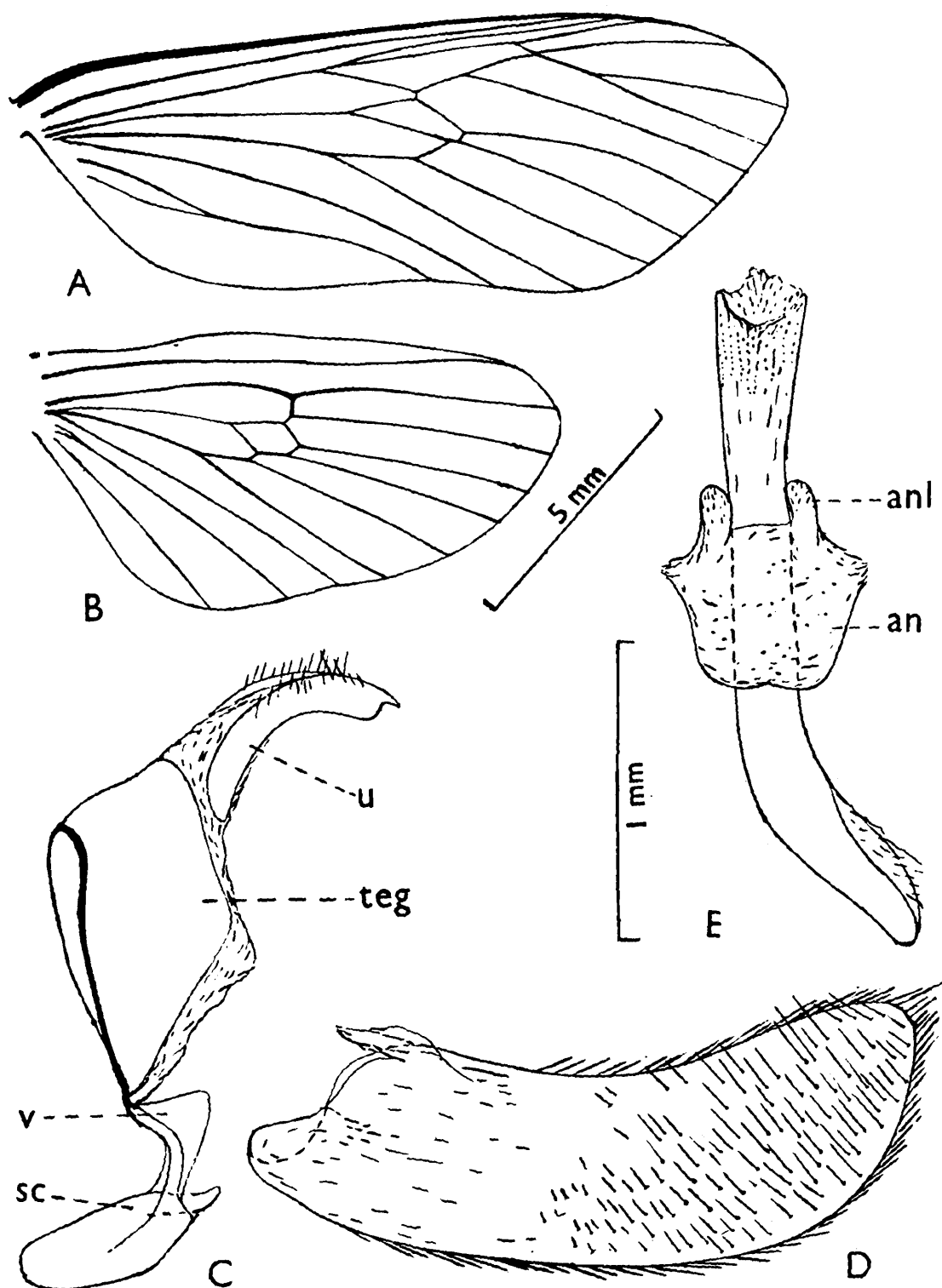
Antennae with 43 shaft-segments; bipectinate up to basal half or roughly 19-21 basal segments; rami short, the longest ones as long as two middle segments of shaft in female and four segments in male, the outer ones shorter than the inner ones; the distal segments serrate; tip simple. Labial palpi extremely short and nearly porrect. Frenulum spine single in male and four in female. Legs with a single pair of minute spurs on hind tibiae; arolium well developed. Abdomen longer than hind wings.

Venation.—Fore wing (Text-fig. 15A) : Areole moderately large, normal and projecting outside the cell angle by about half its length or a little more; veins R_1 and R_2 arise from areole; R_3 connate with R_4+5 ; M_1 from above the angle; median cell with the upper branch ending at upper angle of cell and not distorting the areole, lower branch ending at M_3 or between Cu_{1a} — M_3 . Hind wing (Text-fig. 15B) : Vein M_1 arises from well below the angle; median cell with upper and lower branches ending, respectively, between veins M_1 — M_2 and Cu_{1a} — M_3 .

Genitalia.—Male (Text-fig. 15C-E) : Uncus about three-and-a-half to four times as long as its width in middle, sclerotised on the dorsal and the lateral sides, leaving some weakly sclerotised area in the centre above the tegumen; the tip hooked, pointed and with fine setae. Tegumen broadly quadrangular. Saccus short and broadly cylindrical. Claspers about thrice as long as the width in middle, simple; uniformly wide throughout but somewhat narrower distally. Juxta broadly quadrangular and with extremely short lobes, the latter beset with fine setae. Aedeagus long, narrow and without striations, not differentiated into basal and apical portions. Female : Not studied.

Measurements.—Expanse: Male, 25-37 mm.; female, 34 mm. length: Fore wing : male, 11-14 mm; female, 14 mm. Hind wing : male, 8-10 mm.; female, 10 mm. Abdomen : male, 9-10 mm.; female, 14 mm. Whole body : male, 13-15 mm.; female, 19 mm.

Material examined.—Three examples (types) as follows : India : Bihar : Pusa, 1 ♂, 15.vi.1918 (no.L41/3), 1 ♂, 27.vi.1918



Text-fig. 15. *Phragmataecia purpureus* Fletcher : (A) and (B) Fore and hind wing venation, respectively. (C) male genitalia in a lateral view (D) A clasper in a inner view. (E) Aedeagus, with the juxta attached. (A & B ; C to E of the same magnifications).

(no.L41/5) [Both Paralectotype] ; and 1 ♀ , 10.vii.1918 (no.L41/4, "Figured") [Lectotype]. All (Boy coll.) from Kanra root (*Saccharum arundinaceum*) and reared in laboratory (C. S. 1805) (ex. colln. I.A.R.I.).

Distribution.—India, Bihar (Pusa).

Remarks.—Fletcher (1928) described this species on the basis of larval characters only and gave no account of its adult, except that he figured a female specimen. He (*loc. cit.*) also did not designate any type category to these specimens, except that he labelled one specimen, a female, as 'Figured', which resembled with the one published by him. This specimen has been designated by the present author as 'Lectotype' and the remaining as 'Paralectotypes'. The adults have been described here for the first time.

This species is characterised by the presence of a normal areole unlike in *P. castaneae* and *P. impura*, where it is distorted.

20. *Phragmataecia pallidalae* (Hampson) comb. nov.

(Pl. II, fig. 20 ; Text-fig. 16)

- 1892b. *Cossus pallidalae* Hampson, *Fauna Brit. India, Moths*, 1 : 306 (Type loc.—Sikkim).
 1899. *Cossus pallidalae*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 (4) : 645.
 1923. *Cossus pallidalae*, Dalla-Torre, *Lepid. Cat.*, 29 : 12.
 1933. *Cossus pallidalae*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 809.
 1961. *Catopta* (?) *pallidalae* (Hampson) : Daniel, *Mitt. münch. ent. Ges.*, 51 : 209.

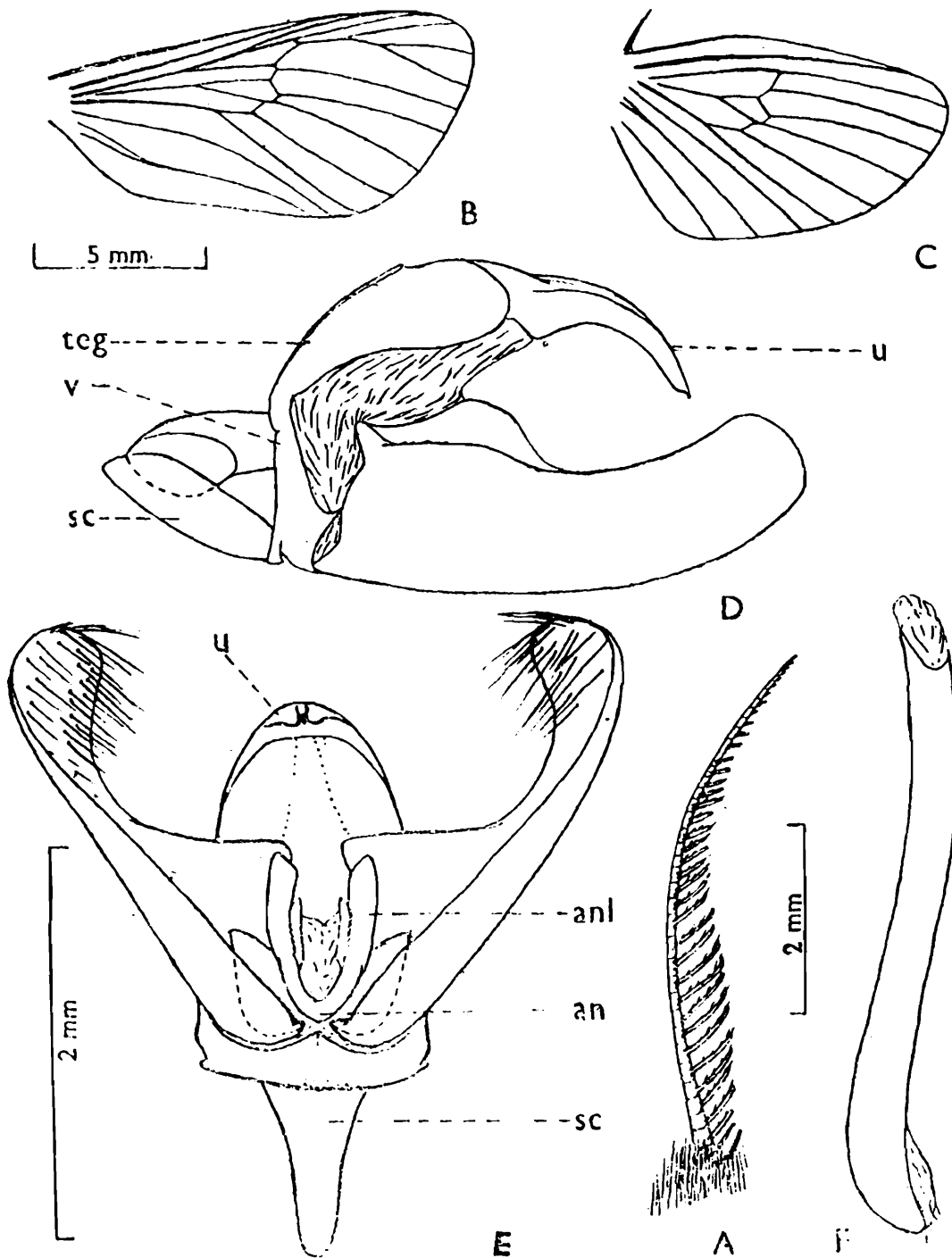
Type : In B. M.

Head, thorax and abdomen ochreous white. Fore wing, especially the cell, slightly suffused with rufous ; with numerous wavy rufous striae in the cell, between vein Cu_{1b} and the inner margin and a few in the outer area ; marginal line rufous. Hind wing white.

Frontal tufts short. Antennae (Text-fig. 16A) with 40 shaft-segments ; bipectinate up to nearly three-fourths of the length from base ; the distal one-fourth minutely serrate ; the longest rami about the length of three middle segments. Labial palpi minute, porrect. Frenulum, retinaculum, tibial spurs and spines as for the genus.

Venation.—Fore wing (Text-fig. 16B) : Areole normal, projecting outside the cell angle by about one-third its length ; vein R_1 arises from near the middle of areole ; R_2 from near the tip of areole ; veins R_3 to R_5 stalked, R_3 from middle of the common stalk of $R_4 + R_5$; M_1 from well below the cell angle ; origin of median cell not in line with the origin of veins R_1 and Cu_{1b} ; upper and lower branches of median cell ending between veins $M_1 - M_2$ and

$Cu_{1a}-M_3$, respectively; veins M_2 and M_3 separate. Hind wing (Text-fig. 16C) : Venation as given in generic characters.



Text-fig. 16. *Phragmataecia pallidulae* (Hampson) : (A) Male antenna showing pectinations of one side. (B) and (C) Fore and hind wing venation, respectively. (D) and (E) Male genitalia in lateral and inner views, respectively. (F) Aedeagus. (B-C; and D to F of the same magnifications).

Genitalia.—Male (Text-fig. 16D-F) : Uncus triangular, slightly sclerotised; with a fine distal point and having setae on dorsal surface.

Tegumen broader at the latero-dorsal than at the lateral side. Saccus cylindrical, about one-third as wide as its length. Claspers simple and weakly sclerotised ; costa produced inwards, on the mesal side, into a short fold, and coming close to that of other side ; with a few setae mesally, near the distal end. Juxta reduced, horse-shoe shaped, anellus lobes thicker. Aedeagus simple, slender and poorly differentiated into a base and an apical portion.

Measurements.—Expanse : fore wing, 29 mm. Length : fore wing, 13 mm. ; hind wing, 10 mm. ; abdomen, 10 mm. ; whole body, 15 mm.

Material examined.—Bhutan : 1 ♂, 20.iii.1892 (G. G. Dudgeon coll.) (ex. colln. B.M.).

Distribution.—Sikkim and Bhutan.

Remarks.—Hampson (1892b) described *pallidulae* as a species of the genus *Cossus* and placed it under the category "Male with the antennae serrated at tip, the branches of the proximal half longer. Fore wing with the areole much larger." Hitherto it was considered as a *Cossus* species until Daniel (1961) placed it in the genus *Catopta*, with some doubt, on the basis of the study of the male holotype. The male before me, from Bhutan, received from B.M., has all the distinctive characters of the genus *Phragmataecia*, e.g., the antennae having pectination in basal three-fourths part, a large areole in fore wing, a single pair of hind tibial spurs, absence of tarsal spines, and presence of arolium in between the claws. Moreover, Hampson's placing of the species in the category as mentioned above, and these characters of the species suggest that it actually belongs to the genus *Phragmataecia* and not to *Cossus* or *Catopta*.

It is close to other three species, viz., *castaneae*, *purpureus* and *impura* in the character of uncus, but differs from the latter by longer uncus and saccus. From the former two species it differs in the structure of juxta which is reduced and horse-shoe shaped.

21. *Phragmataecia terebrifer* Fletcher

(Pl. II, fig. 21 ; Text-fig. 17)

1920. *Phragmataecia* sp. Fletcher and Ghosh, *Rep. 3rd. Ent. Mtg.*, 1 : 374 (pl. 35, fig. 1).
 1928. *Phragmataecia terebrifer* Fletcher, *Scient. Rep. agric. Res. Inst. Pusa*, 1926—27 : 58, pl. I, fig. 2a-d (Type loc.—Pusa, Bihar, India).

Type : In I. A. R. I.

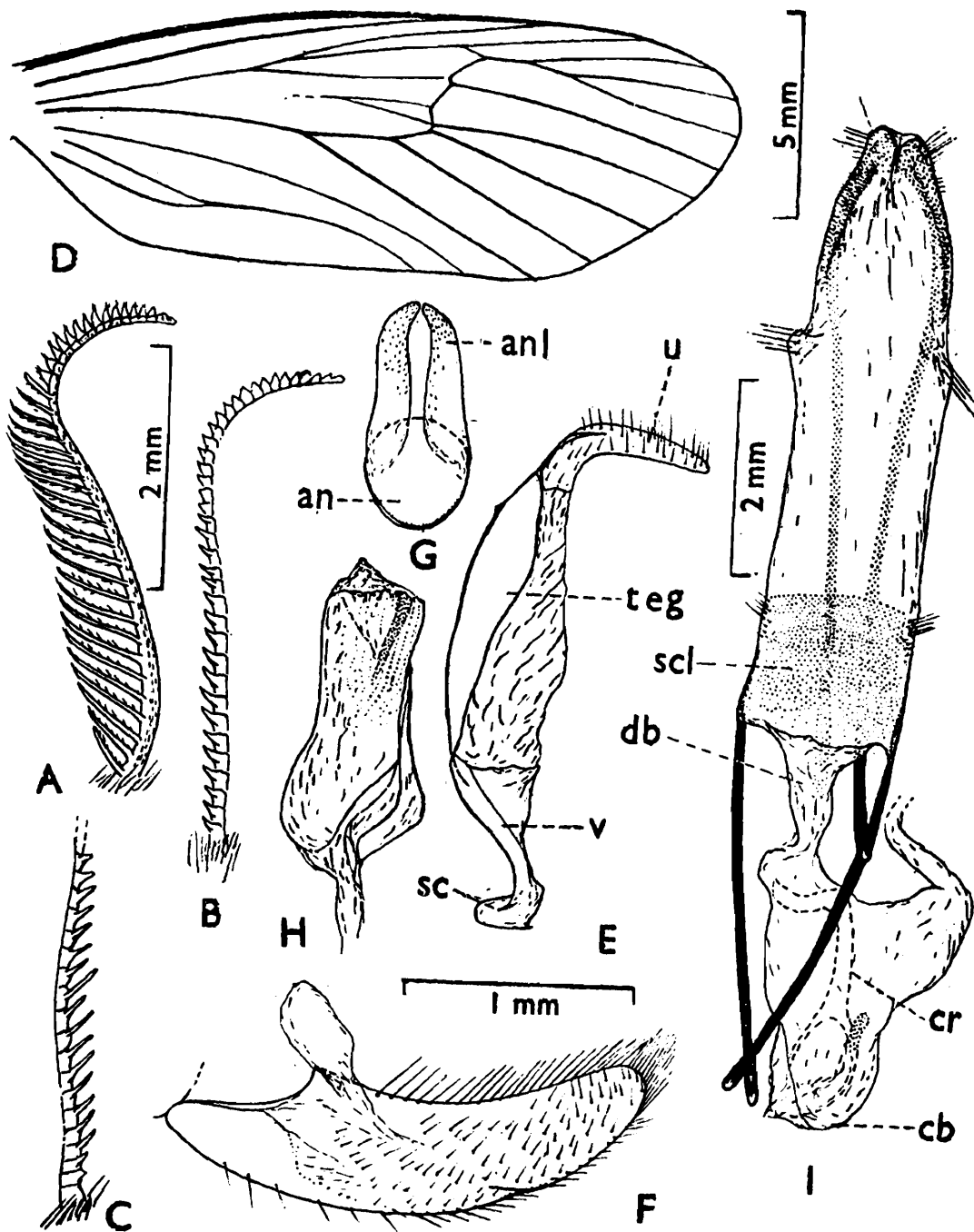
Hosts : *Saccharum spontaneum* stem, *Saccharum arundinaceum* and *Andropogon sorghum*.

Head, thorax and abdomen dark brown. Frontal tufts brown, blackish on sides. Antennae brown. Labial palpi dark brown. Fore wings dull brown and grizzled with scales, numerous short striae all along the costa, median and the inner areas, thus giving an apparent look of three longitudinal fascia in female. These fascia are more prominent before the discocellular in male. Hind wings pale brown to brown and almost without markings. Legs blackish on upperside, paler beneath. Underside of body and wings paler than above, that of the latter with darker markings.

Head with the labial palpi short, nearly porrect, not projecting beyond frons. Antennae (Text-fig. 17 A-C) with 36-43 segments in the shaft ; minutely bipectinate up to a little more than basal half of the length ; the longest rami as long as four segments of the shaft in male and two in the female ; the rami of the inner and outer sides equal in length in male and unequal in female, *i.e.*, in the latter the rami are longer on the inner side than those on the outer side ; the distal segments serrate ; the tip simple. Frenulum spines single in male and four in female. Legs without tarsal spines ; arolium well developed. Abdomen as long as hind wings or slightly longer.

Venation.—Fore wing (Text-fig. 17D) : Areole long, projecting outside the cell only by about one-fifth of its length ; veins R_1 and R_2 arise from areole, R_2 as far from the tip of areole as R_1 from the origin of areole ; R_3 to R_5 stalked, R_3 arising from middle of the common stalk ; M_1 from well below the angle of cell ; median cell present, with the upper and lower branches ending between M_1 — M_2 and at M_2 , respectively. Hind wing : Vein M_1 from well below the cell angle ; median cell present, with its branches ending between M_1 — M_2 and Cu_{1a} — M_3 .

Genitalia.—Male (Text-fig. 17E-H) : Uncus about twice as long as its width in middle, the tip blunt and rounded, not produced into a point. Tegumen triangular, broadest at the dorso-lateral side. Saccus short. Clasper simple, narrowed distally, about three times as long as its width in middle. Juxta subrounded ; anellus lobes from near the apical area, broader at base, slightly incurved and narrowing apically. Aedeagus small ; vesica with some striation on one side and beset with short spines. Female (Text-fig. 17 I) : Short and broad ; genital tube short ; ostium bursae simple, without any sclerotisation ; ductus bursae membranous, short and enters into a lobe of corpus bursae, the latter membranous ; signum either elongate or rounded ; genital plate sclerotised on both dorsal and ventral sides.



Text-fig. 17. *Phragmataecia terebrifer* Fletcher : (A) Male antenna showing pectinations of one side. (B) and (C) Outer and Inner rows, respectively of pectination in a female antenna. (D) Fore wing venation. (E) Male genitalia in a lateral view, without claspers. (F) A clasper in a inner view. (G) Juxta. (H) Aedeagus. (I) Female genitalia in a dorsal view. (A-C ; E-H of the same magnifications).

Measurements.—Expanse : Male, 25-28 mm. ; female, 30-42 mm. length : Fore wing : Male, 10-13 mm. ; female, 13-18 mm. Hind wing : Male, 8-10 mm. ; female, 9-14 mm. Abdomen : Male, 8-10 mm. ; female, 10-16 mm. Body : Male, 12-25 mm. ; female, 18-23 mm.

Material examined.—47 ♂♂, 17 ♀♀, as follows : India : Bihar : Pusa, 1 ♀, 1.x.1917 (Regd. no. L42/8) ; 2♀♀, 15.x.1917 (Regd. nos. L41/7 ; L41/14, the latter labelled “FIGURED” and designated as ‘Lectotype’) ; 1 ♂, 4.x.1918 (Regd. no. L41/18) ; 1 ♀, 6.x.1919 (Regd. no. L42/13) ; 1 ♂, 11.x.1919 (Regd. no. L42/9) ; 1 ♀, 6.xi.1919 (Regd. no. L42/16) (all coll. *Boy*) ; 1 ♀, 25.ix.1923 (Regd. no. L41/25) (all labelled “Boring *Saccharum spontaneum*, Batri”) ; 1 ♂, at light, 6.x.1923 (*Paries* coll.). Assam, Sarbhog, 1 ♀, 4.x.1917 (*Fletcher* coll.) (Regd. no. L42/17). (all, except L41/14 designated as ‘Paralectotypes’ ex colln. I.A.R.I.) ; Lekhabali, 44 ♂♂, 10 ♀♀ at light, 6—8.x.1966 (*S. K. Tandon* and *G. S. Arora* coll.). Bengal : Jalpaiguri Dist., Rydak forest, 1 ♀, 10.ix.1975 (*H K. Bhoumik* coll.).

Distribution.—India, Bihar (Pusa), Assam.

Remarks.—Fletcher (1928) described this species too, like *P. purpureus*, on the basis of larval characters. He (*loc. cit.*) neither described the adult nor designated any type category, but only labelled one specimen, a female, as ‘Figured’, which resembled with the one published by him (*loc. cit.*). These specimens, in I. A. R. I., have been examined by the present author and the one labelled as ‘Figured’ has been designated as ‘Lectotype’ and the remaining as ‘Paralectotypes’

This species is close to *P. parvipunctus* (Hampson) and *P. dudgeoni* Arora in the shape of uncus which is broad and rounded distally. It, however, differs from both the species by the areole which projects about one-fifth its length (about half or more its length in the other two species) outside the cell angle and by the aedeagus which is smaller than in the other two species.

Hitherto known from Bihar, the species is being recorded from Assam and Bengal for the first time.

22. *Phragmataecia parvipunctus* (Hampson)

(Text-fig. 18)

- 1892b. *Cossus parvipunctus* Hampson, *Fauna Brit. India, Moths*, 1 : 306 (Type loc.—Naga Hills, India).
 1918. *Phragmataecia parvipunctus*, Turner, *Trans. ent. Soc. Lond.*, 66 : 160, 161.
 1923. *Cossus parvipunctus*, Dalla-Torre. *Lepid. Cat.*, 29 : 12.
 1933. *Cossus parvipunctus*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 809.

Type : A male in B. M

Hosts : *Saccharum officinarum*.

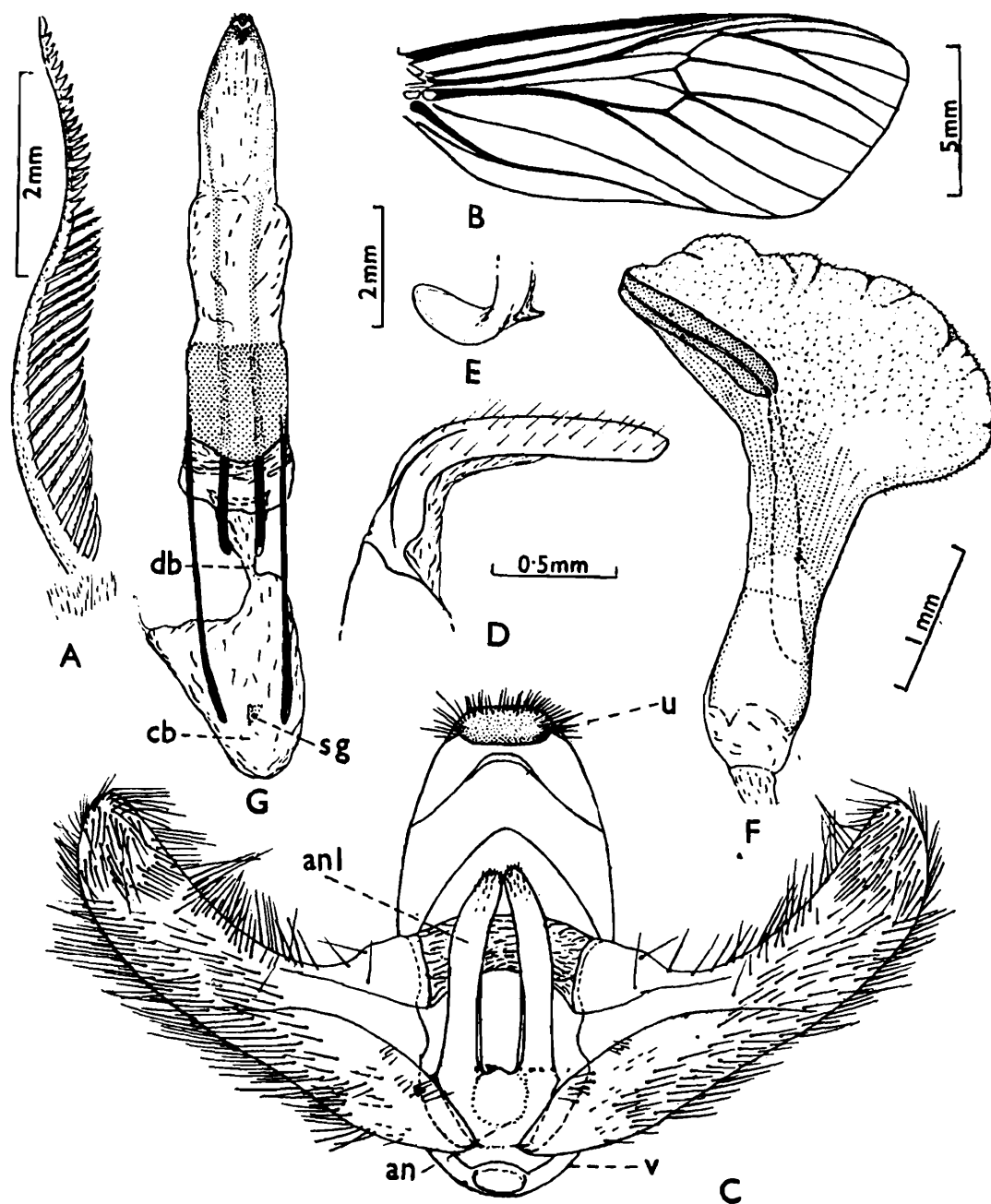
The material before me, for the present study, consists of three examples from Ceylon. The coloration of the specimens seem to have got damaged in the flood at Varanasi when some of the Z.S.I. collections were submerged.

Frontal tufts brown. Antennae brown, the branches whitish at their tips. Labial palpi dark brown. Thorax, wings and abdomen brown. Underside of thorax, near the base of fore legs, dark brown, otherwise as on upper side. Legs generally brown; tarsi black, with narrow, pale brown to whitish bands at joints.

Antennae (Text-fig. 18A) bipectinate up to two-thirds from base, distal one-third serrate; the branches shorter at base and at apical part of the pectinate portion, the longest rami as long as four to five middle segments of shaft, the terminal segment long; antennae in female simple and without pectination (incomplete and with only 21 segments in an example available for study). Labial palpi short and porrect. Frenulum spines single in male and three in female. Tarsal spines wanting; arolium in between the claws well developed. Abdomen as long as wings.

Venation (Text-fig. 18B).—Venation in both the wings mainly as in the genus. Fore wings with a large areole, the latter projecting beyond the cell angle by about half its length; vein R_1 arises from basal one-third of areole; R_2 from near the tip of areole; R_3 shortly stalked with R_4 and R_5 ; M_1 from well below the angle; median cell large, with upper and lower branches ending between M_1 — M_2 and M_2 — M_3 or at M_3 , respectively.

Genitalia.—Male (Text-fig. 18C-F) : Highly sclerotised as a whole. Uncus uniformly broad from base to near the distal end; about three times as long as its width in middle; distal end slightly narrowed, rounded, slightly depressed in the middle and more or less duck-beak shaped. Tegumen broad dorso-laterally, narrower laterally. Vinculum narrow and ending into a short upturned saccus. Claspers simple, without sclerotisation and about four times as long as the width in middle; broader in the middle than at the distal end, the latter narrowly rounded. Juxta narrow at base; lateral margins oblique and continuous with anellus lobes, the latter broad up to basal half but narrowing distally. Aedeagus well built, indistinctly differentiated into base and vesica, the latter striated and with a narrow sclerotised portion on one side. Female (Text-fig. 18G) : Ostium bursae simple, without any sclerotisation; ductus bursae short, membranous and broad at base; corpus bursae large, broadly triangular; with a large lobe on one side, into which opens the ductus bursae, and a fine duct on the other side opening into genital tube; signum triangular, with a shallow depression and beset with fine setae;



Text-fig. 18. *Phragmataecia parvipunctus* (Hampson): (A) Male antenna showing pectinations of one side. (B) Fore wing venation. (C) Male genitalia in inner view, with claspers. (D) and (E) Uncus and saccus, respectively in a lateral view. (F) Aedeagus. (G) Female genitalia in a dorsal view. (C & F; D & E of the same magnifications).

genital plates strongly sclerotised both dorsally and ventrally; posterior apodemes extending far beyond the genital plates and reaching as far as the corpus bursae.

Measurements.—Expanse; Male and female, 40 mm. Length: Fore wing: male, 17 mm.; female, 18 mm. Hind wing: male

and female, 14 mm. Abdomen : male and female, 14 mm. Body : male and female, 19 mm.

Material examined.—Three specimens as follows : Ceylon : Maskeliya, 1 ♂, —.ii.— ; 1 ♂, —.iii.—, 1 ♀, —.iv.— (*E. E. Green* coll.) (no further data).

Distribution.—India (Nilgiris and Naga Hills), Ceylon.

Remarks.—Referable to the genus *Phragmataecia*, it was placed by Hampson (1892b) originally in the third category of the genus *Cossus* Fabricius, *i.e.*, "Male with the antennae serrated at tip; the branches of the proximal half longer. Fore wing with the areole much larger." Turner (1918) figured the wing venation of this species and placed it under the genus *Phragmataecia*. Dalla-Torre (1923), however, catalogued it under the genus *Cossus*, followed by Gaede (1933).

The present study of the external and genitalic characters clearly indicates that the species belongs to the genus *Phragmataecia* and to the category of those species *viz.*, *terebrifer* Fletcher and *dudgeoni* Arora, in which the uncus is rounded at the tip. It, however, differs from both *terebrifer* and *dudgeoni* for its areole being projected outside the cell angle by half its length *vs.* one-fifth in *terebrifer* and one-third in *dudgeoni*, and in the juxta having oblique lateral margin unlike in the other two species where the margins are curved.

Hitherto known from India, the species is being reported from Ceylon for the first time.

23. *Phragmataecia dudgeoni* Arora

(Pl.II, fig. 22 ; Text-fig. 19)

1974. *Phragmataecia dudgeoni* Arora, *Oriental. Ins.*, 8 (2) : 157-159. (Type loc.—Bhutan).

Type : In Z. S. I.

Head brown ; frontal tufts brown to fuscous brown ; antennae pale brown to whitish above, brown below ; labial palpi fuscous brown, pale on the inner side. Thorax and abdomen fuscous brown, the latter with tufts of brown scales on each segment. Fore wings brown ; the area along the costa, up to the basal two-thirds and along the cubital area, little beyond the discocellulars, distinctly fuscous, with numerous short, chocolate brown striae ; a short chocolate brown triangular stigma formed by the confluence of the striae, may be present on the upper angle of the cell, the stigma being faint or absent in some of the specimens ; the area below and beyond the

cell marked by numerous striae, some of which join and end up into five spots in an oblique row, the striation being uniform and without the above-mentioned confluence in some of the specimens. Hind wings brown, unmarked; costa not shining. Underside of both the wings striated, the striation on the fore wings as on the upper side. Legs pale brown, with some fuscous scales.

Antennae (Text-fig. 19B) bipectinate up to two-thirds from the base, the distal segments serrate except the last which is short and simple; the rami longest in the middle, being about the length of five segments of the shaft. Labial palpi short and porrect. Legs fringed with hairy scales up to tibiae; hind tibiae with a pair of short unequal spurs; tarsi without spines, with first segment longer than the rest; arolium (Text-fig. 19C) well developed. Frenulum single and stout; retinaculum well developed and curved at tip.

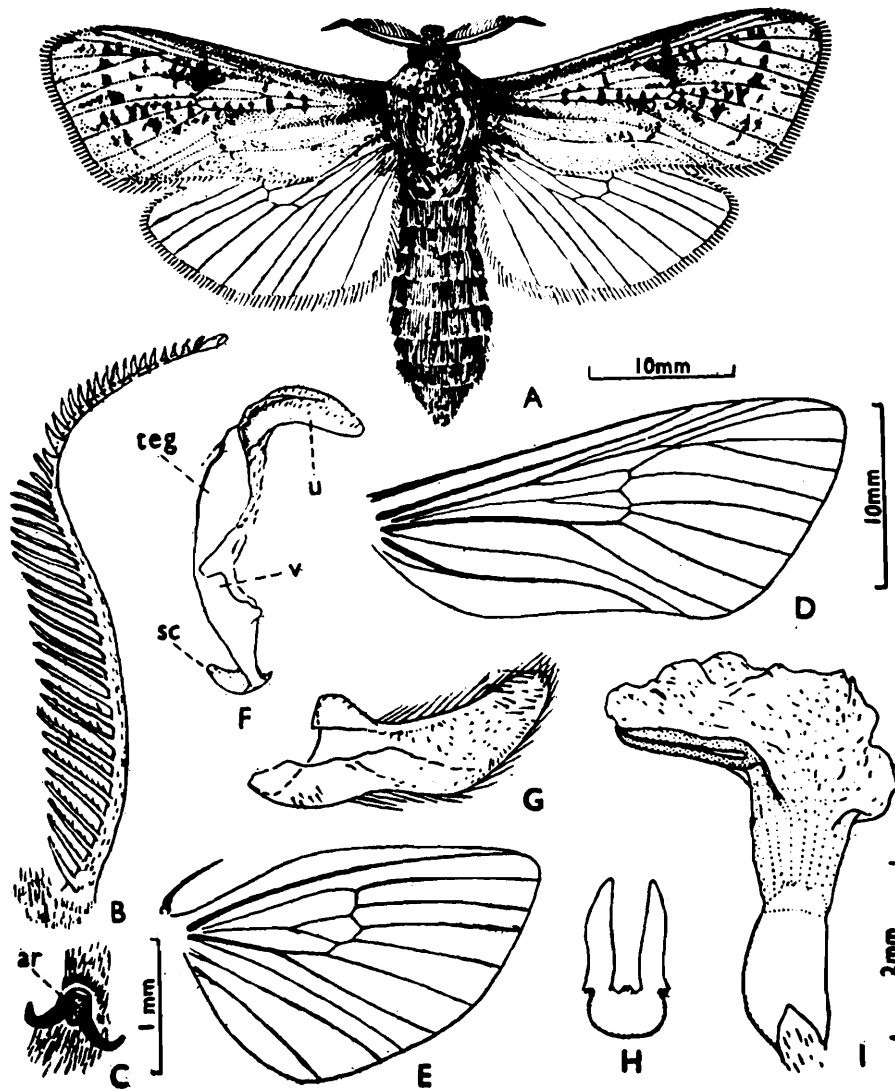
Venation.—Fore wing (Text-fig. 19D) : Areole long, projecting by about one-third its length outside the cell angle; vein R_1 arises from basal one-third of areole; R_2 from near the tip of areole; R_3 shortly stalked or anastomosed with the base of $R_4 + R_5$; M_1 from well below the angle of cell; median cell large, with its upper and lower branches ending between veins M_1-M_2 and M_2-M_3 or at M_3 , respectively; M_2 and M_3 close at base but distinctly separate; Cu_{1a} and Cu_{1b} from before the lower angle of cell. Hind wing (Text-fig. 19E) : Without any cross bar between vein Sc and Rs, *i.e.*, the latter two veins free; M_1 well below Rs; median cell large, with its branches ending between M_1-M_2 and $Cu_{1a}-M_3$; veins M_2 and M_3 wide apart.

Genitalia.—Male (Text-fig. 19F-I) : Uncus curved from near the base and highly sclerotised; about one-and-a-half times as long as its width in middle, the distal end narrow, rounded and blunt, and half the width of the middle portion. Tegumen broadly triangular; vinculum broadest in the middle. Saccus short and narrow, with its tip slightly upturned. Clasper broad near the middle and at base, about four times as long as its width in middle. Juxta almost rounded and without distinct median lobes; the lateral lobes long and narrow. Aedeagus well developed, with an indistinct base and a large vesica, the latter sclerotised on one side.

Female : Not known.

Measurements.—Expanse, 41–55 mm. Length : Fore wing, 19–25 mm.; hind wing, 15–19 mm.; abdomen, 12–17 mm. whole body, 19–25 mm.

Material examined.—Seven examples : Bhutan : 1 ♂, (holotype, No. 1469/H10), and 6 ♂♂, (paratypes, Nos. 1470–1475/H10) —.iii.1895, G. C. Dudgeon coll.) (All deposited in Z.S.I.).



Text-fig. 19. *Phragmataecia dudgeoni* Arora : (A) An outline drawing of the male holotype. (B) Male antenna showing pectination of one side. (C) A portion of the hind leg, with arolium. (D) and (E) Fore and hind wing venation, respectively. (F) Male genitalia in a lateral view, without claspers. (G) A clasper in a inner view. (H) Juxta. (I) Aedeagus (D & E ; B, F to I of the same magnifications).

Distribution.—Bhutan

Remarks.—*Phragmataecia dudgeoni* comes very close to *P. parvipunctus* (Hampson) in respect of the bipectinate antennae, certain characters of wing venation and the genitalia. It can, however, be differentiated from *parvipunctus* by the following characters : In the fore wing the areole is long, arising from much before the point of origin of veins Cu_{1b} and R_1 , unlike in *parvipunctus* where the areole is short and its origin is nearly in the line with that of vein Cu_{1b} ; the fore wing with an oblique row of striae beyond the cell and a patch on the upper angle of the cell (prominent in certain

examples or faint or absent in others) whereas in *parvipunctus* there is a row of spots on the vein 1A. In respect of the male genitalia it differs from *parvipunctus* by the shape of uncus which is short and stout; about one-and-a-half times as long as its width at the middle, the distal part narrow, with its tip about half as wide as the width at the middle, whereas in the latter species the uncus is somewhat long and narrow; and nearly uniformly broad throughout.

24. *Phragmataecia clara* (Bryk) comb. nov.

(Pl. II, fig. 23 ; Text-figs. 20, 21)

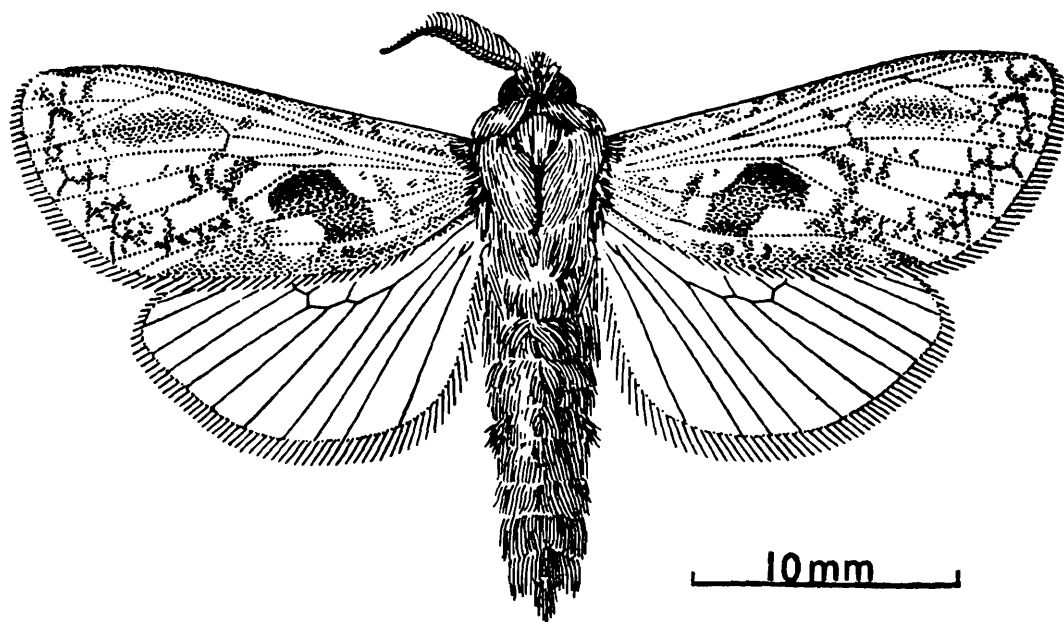
1950. *Xyleutes clara* Bryk, *Ark. Zool.* 42A (19) : 47, pl.iii, fig. 1 (Type loc.-Mekane, 90 km. E. of Moulmein, Tenasserim, Burma).

Type : In Rm.

Head, thorax and abdomen ochreous white. Frontal tufts ochreous brown in front, blackish below and laterally. Antennae brown, covered with white scales above throughout. Eyes black. Labial palpi blackish. Fore wings ochreous white throughout, with brown striae along costa and in between veins in the postmedial area ; a large, prominently curved geminate spot present below the cell, the larger one blackish in the upper half and reddish brown in the lower half ; the smaller one reddish brown all over : a small prominent and light-blackish spot present in sub-median fold ; black striae near the apical margin between veins R_3 and R_5 either present or absent. Hind wings ochreous white, without markings. Legs ochreous brown, intermixed with blackish scales ; tarsi somewhat darker and with an indistinct band of paler scales. Abdomen on both upper and lower sides ochreous white, covered with woolly hair. Underside of both wings without markings.

Antennae (Text-fig. 21A) bipectinate up to basal two-thirds ; the longest rami about the length of five segments in the middle ; remaining ones serrate ; the terminal joint simple. Labial palpi short. Hind wing with a well developed frenulum spine ; retinaculum elongate, and weakly curved. Legs without tarsal spines ; hind tibiae with a single pair of minute spurs ; claws with well developed arolium. Abdomen shorter than, or as long as, hind wings.

Venation.—Fore wings (Text-fig. 21B) : Areole long, projecting outside the cell angle by about one-third its length ; vein R_1 arises from areole and in line with the origin of median cell ; R_2 from near the distal end of areole ; R_3 shortly stalked with $R_4 + R_5$, nearer to base than to R_5 ; M_1 generally from the upper angle of cell (from below the angle in type), rarely from above ; median cell with



Text-fig. 20. *Phragmataecia clara* (Bryk) : An outline drawing of the male holotype.

its upper and lower branches ending between veins M_1 — M_2 and Cu_{1a} — M_3 , respectively ; M_2 and M_3 separate. Hind wing venation mainly as for the genus.

Genitalia.—Male (Text-fig. 21C-F) : Uncus triangular and sclerotised ; narrowing gradually into a narrow rounded tip. Saccus short and rounded. Clasper weakly sclerotised, with only a few setae on the inner side ; about four-and-a-half times as long as its width in middle ; the distal end narrow. Juxta horse-shoe shaped ; anellus lobes long, about four times as long as the width. Aedeagus weakly differentiated into a short base and a large striated and sclerotised apical part, the latter with membranous vesica.

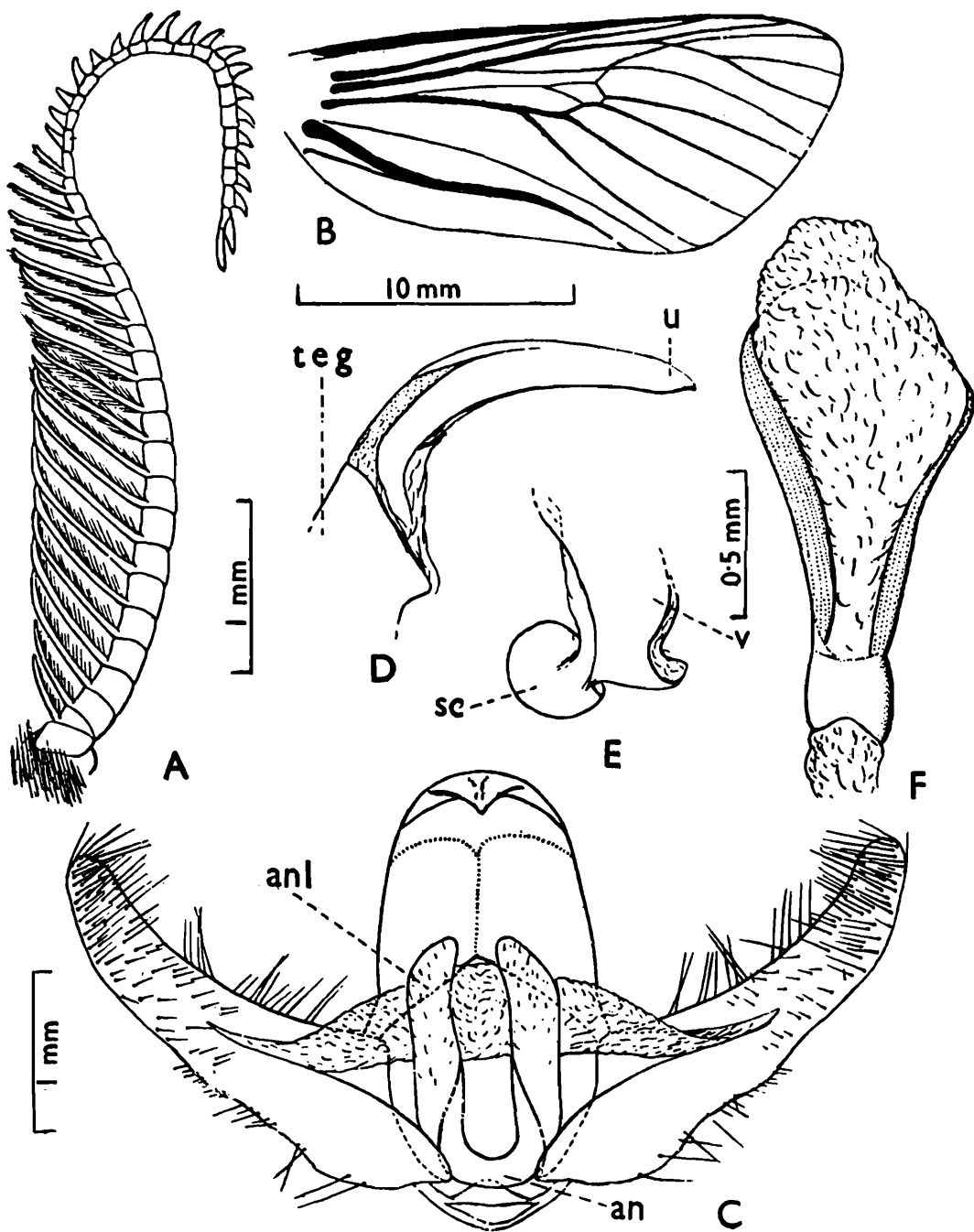
Female : Not known.

Measurements.—Type material : Expanse : Fore wing, 38.5 mm. Length : Fore wing, 18 mm. ; hind wing, 13 mm. ; abdomen, 11 mm. ; body, 18 mm.

Other material.—Expanse : Fore wing, 35—40 mm. Length : Fore wing, 16—19 mm. ; hind wing, 12—15 mm. ; abdomen, 11—15 mm ; whole body, 18—22 mm.

Material examined.—Six examples as follows : Sikkim : 548.63 m., 2♂♂, —.ix and .x. 1897 (G. C. Dudgeon coll.).

Bhutan : 3♂♂, 6.ix.1894 (G. C. Dudgeon coll.)



Text-fig. 21. *Phragmataecia clara* (Bryk) : (A) Male antenna showing pectinations of one side. (B) Fore wing venation. (C) Male genitalia in inner view, with claspers. (D) Uncus and a portion of tegumen in a lateral view. (E) A portion of vinculum and saccus in a lateral view. (F) Aedeagus. (C & F; D & E of the same magnifications).

Burma : Tenasserim, Mekane, 90 Km. east of Moulmein, 'Typus' 1 ♂, 2—8.xi.1934 (*Malaise* coll.) (ex. colln. Rm., Stockholm).

Distribution.—India (Sikkim), Bhutan and Burma.

Remarks.—Referable to the genus *Phragmataecia*, it was described as a species of the genus *Xyleutes* Hübner (*vide* Bryk, 1950). The type (male), on examination, was found to have the antennae bipectination up to basal two-thirds, the reduced labial palpi, arolium in between the claws, and no tarsal spines and gnathos. These are the characteristic features of the genus *Phragmataecia* and leave no doubt in the species belonging to this genus.

Phragmataecia clara is close to *stigmaticus* and infact the above-mentioned specimens from Sikkim and Bhutan, present in Z.S.I, were confused for *stigmaticus*. It, however, differs from the latter in the absence of an oblique series of striae on the fore wing (present in *stigmaticus*); in having a rounded saccus and horse-shoe shaped juxta, whereas in *stigmaticus* the saccus is short and narrow and the juxta rounded.

It is also close to *obliquifascia* but can be separated by the absence of oblique band on the fore wing (present in *obliquifascia*) and by the underside coloration of abdomen which is ochreous white in this species *vs.* black in *obliquifascia*.

Phragmataecia clara, hitherto known from Burma, is being reported from India (Sikkim) and Bhutan, for the first time.

25. *Phragmataecia stigmaticus* (Moore) comb. nov.

(Pl. II, figs. 24-25 ; Text-fig. 22)

- 1879b. *Zenzera stigmatica* Moore, *Descr. Indian Lep. Atk.* : 86 (Type loc.-Darjeeling, India).
 1887. *Zeuzera stigmatica*, Cotes and Swinhoe, *Cat. Moths of India* : 234.
 1892. *Zeuzera stigmaticus*, Kirby, *Cat. Lep. Het.* : 872.
 1892b. *Cossus stigmaticus* (Moore) : Hampson, *Fauna Brit. India, Moths*, 1 : 306.
 1923. *Cossus stigmaticus* Dalla-Torre, *Lepid. Cat.*, 29 : 13.
 1896a. *Azygophelps stigmaticus*, Hampson, *Fauna Brit. India, Moths*, 4 : 473.
 1899. *Duomitus stigmaticus*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 (4) : 646.
 1933. *Xyleutes stigmaticus*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 819
 1950. *Zeuzera stigmaticus*, Bryk, *Ark. Zool.*, 42 (A) 19 : 46 (Sikkim and Bhutan).

Type : In Ber. Mus.

Frontal tufts and the labial palpi black, intermixed with white-scales. Antennae brown. Upperside of wings pale golden-yellow. Fore wings with a prominent, curved geminate spot, which is blackish above and reddish below ; some confluent, brownish striae along costa, a clouded series of striae obliquely from the apex to the spot

and a paler series on the outer margin, also present. Hind wings pale golden yellow, glossy at the base and without markings. Underside of wings dull golden-yellow; reticulations and the upper spot on fore wing fuliginous brown; the lower reddish portion of the large spot and the spot below the cell obsolete. Legs with brownish bands at the joints and tarsi. Legs and the abdomen covered with woolly, golden-yellow hair.

Frontal tufts small. Antennae (Text-fig. 22B) bipectinate up to nearly three-fourths from the base, the distal part serrate, the teeth small; the longest rami about the length of 5 shaft-segments; the shaft with about 36 segments. Labial palpi extremely minute, porrect. Frenulum, retinaculum, tibial spurs and arolium (Text-fig. 22C-D) as for the genus; tarsal spines absent. Abdomen as long as hind wings.

Venation.—Fore wing : Areole long and normal, projecting outside the cell by about one-third its length; vein R_1 arises from areole and almost in between vein Cu_{1a} — Cu_{1b} ; R_2 from near the tip; vein R_3 shortly stalked with $R_4 + R_5$; M_1 well below the angle; median cell short, with the upper and lower branches ending between M_1 — M_2 and Cu_{1a} — M_3 , respectively; veins M_2 — M_3 separate but close. Hind wing : Venation as for the genus.

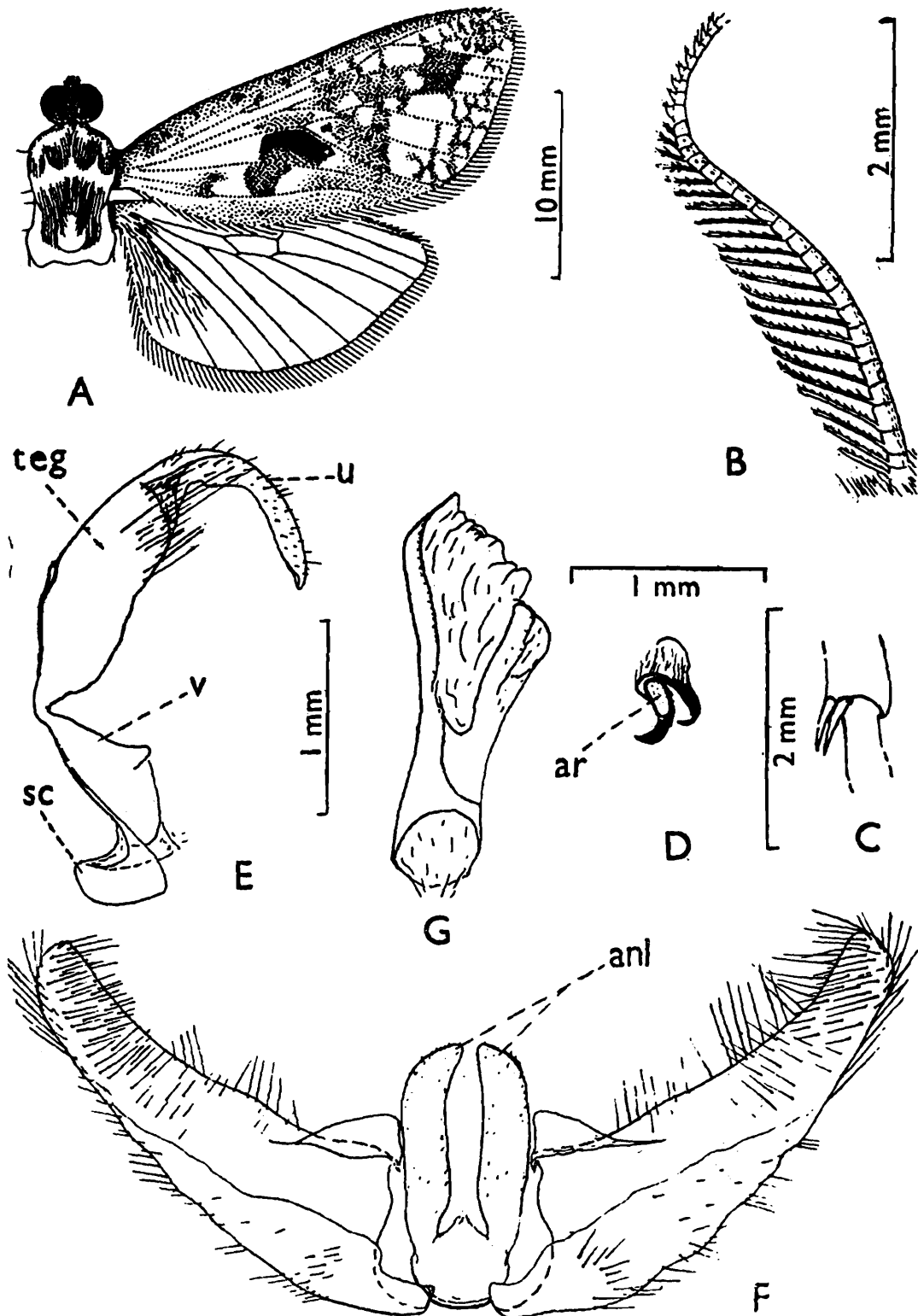
Genitalia.—Male (Text-fig. 22E-G) : Uncus triangular and sclerotised, gradually narrowing towards the distal end and ending in a narrow point. Saccus short. Clasper weakly sclerotised and with numerous setae on mesal side; narrowing gradually towards the distal end and about four times as long as its width in middle; distal end narrow and about half the width in middle. Juxta rounded; anellus lobes about five times as long as the width in middle and narrowing distally. Aedeagus with weak differentiation into a short basal and a large striated and sclerotised apical portion, the latter with membranous vesica.

Female : Not known.

Measurements.—Type ♂ : Expanse, 48.5 mm. Length : Fore wing, 22 mm.; hind wing, 17 mm. (Abdomen broken).

Other material : Expanse : 41 mm. Length : Fore wing, 18 mm.; hind wings, 13.5 mm.; abdomen, 13.5 mm., body, 19 mm.

Material examined : Two examples as follows : India : West Bengal : Darjeeling, 1 ♂ 'Type' (colln. Atkinson, Staudinger coll.) (ex. colln. Ber. Mus.) (type labelled "*Zenzera bistigma*"). Arunachal Pradesh : Kameng; Rahung, 1830 m., 1 ♂, 14.ix.1961 (*S. Biswas* coll.)



Text-fig. 22: *Phragmataecia stigmaticus* (Moore) : (A) An outline drawing of the male holotype, showing one side only (specimen badly damaged). (B) A portion of the male antenna with pectinate branches of one side. (C) A portion of the hind leg with a single pair of tibial spurs. (D) Tarsal claws with arolium. (E) Male genitalia in a lateral view, without claspers. (F) Claspers in a inner view, with juxta. (G) Aedeagus. (E to G of the same magnifications).

Distribution.—India (West Bengal, Arunachal Pradesh, Sikkim), Bhutan.

Remarks.—Referable to the genus *Phragmataecia*, this species has been hitherto transferred several times, from one genus to another. Hampson (1892b) transferred it from *Zeuzera* to his third category of the genus *Cossus*, i.e., "Male with the antennae serrate at tip, the branches of the proximal half longer. Fore wing with the areole much larger", but later (1896) transferred it to the genus *Azygophelps*. Later, Dudgeon (1899) placed it in the genus *Duomitus* followed by Gaede (1933), who placed it under the genus *Xyleutes*, obviously because of the *Duomitus* having been synonymised with the former genus. The present study of the type shows that the species belongs to the genus *Phragmataecia* as it has all the characters of this genus.

This species along with *P. clara* (Bryk) can be separated from all the other species of the genus *Phragmataecia*, known from the Indian subregion, by the presence of golden yellow woolly hair on abdomen and legs. For differences from *P. clara* see under that species.

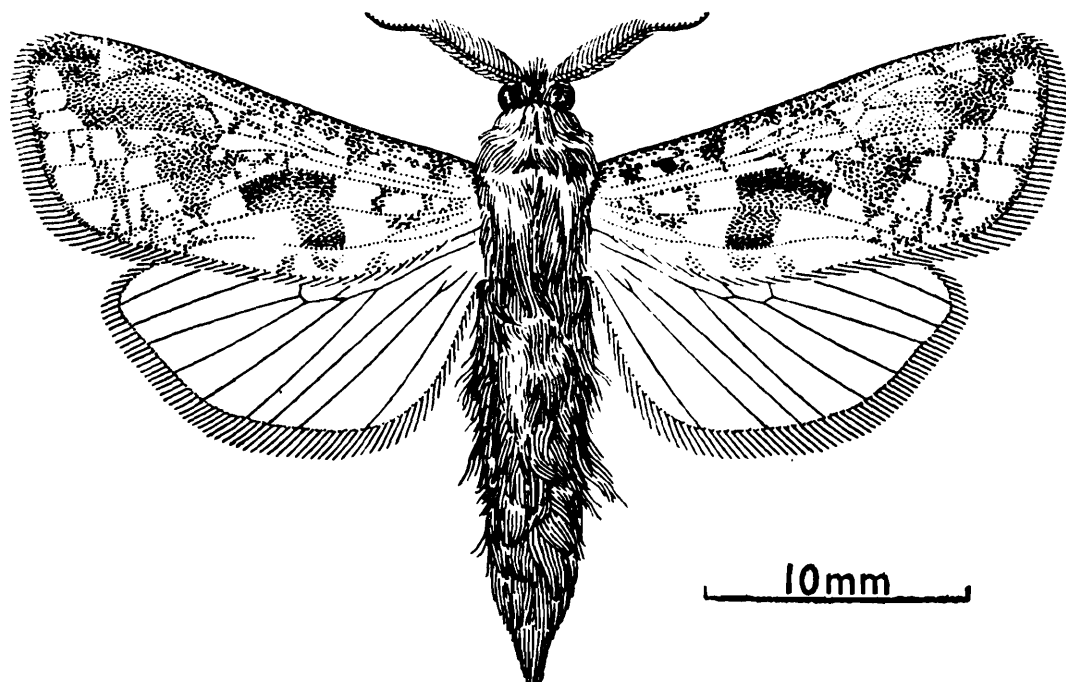
26. *Phragmataecia obliquifascia* (Bryk) comb. nov.

(Pl. II, figs. 26-27 ; Text-figs. 23, 24).

1950. *Xyleutes obliquifascia* Bryk, *Ark. Zool.*, 42A (19) : 46, pl. III, fig. 3 (♂). (Type loc.—Kambaiti 2000 m., Burma).

Type : In Rm.

Frontal tufts and the base of antennae covered with black and white scales. Antennae brown, darker at tips. Labial palpi black. Thorax and abdomen golden yellow ; tegulae black anteriorly, mixed with whitish scales, and with golden yellow ones posteriorly. Fore wings silky white ; veins umber brown ; costa marked with several dark brown close striae ; an oblique well-defined dark brown band from apex to vein Cu_2 , and a curved geminate spot, below the cell between the base of vein Cu_2 and 1A, present ; the upper half of the larger part of geminate spot dark, rather blackish ; the lower half of the larger spot and whole of the smaller part of the geminate spot golden orange ; inner margin almost devoid of markings ; the area between oblique band and the outer margin marked by short brown striae from M_2 -1A. Hind wings pale ochreous white, with pale golden-yellowish cilia. Underside of both the wings whitish ; fore wings with the markings as on the upper side, spots not as brightly coloured as above ; hind wings with a few striae on the costa near the apical one-third. Underside of abdomen blackish throughout, and mixed with woolly-white hair. Legs greyish yellow, femora covered with woolly-white hair, mixed with blackish grey ones ; tarsi blackish, with white segmental bands.



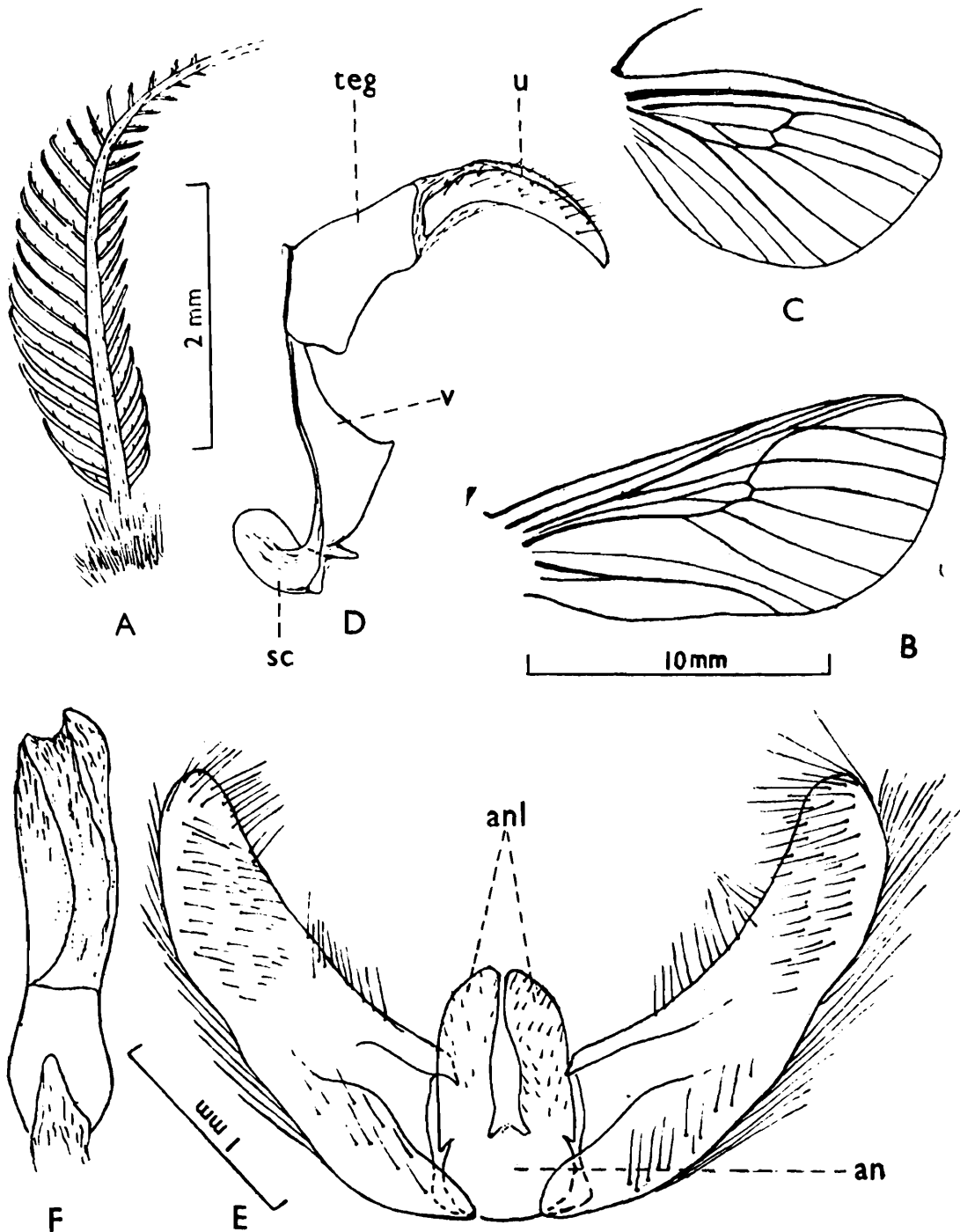
Text-fig. 23. *Phragmataecia obliquifascia* (Bryk) : An outline drawing of the male holotype.

Antennae (Text-fig. 24A) with 35 shaft-segments ; bipectinate up to the basal two-thirds ; the distal one-third serrate ; the longest rami about the length of four middle segments of shaft. Labial palpi minute. Frenulum, retinaculum, legs, spines and spurs as given for the genus.

Venation.—Fore wing (Text-fig. 24B) : Areole normal, long, projecting about one-fourth outside the cell ; vein R_1 arises from near the middle of areole, almost in line with origin of Cu_{1a} , or between origin of Cu_{1a} and Cu_{1b} ; R_2 from near the tip of areole ; R_3 stalked with $R_4 + R_5$; M_1 from well below the angle of cell ; median cell large, with the upper and lower branches ending between $M_1 - M_2$, and $Cu_{1a} - M_3$, respectively ; M_2 and M_3 separate but close. Hind wing (Text-fig. 24C) : Venation as for the genus.

Genitalia.—Male (Text-fig. 24D-F) : Uncus weakly sclerotised, triangular, broad basally, gradually narrowing distally into a narrow and rounded tip ; vinculum broad in the upper part. Saccus short. Clasper long, broader at the base, about four times as long as its width in the middle, and narrow distally. Juxta rounded ; anellus lobes long and narrow, about thrice as long as wide and narrower apically. Aedeagus short and slender, vesica not much enlarged.

Measurements.—Type material : Expanse : Fore wing, 39 mm. Length : Fore wing, 18 mm. ; hind wing, 14 mm. ; abdomen, 12 mm. ; whole body, 20 mm.



Text-fig. 24. *Phragmataecia obliquifascia* (Bryk) : (A) A portion of the male antenna showing pectinations. (B) and (C) Fore and hind wing venation, respectively. (D) Male genitalia in a lateral view, without claspers (E) Claspers in a inner view, with juxta. (F) Aedeagus. (B & C ; D to F of the same magnifications).

Other material.—Expanse : Fore wing, 37 mm. Length : Fore wing, 17 mm. ; hind wing, 12 mm. ; abdomen, 12 mm. , body, 18 mm.

Material examined.—Two examples as follows : India : Assam ; Lekhabali, 1 ♂, 7.x.1966 (*S. K. Tandon* and *G. S. Arora* coll.).

Burma : NE.Burma, Kambaiti, 2000 m., 'Types' 1 ♂, 12-17. vi. 1934 (*Malaise*).

Distribution.—India (Assam), Burma.

Remarks.—Referable to the genus *Phragmataecia*, the species was hitherto known under the genus *Xyleutes* (*vide* Bryk, 1950). It is very close to the other species *viz.*, *clara* and *stigmaticus*. (For detailed differences see under these species). On the basis of study of the type and other material present, the species has been transferred to the genus *Phragmataecia*, as done in *clara* and *stigmaticus*.

Hitherto known only from Burma (Type locality), this species is being recorded from India (Assam, Lekhabali) for the first time.

Genus *Xyleutes* Hübner

1822. *Xyleutes* Hübner, *Verz. bek. Schmett.* : 195 (Type *crassa* Drury from Africa).
1822. *Morpheis* Hübner, *Verz. bek. Schmett.* : 196 (Type *pyracmon* Cramer from Surinam) (*syn.* Dalla-Torre, 1923).
1822. *Chalcidica* Hübner, *Verz. bek. Schmett.* : 197 (Type *mineus* Cramer from Java) (*syn.* Hampson, 1892b ; Turner, 1918).
1844. *Strigoides* Guerin, *Icon. Reg. Anim. Ins.* : 505 (Type *leucolophus* Guer. from Amboina) (*syn.* Dalla-Torre, 1923).
1854. *Endoxyla* Herrich-Schäffer, *Samml. Ausser. Schmett.*, 1 : 7 (Type *d'Urvillei* from Australia (*syn.* Turner, 1918).
1880. *Duomitus* Butler, *Ann. Mag. nat. Hist.*, (5) 6 : 68 (Type *ligneus* Butler from Darjeeling) (*syn.* Piepers & Snellen, 1900).
1883. *Hinnaeya* Moore, *Lep. Ceylon*, 2 : 153 (Type *leuconota* Walker from Ceylon) (*syn.* Hampson, 1892 b ; Turner, 1918).
1887. *Duomitus*, Cotes and Swinhoe, *Cat. Moths of India* : 234.
1892. *Strigoides*, Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.*, 1 : 280.
1892. *Chalcidica*, Kirby, *Cat. Lep. Het.* : 872.
1892. *Xyleutes*, Kirby, *Cat. Lep. Het.* : 873.
1892. *Duomitus*, Kirby, *Cat. Lep. Het.* : 877.
- 1892b. *Duomitus*, Hampson, *Fauna Brit. India, Moths*, 1 : 307.
1900. *Endoxyla*, Piepers and Snellen, *Tijdschr. Ent.*, 43 : 38.
1905. *Xyleutes*, Schaus, *Proc. U.S. Nat. Mus.*, 29 : 339.
1912. *Duomitus*, Seitz, in *Seitz Macrolepidoptera of the World*, 2 : 418.
1917. *Xyleutes*, Chapman, *Entomologist's Rec.*, 29 (3) : 5.
1918. *Xyleutes*, Turner, *Trans. ent. Soc. Lond.*, 66 : 162, 163, 174.
1923. *Xyleutes*, Dalla-Torre, *Lepid. Cat.*, 29 : 49.
1929. *Xyleutes*, Gaede, in *Seitz Macrolepidoptera of the World*, 14 : 546.
1933. *Xyleutes*, Gaede, in *Seitz Macrolepidoptera of the World*, 10 : 813.
1950. *Xyleutes*, Bryk, *Ark. Zool.*, 42A (19) : 46.
- 1951b. *Chalcidica*, Viette, *Lambillionea*, 51 (5-8) : 40.
- 1951b. *Duomitus*, Vietta, *Lambillionea*, 51 (5-8) : 42.
- 1951b. *Endoxyla*, Viette, *Lambillionea*, 51 (5-8) : 42.

- 1951b. *Hinnaeya*. Viette, *Lambillionea*, 51 (5-8) : 43.
 1951b. *Strigoides*, Viette, *Lambillionea*, 51 (11-12) : 71.
 1951b. *Xyleutes*, Viette, *Lambillionea*, 51 (11-12) : 72.
 1957. *Xyleutes*, Roepke, *Verh. K. ned. Akad. Wet. Afd. Nat.*, (2) 52 (1) : 18.
 1965. *Xyleutes*, Müller, *Dt. Z. Ent.*, 12 (3) : 245.

Type species : *Noctua crassa* Drury.

(a) General

Hübner (1822) while erecting the genus *Xyleutes* listed four species, viz., *crassa* Drury, *strix* Linn., *cossus* Linn., and *terebra* Schiffermüller, but did not designate any type of the genus. Gaede (1929) cited *crassa* Drury as the type, and has been followed by Viette (1951b) and Roepke (1957).

The earliest record of a *Xyleutes* species from India is by Donovan (1800) who recorded '*Mineus*' from Bengal. Walker (1856) described *leuconota* and *signata*; Butler (1800) described *ligneus*; and Moore (1877, 1879b) added two species, viz., *nigra* and *pardicolor*, from the Indian region. Hampson (1892b) in his 'Fauna of British India', synonymised *ligneus* and *signata* with *ceramicus* and *strix*, respectively, both belonging to the family Cossidae, and *pardicolor* to *Arbela quadrinotata* Walker, belonging to the family Arbelidae. He (*loc. cit.*) also described a new species, viz., *Duomitus fuscipars* from Sikkim, thus bringing the number of species from India to six. Dudgeon (1899) added a species from Sikkim, viz., *Duomitus pardalis*, which was later synonymised by Gaede (1933) with *pardicolor* Moore. Bryk (1950) referred two more species, *obliquifascia* and *clara*, to *Xyleutes*. These have, however, been transferred to the genus *Phragmataecia* in the present revisionary study.

Thus, in all seven species are hitherto known from the Indian subregion. Except *Xyleutes fuscipars* (Hampson), of which no material was available, all other species have been redescribed from the actual material. In case of *X. pardicolor* (Moore), the type was examined. A new species from Andamans has been described here.

(b) Characters of the Genus *Xyleutes* Hübner

Antennae in male bipectinate from base up to nearly the middle, the distal part minutely serrate; in female simple throughout, with the shaft cylindrical from base up to the middle, but laterally flattened beyond the middle. Labial palpi either short or long, nearly always porrect, the third segment shortest. Wings long and narrow in male, broader in female, the expanse reaching sometimes up to 180 mm. in females. Abdomen shorter or longer than the hind wings. Frenulum spine single in male, as many as 20-30 in female; retinaculum

in male forming an elongated lobe. Hind tibiae with a single pair of minute spurs. Tarsal spines sparse from first to the fourth joint and absent or indistinct on the fifth. Arolium absent.

Venation.—Fore wings : Areole either large and projecting by one-third its length outside the cell angle, or short and projecting by half its length ; vein R_1 usually arises from near the distal end of areole, rarely from cell, in the latter case the areole reduced in size ; vein R_3 close to or shortly stalked with $R_4 + R_5$; M_1 from well below the upper angle of cell (except in *pardicolor* and *kapuri* where it is either from angle or above) ; median cell with the upper branch ending between $M_1—M_2$, and the lower branch between veins $Cu_{1a}—M_3$; M_2 and M_3 close, M_2 arises from above the angle and M_3 from the angle. Hind wings : With vein Sc free ; veins Rs and M_1 wide apart at base ; median cell with the branches ending as in the fore wing : veins M_2 and M_3 wide apart at base, M_2 arises from above the angle, M_3 from the angle.

Male genitalia well developed. Claspers broad in middle. Uncus sclerotised, broad at the base and narrower distally. Gnathos present, free and not united with each other mid-ventrally. Juxta generally reduced. Aedeagus well built and differentiated into a short base and a large vesica, the latter always with a well developed and strong cornutal process. Female genitalia with large corpus bursae ; signum and the receptaculum seminalis present ; genital tube long ; genital plate without much sclerotisation.

(c) Relationships of the Genus *Xyleutes* with the other allied Genera

A true Zeuzerine genus, it consists of some of the largest Indian species (*viz. mineus, persona* and *strix*) of the family Cossidae. On account of antennae, which are bipectinate up to the basal half in male, the genus *Xyleutes* is close to *Azygophelps*, but differs from it by the widely separate veins M_2 and M_3 in hind wings and absence of arolium in between the claws ; the antennae simple in female, whereas in *Azygophelps* these are pectinate in both the sexes. From the genus *Zeuzera*, it can be separated by the absence of a cross bar between veins Sc and Rs in hind wings and by having a larger areole in the fore wings. From *Phragmataecia*, it differs by the antennae which are bipectinate up to basal half in male and simple in female unlike in the latter where these are bipectinate up to nearly two-thirds in both sexes ; by the absence of arolium ; and by the presence of tarsal spines.

(d) Geographical Distribution of the Genus *Xyleutes*

The genus *Xyleutes* is known from all the zoogeographical regions except the Palaearctic. Most of the species occur in the Indo-Austra-

lian regions. In the Oriental region the genus is represented in India (Kashmir, Himachal Pradesh, West Bengal, Orissa, Assam, Arunachal Pradesh, Sikkim), Bhutan, Bangladesh, Burma, Ceylon, Indochina, Indonesia and Philippines.

(e) *Key to Indian Species of the Genus Xyleutes*

1. Areole in the fore wing moderately large ; vein R_1 arising from cell 2
 Areole in the fore wing very large ; R_1 arising from areole 3
2. Fore wing with rounded or sub-rounded spots all over Hind wing with coloured patches in between veins from the outer margin to a little inside the cell ; the cell marked in the distal half *pardicolor* (Moore)
 Fore wings with striae all over, striae denser in distal half. Hind wings with striae in between veins from the outer margin up to discocellular and 1A and 2A ; the cell unmarked completely *kapuri* sp.n.
3. Head, thorax and abdomen with metallic shine (bluish-green). Fore wing with large spots *mineus* (Cramer)
 Head, thorax and abdomen without metallic shine. Fore wing without large spots 4
4. Smaller species. Wings blackish, irrorated with greyish scales *nigra* (Moore)
 Larger species. Wings dark brown, and irrorated with whitish scale 5
5. Abdomen with a dark longitudinal line on dorsal and ventral sides. Fore wing with ringed-patches on inner margin *ceramicus* (Walker)
 Abdomen without any longitudinal line on dorsal and ventral sides. Fore wing without ringed-patches, but with numerous striae forming a net work 6

6. Thorax and the last abdominal segment covered with white scales. Fore wing with a prominent dark streak beyond the cell. Corpus bursae with a rounded signum *persona* (Le Guillou)

Thorax and the last abdominal segment without white scales. Fore wing with a weak streak beyond the cell. Corpus bursae with a triangular signum *strix* (Linn.)

(f) *Descriptions of Species*

27. *Xyleutes pardicolor* (Moore)

(Pl. III, fig. 28 ; Text-fig. 25)

- 1879b. *Zenzera pardicolor* Moore, *Descr. Indian Lep. Atk.* : 86 (Type loc.—Darjeeling).
 1887. *Zeuzera pardicolor*, Cotes and Swinhoe, *Cat. Moths of India* : 234.
 1892b. *Zenzera pardicolor*, Hampson, *Fauna Brit. India, Moths*, 1 : 315 (treated as a syn. of *Arbela quadrinotata* Walker—family 'Arbelidae').
 1892. *Zeuzera pardicolor*, Kirby, *Cat. Lep. Het.* : 872.
 1899. *Duomitus pardalis* Dudgeon, *J. Bombay. nat. Hist. Soc.*, 12 (4) : 645 (Type loc.—Sikkim) [*syn.* Gaede, 1933].
 1900. *Duomitus pardalis*, Hampson, *J. Bombay nat. Hist. Soc.*, 13 : 228.
 1923. *Zeuzera pardicolor*, Dalla-Torre, *Lepid. Cat.*, 29 : 39.
 1923. *Xyleutes pardalis*, Dalla-Torre, *Lepid. Cat.*, 29 : 52.
 1933. *Xyleutes pardicolor*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 819.
 1957. *Xyleutes pardicolor*, Roepke, *Verh. K. ned. Akad. Wet. Afd. nat.*, (2) 52 (1) : 34.

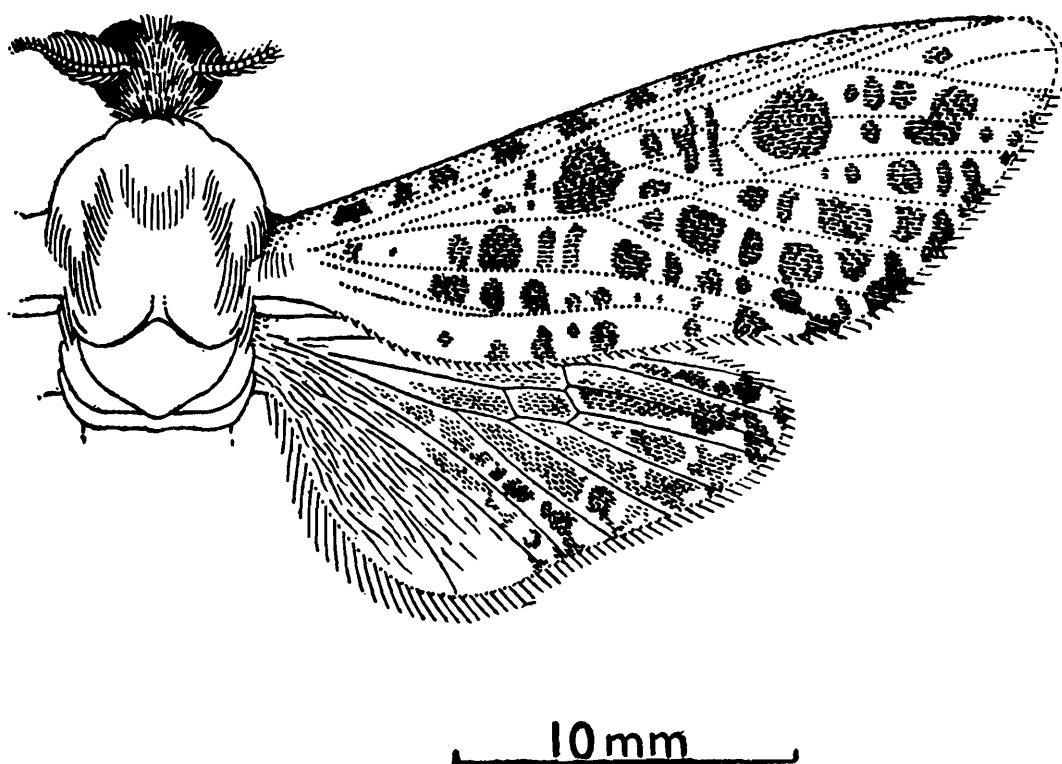
Types : *pardicolor* Moore—a male in Ber. Mus.

pardalis Dudgeon—a male in B. M.

The only material of this species, available for the present study, was that of the type (♂), received from the Berlin Museum, Berlin, and was found to be in a damaged condition. The following description is based on this type.

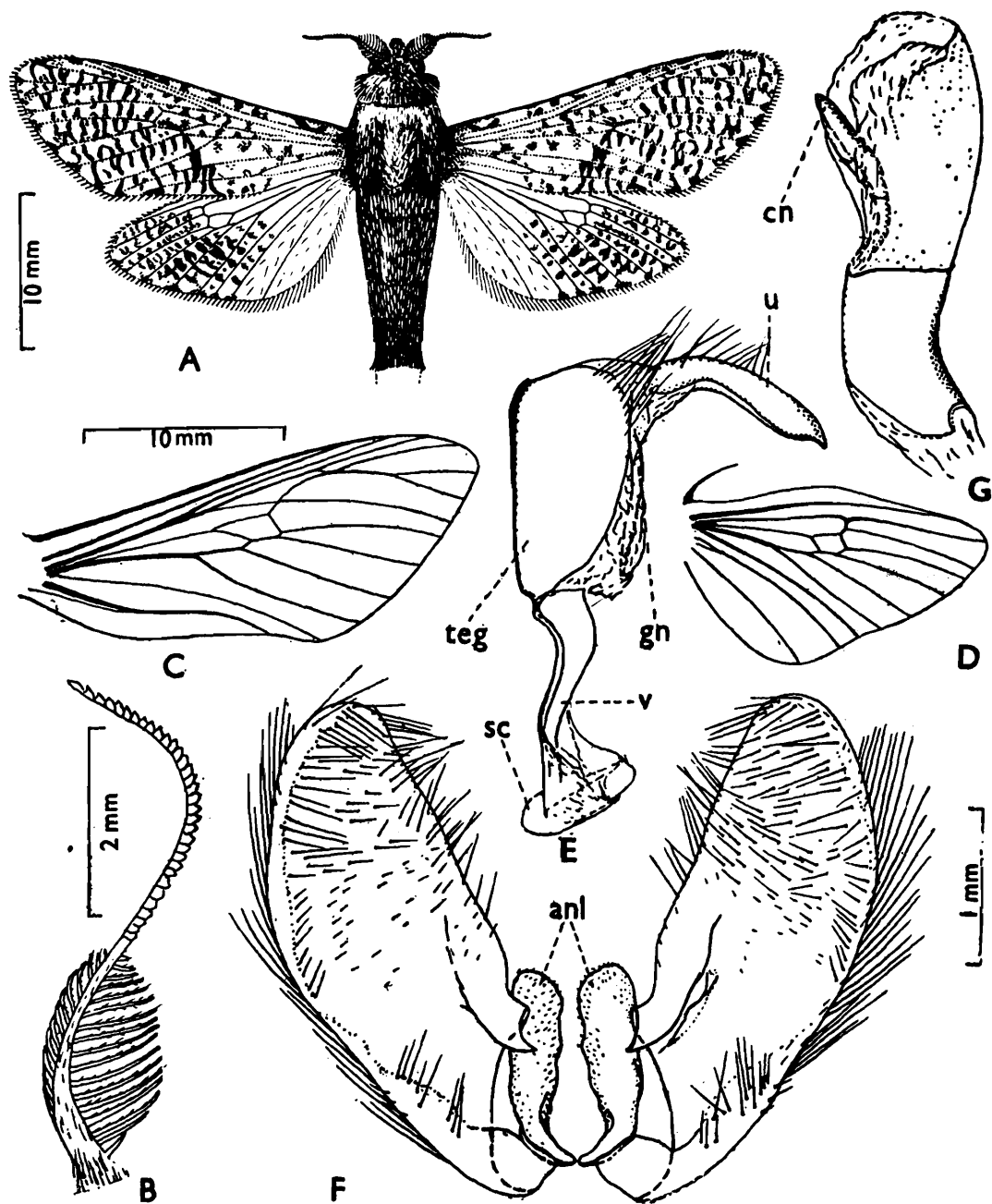
Head with the frontal tufts and the vertex light brown above, blackish in the front and intermixed with light brown scales below. Antennae and eyes brown. Labial palpi blackish brown. Thorax brownish-white, with a row of three black spots on each side ; tegulae

brownish-white, each with a black spot. Fore wings brownish white, with dark brown rounded spots; a prominent series of small spots in between the veins, and a large spot each in the cell and beyond it, present, the latter being the largest; a few spots having a weak reddish tinge, also present in the inner and the marginal areas; veins pale brown to brown. Hind wings also brownish white and with a series of confluent dark brown markings in between the veins and in the distal half of the cell; anterior margin and some area in the cell whitish; inner area pale brown and covered with long hairy scales of the colour of wing. Underside of both wings marked as on the upperside, the area below Cu_2 without any spots; hind wings with a small whitish area at the base of the cell. Legs whitish, with broad black bands.



Text-fig. 25. *Xyleutes pardicolor* (Moore) : An outline drawing of the male type (Specimen badly damaged).

Frontal tufts small. Antennae (incomplete) bipectinate up to basal 16 segments; the rami longest in the middle and as long as about five segments of the shaft; the distal part serrate. Labial palpi short, closely appressed to face and not reaching up to the frontal tufts. Frenulum in the form of a single stout spine; retinaculum short and slightly excurved. Legs with a pair of minute spurs on the hind tibiae; basal four tarsal joints with rows of small spines, the last one without spines, claws without arolium.



Text-fig. 26. *Xyleutes kapuri* sp.n. : (A) An outline drawing of the male holotype (Abdomen partly shown). (B) Male antenna. (C) and (D) Fore and hind wing venation, respectively. (E) Male genitalia in a lateral view, without claspers. (F) Claspers in a inner view with anellus. (G) Aedeagus (C-D ; E to G of the same magnifications).

Venation.—Fore wing (Text-fig. 25) : Areole small, projecting outside the cell angle by half its length and lying almost in line with origin of median cell ; vein R_1 arises from the cell and in line with the origin of vein Cu_{1b} ; vein R_2 from near the distal end of areole ; R_3 stalked with $R_4 + R_5$ and nearer to areole than to R_4 ; M_1 from above the cell angle ; median vein with its branches ending between $M_1—M_2$ and $Cu_{1a}—M_3$, the lower one nearer vein Cu_{1a} than M_3 ; veins

M_2 — M_3 close but separate ; vein M_3 from the angle. Hind wing with the venation mainly as for the genus.

Genitalia.—Not studied.

Measurements.—Type : Expanse, 51 mm. Length : Fore wing, 22.5 mm. ; hind wing, 15 mm. ; abdomen, incomplete in the specimen.

Material examined.—India : West Bengal ; Darjeeling, 1 ♂, 1869 (Staudinger coll.), labelled as "*Zenzera pardicolor* ♂ type Moore" (colln. Atkinson) (ex. colln. Ber. Mus.).

Distribution.—India (West Bengal, Sikkim).

Remarks.—The species differs from all the species of this genus, except *X. kapuri* sp. n., in respect of the origin of vein R_1 , which arises from cell in both of these species, whereas it arises from areole in the other species. From *kapuri* sp.n., it differs by the presence of several rounded or subrounded spots on the fore wing whereas in *kapuri* there are short striae, and by the presence of markings in distal half of the cell in the hind wing whereas in *kapuri* the cell is completely without any markings.

28. *Xyleutes kapuri* sp. n.

(Pl. III, fig. 29 ; Text-fig. 26)

Head with the frontal tufts and labial palpi dark brown, the former brown above. Antennae brown. Collar with a short, black cross streak. Thorax dark greyish brown, upperside marked with two longitudinal, black stripes. Tegulae with a spot each, of the same colour as the stripes on thorax. Abdomen dark-greyish brown. Wings semihyaline ; fore wings marked with numerous, dark brown striae in between veins, those beyond the cell forming lines and those inside and below the cell, fainter ; marginal series of spots from base to vein 1A distinct. Hind wings with the striae present between the cell and the outer margin ; inner area, the cell and the area above it, unmarked. Underside from head up to base of fore legs black. Legs pale reddish brown ; fore and mid tibiae marked on the upperside with two large black spots, hind tibiae without spots ; 1st to 3rd tarsal joints with black bands, 4th and 5th completely black ; claws reddish brown.

Head with the labial palpi short and porrect. Antennae (Text-fig. 26B) bipectinate to nearly one-third its length, the distal part serrate ; shaft with 42 segments, of which 17 pectinate, the last segment simple and elongate ; the rami longest in the middle, as long as about six middle segments. Hind tibiae with a single pair

of short spurs ; tarsi with minute spines from the first to fourth segment ; claws without arolium. Frenulum single, extending far beyond the retinaculum, the latter broad at the base and not curved, about four times as long as its width in middle.

Venation.—Fore wings (Text-fig. 26C) : Areole in fore wing moderately large, with its origin in line with the origin of median cell ; vein R_1 arises from cell and in line with the origin of Cu_{1b} ; R_2 from near the tip of areole ; R_3 shortly stalked with R_4+R_5 ; the latter two forming a long stalk ; M_1 from upper angle of cell ; M_2 and M_3 close at base ; the lower branch of median cell ending between Cu_{1a} and M_3 ; Hind wings (Text-fig. 26D) : Broadly as for the genus.

Genitalia.—Male (Text-fig. 26E-G) : Uncus short, about twice as long as its width in middle and highly sclerotised ; strongly bent from the base and ending into a pointed hooked tip. Gnathos rather weak. Tegumen broadly oval, gradually narrowing towards base ; vinculum narrow, ending into a short saccus. Clasper broadest in the middle, about twice as long as its width in middle ; slightly depressed at the base dorsally and ending in a fold ; simple mesally. Juxta absent ; anellus lobes distinct, narrow at the base and broadly elongate in the distal part. Aedeagus rather short, stout and clearly differentiated into sclerotised base and vesica, the latter with a few striation and a hard cornutal process. Female : Not known.

Measurements.—Holotype : Expanse : Fore wing, 48 mm. Length : Fore wing, 21.5 mm. ; hind wing, 15 mm. ; abdomen, 14 mm. ; whole body, 21 mm. Paratypes : Expanse : Fore wing, 35-52mm. Length : Fore wing, 15-23 mm. ; hind wing, 11-15 mm. ; Abdomen, 11-15 mm. ; whole body, 16-23 mm.

Holotype : A male : India : S. Andaman ; Humphrygunj, 106.68 m. 3.iii.1964 (B. S. Lamba coll.) Paratypes : 8♂♂ ; India : Middle Andaman ; Rangat Rest House, at light, 1♂, 4.i.1973, 1♂, 6.i.1973, 1♂, 7.i.1973, 2♂♂, 8.i.1973 (all G. S. Arora coll.). S. Andaman ; Humphrygunj Rest House, at light, 1♂, 13.iii.1975, 2♂♂, 14.iii.1975 (all G. K. Srivastava coll.). Deposited in Zoological Survey of India.

Remarks.—It is remarkably different from the other Indian species for its wing pattern which is more like *Zeuzera* species.

It is close to *X. pardicolor* (Moore) especially in respect of the origin of the vein R_1 which is from the cell. For differences see under *pardicolor*.

It is also close to a Malayan species, *X. malayica* Roepke, in respect of the wing pattern but, however, can be separated by the pre-

sence of two longitudinal, black stripes on thorax and for the longer stalk of the veins R_4+R_5 in the fore wing. The uncus in male genitalia is short and bent unlike in *malayica* where it is broad, short and straight.

29. *Xyleutes mineus* (Cramer)

(Pl. III, fig. 30 ; Text-fig. 27)

1779. *Phalaena mineus* Cramer, *Papill. Exot.*, 2 : 5, pl. 131, fig. D (Type loc.-Batavia).
1800. *Phalaena bombyx mineus*, Donovan, *Ins. India* : 82 (Bengal).
1821. *Zeuzera viridicans* Eschscholtz, in Kotzebue *Ent. Reise*, 3 : 219, pl. 11, fig. 29 (Type loc.- Ganjam) (*syn.* Kirby, 1892).
1822. *Chalcidica mineus*, Hübner, *Verz. bek. Schmett.* : 197.
1838. *Zeuzera mineus*, Westwood, *Nat. Hist. Ins. India* : 83.
1856. *Zeuzera mineus*, Walker, *List Lep. Het. Brit. Mus.*, 7 : 1535. (Sylhet).
1865. *Zeuzera mineus*, Moore, *Proc. zool. Soc. Lond.* : 822.
1887. *Zeuzera mineus*, Cotes and Swinhoe, *Cat. Moths of India* : 233.
1892. *Chalcidica mineus*, Kirby, *Cat. Lep. Het.* : 872 (Indonesia).
1892. *Zeuzera mineus*, Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.* : 283.
- 1892b. *Duomitus mineus*, Hampson, *Fauna Brit. India, Moths*, 1 : 309. (Bangladesh, India (Calcutta, Sikkim, Ganjam), Java and Manilla).
1899. *Duomitus mineus*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 (4) : 645 (Bengal).
1900. *Endoxyla mineus*, Piepers and Snellen, *Tijdschr. Ent.*, 43 : 39 (Java).
1909. *Duomitus mineus*, Lefroy, *Indian Insect Life.* : 495.
1923. *Xyleutes mineus*, Dalla-Torre, *Lepid. Cat.*, 29 : 52 (Batavia, Bangladesh, India, Manilla, Java, Cambodia, Siam, Philippines and New Guinea).
1933. *Xyleutes mineus*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 818 (India, Indo-china, Sunda Is., Philippines and New Guinea).
- 1951b. *Chalcidica mineus*, Viette, *Lambillionea*, 51 (5-12) : 40 (Batavia).
1955. *Xyleutes mineus*, Roepke, *Trans. R. ent. Soc. Lond.*, 107 : 284.
1957. *Xyleutes mineus*, Roepke, *Verh. K. ned. Akad. Wet. Afd. Nat.*, (2) 52 (1) : 25, 57. (India to Philippines and New Guinea).
1965. *Xyleutes mineus*, Müller, *D. ent. Z.*, 12 (3) : 251.

Type : Lost (*vide* Roepke, 1957).

Antennae, thorax and abdomen dark metallic bluish-green. Fore wings yellowish, with a pinkish tinge, the base bluish green ; spots of the same colour also present along the costa ; the largest ones being one beyond cell, and another just before the apex, smaller spots at the centre near the end of cell ; with a large oval, transverse spot from median nervure to inner margin and another large, longitudinal spot extending from below the end of cell at vein 1A nearly up to the apex at vein R_5 . Hind wing yellowish, with some blackish brown on inner area and bluish black streaks in the inter-spaces

beyond cell ; two spots on costa near apex and a series of marginal spots present. Underside of palpi and thorax, up to fore legs, tinged with metallic blue green.

Head with the labial palpi large, porrect and reaching as far as the frontal tufts. Antennae shaft (Text-fig. 27A) with 60-62 short segments ; bipectinate in male from base to nearly middle of shaft, or up to some 22 segments ; the distal part with about 40 short segments, minutely serrate, the last segment simple, rami very long in the middle, about as long as ten middle segments of shaft ; antennae in female simple, laterally flattened in distal part.

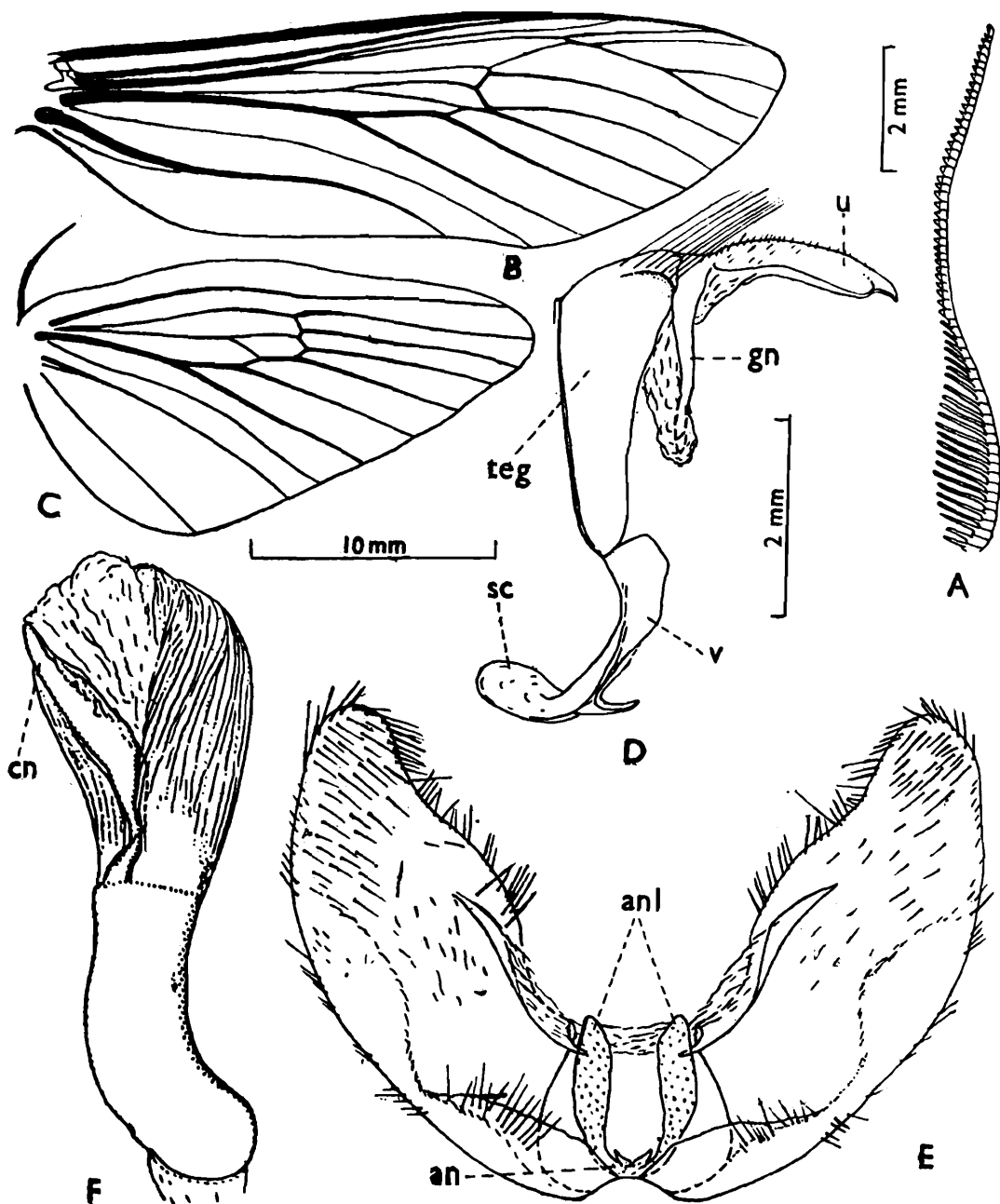
Venation (Text-fig. 27B-C) : Broadly as for the genus.

Genitalia.—Male (Text-fig. 27D-F) : Uncus broadly triangular, sclerotised and sharply pointed downwards in the form of a hook ; about twice as long as its width in middle. Tegumen broadly triangular, narrow at base. Saccus more or less globular. Gnathos long, the ends incurved and coming close to each other but not uniting. Clasper about two-and-a-half times as long as its width in middle ; broader in the middle than at base or apex, the latter almost rounded at the tip and beset with long hair on outer side ; ventral margin wavy. Juxta small and reduced ; anellus lobes long, broader distally. Aedeagus well built ; markedly differentiated into a short base and a large sclerotised and striated vesica, the latter with a hard, sclerotised cornutal process. Female : Ostium bursae and ductus bursae sclerotised ; corpus bursae large, nearly quadrangular, with a signum, the latter slightly depressed and beset with short spinose protuberances ; receptaculum seminalis large and nearly globular, with a fine duct entering into ductus bursae.

Measurements.—Expanse : Fore wing : male, 65 mm. ; female, 110-126 mm. Length : Fore wing : male, 28 mm. ; female, 55-59 mm. Hind wing : male, 22 mm. ; female, 38-40 mm. Abdomen : male, 22 mm. ; female, damaged. Whole body : male, 38 mm. ; female, Damaged.

Material examined.—India : W. Bengal : Darjeeling, 3 ♂♂, 28.ii.1880 (no further data) ; Calcutta, 1 ♀, -x-1870 (no further data). Bihar : Pusa, 1 ♂, 1 ♀, 29.viii.08 (*C.M.E.* coll.) (wild bush) (ex. colln. *I.A.R.I.*). Orissa : Puri, 1 ♂, (no date) (*D. Walsch* coll.). Arunachal Pradesh : Kameng Division, Kimin, 1 ♂, 9.v.1966 (*A.N.T Joseph* coll.). Sikkim : 548.63 m., 1 ♀, -.viii.1897, 1 ♀, -.ix.1897, 2 ♂♂ (no date) (All *G. C. Dudgeon* coll.).

Bangladesh : Sylhet, 1 ♂, 1 ♀, 28.ii.1880 (no other data).



Text-fig. 27. *Xyleutes mineus* (Cramer) : (A) Male antenna showing pectinations of one side. (B) and (C) Fore and hind wing venation, respectively. (D) Male genitalia in a lateral view, without claspers. (E) Claspers in inner view, with anellus. (F) Aedeagus., (B & C ; D to F of the same magnifications).

Distribution.—This is a very widely distributed species in the Oriental region and is recorded from India (W. Bengal, Sikkim, Assam, Arunachal Pradesh, Bihar and Orissa), Bangladesh (Sylhet), Indonesia, Thailand, Indo-china (Cambodia) and the Philippines. It is also known from New Guinea in the Australian region.

Remarks.—Cramer (1779) while describing the species from Batavia, illustrated a male with the antennae filiform, though he mentions

them as "plumose" Later, Donovan (1800) figured a male from Bengal and characterised it as "Antennae gradually tapering from base" As also stated by Roepke (1957), the antenna in the male figured by Cramer (1779) is erroneous and does not represent the true structure of male antenna.

This species is readily distinguishable from all the other species of the genus by its metallic bluish-green tinge on the body and by the large conspicuous spots on both wings which are also tinged with metallic bluish-green. In male genitalia, it is characterised by reduced juxta which is without a median lobe ; and the corpus bursae, in the female genitalia, having a quadrangular signum.

30. *Xyleutes nigra* (Moore)

(Pl. III, fig. 31)

1877. *Zeuzera nigra* Moore, *Ann. Mag. nat. Hist.*, (4) 20 : 348. (Type loc.-Ceylon).
 1883. *Zeuzera nigra*, Moore, *Lep. Ceylon*, 2 : 155.
 1887. *Zeuzera nigra*, Cotes and Swinhoe, *Cat. Moths of India* : 233.
 1892. *Zeuzera nigra*, Kirby, *Cat. Lep. Het.* : 872.
 1892b. *Duomitus nigra*, Hampson, *Fauna Brit. India, Moths*, 1 : 307. (Nilgiris, Ceylon).
 1923. *Xyleutes nigra*, Dalla-Torre, *Lepid. Cat.*, 29 : 52. (Nilgiris, Ceylon).
 1933. *Xyleutes nigra*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 816 (Nilgiris, Ceylon).

Type : In B.M.

Host : Coffee.

Head, thorax and abdomen blackish. Frontal tufts blackish, irrorated with grey scales. Antennae and labial palpi blackish. Fore wings blackish, densely irrorated with greyish scales ; a large area beyond the cell angle without greyish scales. Hind wings blackish, densely irrorated with grey scales in the lower half of wings ; the area between costa and cell golden yellow to pale ochreous. Underside of fore wings with the coloration as on upperside ; hind wings without pale ochreous colour above the cell, otherwise as on upper-side. Legs black.

Antennae simple (incomplete and damaged apically). Labial palpi short and slender. Frenulum spines several. Legs with the spurs and spines, as for the genus.

Venation.—Mainly as for the genus.

Genitalia.—Not studied (abdomen damaged in the specimens available for this study).

Male : Not known.

Measurements.—Expanse : Fore wing, 48-72 mm. Length : fore wing, 23-34 mm. ; hind wing, 14-21 mm. ; abdomen, 15-30 mm. ; whole body, 21-44 mm.

Material examined.—2 examples as follows : Ceylon ; Kandy, 1 ♀, 16.x.1903 ; 1 ♀, -v.1905 (Both *E.E. Green* coll.).

Distribution.—India (Nilgiris), Sri Lanka

Remarks.—Referable to the genus *Xyleutes*, it can very well be differentiated from the other species by the colour of its body and wings which are irrorated with grey scales.

31. *Xyleutes ceramicus* (Walker)

(Pl. III, fig. 32 ; Text-fig. 28)

1865. *Zeuzera ceramica* Walker, *List Lep. Brit. Mus.*, 32 : 587 (Type loc.-Ceram, Amboina, Indonesia).
1880. *Duomitus ligneus* Butler, *Ann. Mag. nat. Hist.*, (5) 6 : 68. (Type loc.-Darjeeling) (*syn.* Hampson, 1892(b)).
1886. *Duomitus ligneus* Butler, *Ill. Typ. Lep. Het.*, 6 : 29.
1887. *Duomitus ligneus*, Cotes and Swinhoe, *Cat. Moths of India* : 234.
1892. *Endoxyla bosschae* Heylaerts, *Annls. Soc. ent. Belg.*, 36 : 45 (Type loc.-Borneo) (*syn.* Roepke, 1957).
1892. *Strigoides ceramica*, Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.* : 280.
- 1892b. *Duomitus ceramicus*, Hampson, *Fauna Brit. India, Moths*, 1 : 307 (Sikkim, Indonesia and New Zealand).
1892. *Xyleutes ceramicus*, Kirby, *Cat. Lep. Het.* : 875 (Nias and Indonesia).
1892. *Duomitus' ligneus*, Kirby, *Cat. Lep. Het.* : 877. (Darjeeling).
1899. *Duomitus ceramicus*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 (4) : 645 (Sikkim).
1916. *Strigomorphus ceramicus*, Houlbert, in Oberthur *Etud. Lep. Comp.*, 11 : 113.
1916. *Endoxyla bosschae*, Houlbert, in Oberthur *Etud. Lep. Comp.*, 11 : 113.
1916. *Duomitus ceramicus*, Beeson, *Rep. Bd. scient. Advice India, 1914-15* : 167.
1917. *Duomitus ceramicus*, Chatterjee, *Rep. Bd. scient. Advice India, 1915-16* : 174.
1918. *Duomitus ceramicus*, Beesor, *Rep. Bd. scient. Advice India, 1915-16* : 96.
1923. *Endoxyla bosschae*, Dalla Torre, *Lepid. Cat.*, 29 : 49 (Panama).
1923. *Xyleutes ceramicus*, Dalla Torre, *Lepid. Cat.*, 29 : 50 (Ceram, Nias, New Zealand and Darjeeling (India)).
1933. *Xyleutes ceramicus*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 818 (Ceram, Nias, New Zealand).

1936. *Xyleutes ceramicus*, Atkinson, *Indian For. Res. (N. S.) Ent.*, 2 (1) : 98 (Rangoon).
1941. *Xyleutes ceramicus*, Beeson, *The Ecology and the Control of Forest Insects of India and the Neighbouring Countries* : 573, 953.
- 1951b. *Xyleutes ceramicus*, Viette, *Lambillionea*, 51 (5-12) : 42.
1955. *Xyleutes ceramicus*, Roepke, *Trans. R. ent. Soc. Lond.*, 107 : 284 (New Guinea).
1957. *Xyleutes ceramicus*, Roepke, *Verh. K. ned. Akad. Wet. Afd. Nat.*, (2) 52 (1) : 34-35 (Burma, Malaya Peninsula).
1958. *Xyleutes ceramicus*, Kaput, in *Problems of Humid Tropical Regions* : 63.
1959. *Xyleutes ceramicus*, Insects : In *Wealth of India*, 5 : 205 (C.S.I.R., New Delhi).
1959. *Xyleutes ceramicus*, Mathur and Singh, *Forest. Bull. Dehra Dun*, 171 (4) : 61.
- 1961a. *Xyleutes ceramicus*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (8) : 36.
1965. *Xyleutes ceramicus*, Müller, *Dt. ent. Z.*, 12 (3) : 248-250.

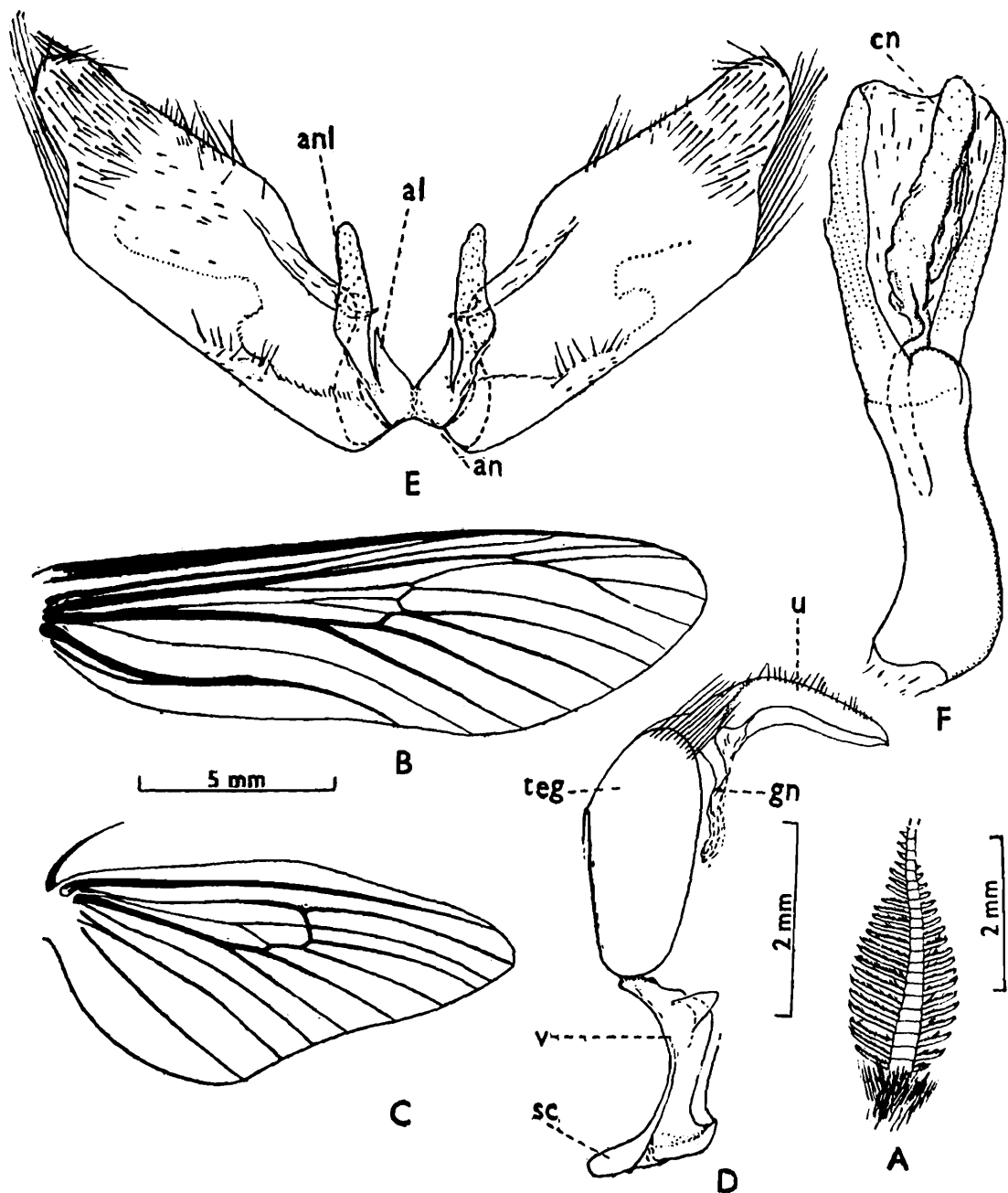
Types : *ceramica* (Walker). In colln. Wallace, Ox. Univ. Mus.
ligneus Butler—In B.M.
bosschae Heylaerts—In Leiden Museum.

Hosts : *Callicarpa arborea* Roxb. ; *Clerodendron infortunatum* Linn. ; *Duabanga sonneratioides* ; *Sesbania grandiflora* ; *Spathodes companulata* ; *Tectona grandis*.

Body cinereous. Antennae and labial palpi brown. Thorax yellowish brown ; marked with two longitudinal brownish-black stripes. Fore wings with the ground colour yellowish brown ; with several black costal dots from base to apex and lines in between veins and in & around cell, the lines beyond the cell prominent ; a large white-ringed patch, tessellated with black around tornus, extending along outer and inner margins. Hind wings brownish, tessellated with black ; a few indistinct submarginal white spots, similar to those on the fore wing, also present. Abdomen yellowish brown at base, with blackish bands on the sides from near the base to 4th segment but brownish in the distal half ; a longitudinal blackish line present both dorsally and ventrally. Underside of wings yellowish brown, markings brownish black and more prominent than on the dorsal side ; thorax and legs brownish black ; tarsi yellowish brown at or near the base, the lateral sides brownish black.

Head with the antennae (incomplete in all the examples available for study) bipectinate (Text-fig. 28A) up to 22-26 segments, the rami longest in the middle, about as long as four segments. Labial palpi well developed, slender, nearly porrect and reaching the frontal tufts. Legs with the spurs and spines, and frenulum and retinaculum, as for the genus.

Venation.—Fore wing (Text-fig. 28B) : Areole very large, extending beyond the cell ; vein R_1 arises from the areole and in line with the origin of median cell and vein Cu_{1b} , rarely the median cell arising before the origin of areole ; R_2 from near the tip of areole ; R_3 shortly stalked with R_4+R_5 ; M_1 from well below the angle (except in one example where M_1 is obsolete in the left wing, and arises from angle of cell in the right) ; M_2-M_3 generally close, rarely stalked. Hind wing (Text-fig. 28C) : Broadly as given in generic characters.



Text-fig. 28. *Xyleutes ceramicus* (Walker) : (A) A portion of the male antenna showing pectinations. (B) and (C) Fore and hind wing venation, respectively. (D) Male genitalia in a lateral view, without claspers. (E) Claspers in inner view, with juxta. (F) Aedeagus. (B & C ; D to F of the same magnifications).

Genitalia.—Male (Text-fig. 28D-F) : Uncus sclerotised ; a little less than twice as long as its width in middle ; broader at base than in distal portion, the latter narrow and blunt, not pointed. Tegumen broadly, oval, sclerotised. Gnathos extending laterally inwards but not meeting with each other ; vinculum broad above, with a short conical process. Saccus short, flattened, more or less broadly quadrangular. Claspers simple, about three times as long as the width in middle ; costa produced inwards into a short, blunt prolongation ; deeply incurved ventrally near distal margin, the apex narrow and about half the width of middle. Juxta reduced, with two short median lobes ; anellus lobes longer than juxta lobes and rounded at tips. Aedeagus well developed, markedly differentiated into a short base and a large vesica, the latter sclerotised, striated and with a hard cornutal process on one side.

Measurements.—Expanse : Fore wing, 65-120 mm. Length : fore wing, 31-55 mm. ; hind wing, 20-40 mm. ; abdomen, 26-38 mm. ; body, 23-55 mm.

Material examined.—Five examples as follows : India : West Bengal : Darjeeling, 1 ♂, (no date) (*W.D.* coll.). Sikkim : 548.63 m., 2 ♂♂, -vii.1898 (*G. C. Dudgeon* coll.)

Burma : N. Shan States, 1 ♂, 1 ♀, 16. v. 1914 (*C.F.C. Beeson*) (ex. *Tectona grandis*) (ex. colln. F.R.I.).

Distribution.—It is a widely distributed species in the Orient and is known from India (W. Bengal, Sikkim), Burma, Malaya Archipelago, Indonesia (Ceram, Nias, Borneo, Java, Sumatra, New Guinea) and Indo-china.

Remarks.—Referable to the genus *Xyleutes*, it is widely distributed in the Orient region. From India (Darjeeling) it was described under the name *Duomitus ligneus* by Butler (1880). and was treated *vide* Hampson, 1892b) as a synonym of *ceramica*. Beeson (1941), however, mentioned that the species does not occur in India and Ceylon. Recently Roepke (1957), although mentions that it is not known from India and Ceylon and records its western limit as Burma and Malaya Peninsula, cites *ligneus* Butler, from Darjeeling, under the synonymy of *Xyleutes ceramica ceramica* (Walker). Evidently the distribution of *ligneus* escaped the notice of both Beeson (1941) and Roepke (1957) and if *ligneus* Butler is to be considered as synonym of *ceramica*, the later has to be accepted as occurring in India.

It is characterised by the presence of a whitish ringed-patch around the tornus in the fore wing and a well marked median longitudinal line each on dorsal and ventral surfaces of abdomen (which are absent in the other Indian species).

32. *Xyleutes persona* (Le Guillou)

(Pl. III, fig. 33 ; Text-fig. 29, 30)

1841. *Cossus persona* Le Guillou, *Revue zool.*, 4 : 257. (Type loc.-Samarang, Java, Indonesia).
1844. *Strigoides leucolophus* Guerin, *Icon. Regne Animal* : 505 (Type loc.-Amboina, New Guinea) (*syn.* Gaede, 1933 ; Roepke, 1957).
1856. *Zeuzera leuconota* Walker, *List Lep. Brit. Mus.*, 7 : 1538. (Type loc.-Ceylon) (*Syn.* Dalla-Torre, 1923).
1859. *Zeuzera leuconotus*, Horsfield and Moore, *Cat. Lep. Mus. E.I.C.*, 2 : 437.
1867. *Zeuzera leuconotus*, Moore, *Proc. zool. Soc. Lond.* : 686 (Calcutta, Dum Dum).
1883. *Hinnaeya leuconota*, Moore, *Lep. Ceylon*, 2 : 153 (Ceylon).
1886. *Zeuzera leuconotus*, Butler, *Ill. Typ. Lep. Het.*, 6 : 28. (Ceylon, Darjeeling (India) and Silhet (Bangladesh)).
1887. *Zeuzera leuconota*, Cotes and Swinhoe, *Cat. Moths of India* : 233.
1892. *Zeuzera leuconota*, Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.* : 283.
1892. *Xyleutes leucolophus*, Kirby, *Cat. Lep. Het.* : 874.
1892. *Xyleutes leuconotus*, Kirby, *Cat. Lep. Het.* : 874.
- 1892b. *Duomitus leuconotus*, Hampson, *Fauna Brit. India, Moths*, 1 : 307 (Ceylon, Calcutta, Simla, Sikkim).
1895. *Duomitus leuconotus*, Swinhoe, *Trans. ent. Soc. Lond.* : 29.
1899. *Duomitus leuconotus*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 (4) : 645.
1900. *Cossus persona*, Piepers and Snellen, *Tijdschr. Ent.*, 43 : 39 (Treated as synonym of *Endoxyla strix* (Linn.)).
1903. *Cossus persona*, Poujade, *Bull. Soc. ent. Fr.* : 122 (S. India, Ceylon and Java).
1904. *Duomitus leuconotus*, Stebbing, *J. Asiat. Soc. Beng.*, 73 (2) : 25.
1909. *Duomitus leuconotus*, Lefroy, *Indian Insect Life* : 495.
1912. *Duomitus leuconotus*, Seitz, in Seitz *Macrolepidoptera of the World*, 2 : 418 (Kashmir).
1916. *Xyleutes persona*, Houlbert, in Oberthur, *Etud. Lep. Comp.*, 11 : 79.
1923. *Strigoides leucolophus*, Dalla-Torre, *Lepid. Cat.*, 29 : 51 (Amboina, Papua).
1923. *Xyleutes persona*, Dalla-Torre, *Lepid. Cat.*, 29 : 53 (India (Simla, Calcutta, Sikkim), Ceylon and China).
1933. *Xyleutes leuconotus*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 817.
1937. *Xyleutes leuconotus*, Dupont, *Ent. Meded. Ned. India*, 3 : 12 (Java).
1941. *Xyleutes persona*, Beeson, *The Ecology and the Control of Forest Insects of India and Neighbouring Countries* : 580.
1945. *Xyleutes leucolophus*, Sevastopulo, *J. Beng. nat. Hist. Soc.*, 19 : 115.
1955. *Xyleutes leucolophus*, Roepke, *Trans. R. ent. Soc. Lond.*, 107 : 283 (New Guinea).
1957. *Xyleutes persona*, Roepke, *Verh. k. ned. Akad. Wet. Afd. Nat.*, (2) 52 (1) : 22 (India, Ceylon, S. Asia, New Guinea, Greater Sunda Is.).
1958. *Xyleutes leuconotus*, Bhasin, Roonwal and Singh, *Forest Bull. Dehra Dun*, 171 (2) : 84, 80, 90.

1959. *Xyleutes leuconotus*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (4) : 62.
1965. *Xyleutes persona*, Müller, *Dt. ent. Z.*, 12 (3) : 253.

Types : *persona* Le Guillou, in Paris Mus.; *leuconotus* Walker, in B.M.

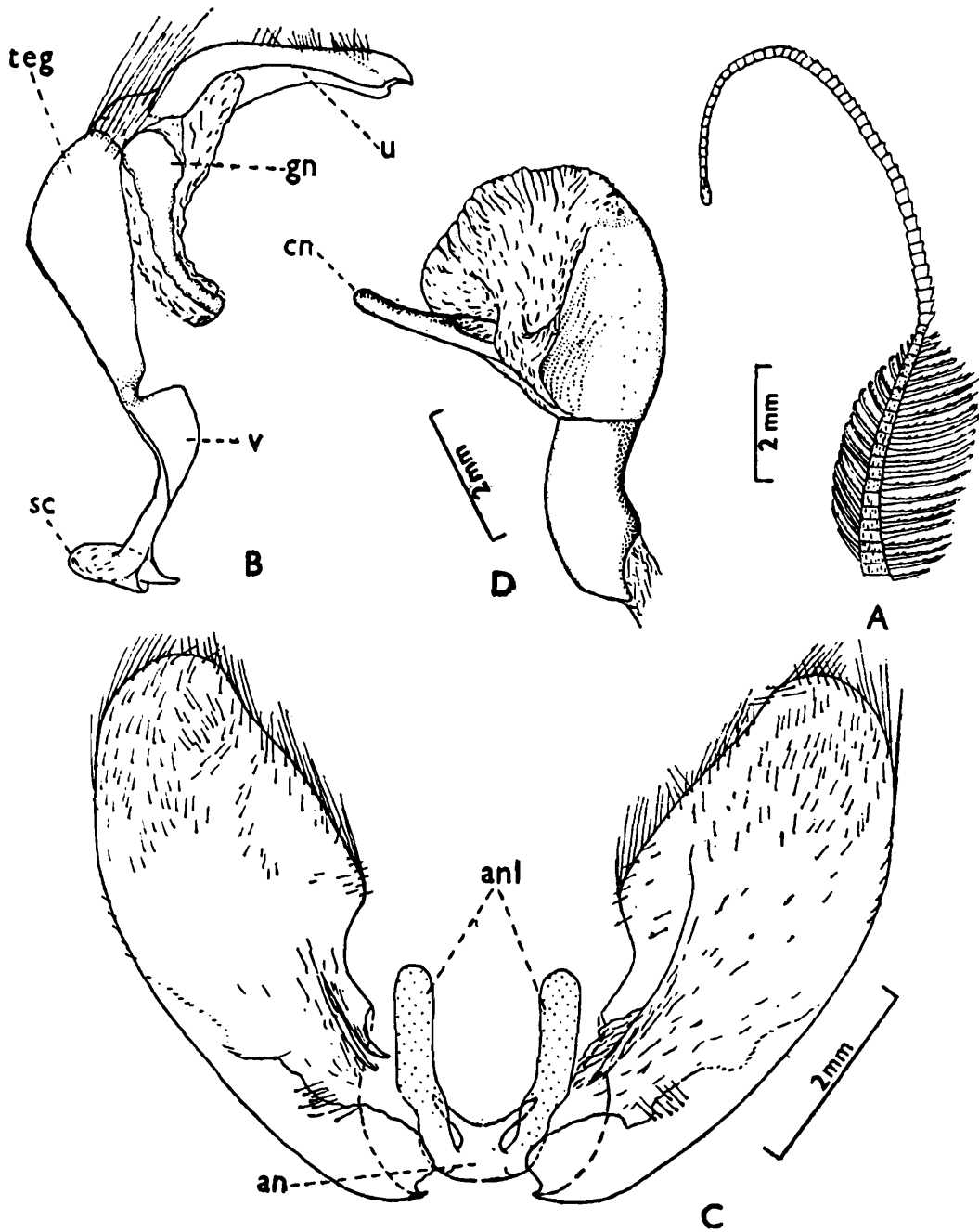
Hosts : *Cassia fistula*, *Cassia multijuga*, *Cassia nodosa*, *Cassia renigera*, *Cassia siamea*, *Durio zibethinus* and *Premna* sp.

Head with the antennae, labial palpi and frontal tufts dark brown. Thorax whitish throughout. Wings dark brown. Abdomen dark brown, except the base and the last segment which have whitish scales dorsally. Legs dark to blackish brown. Fore wings with the base covered with white scales, which are continuous with the white patch of scales along the inner margin up to the tornal angle ; a white patch also present at the apex ; the remaining portion of wing dull blackish-brown and marked with numerous blackish striae in between veins, forming short and long streaks, the prominent one being beyond the discocellular in the space between veins M_1-M_2 . Hind wings smoky brown, with a white patch on inner area near the anal angle ; outer area marked with blackish brown striae ; the area along costa and the base unmarked but with some shine. Underside of both wings smoky brown and of abdomen pale yellowish brown, the latter with segmental lateral white spots.

Antennae (Text-fig. 29A) long, the shaft with about 75 segments ; in male, bipectinate up to basal half, or a little less (up to basal 25 segments), the distal part serrate, the tip simple ; rami very long, about as long as ten middle segments of shaft ; antennae in female simple. Labial palpi well developed, long and nearly porrect or slightly ascending, and closely appressed to face, reaching as far as the frontal tufts. Legs with the spurs, spines, frenulum and retinaculum as given for the genus.

Venation.—Fore wing : vein R_1 arises in line with the origin of median cell and vein Cu_{1b} ; vein R_3 connate or stalked with veins R_4+R_5 ; other features as for the genus. Hind wing : Broadly as for the genus.

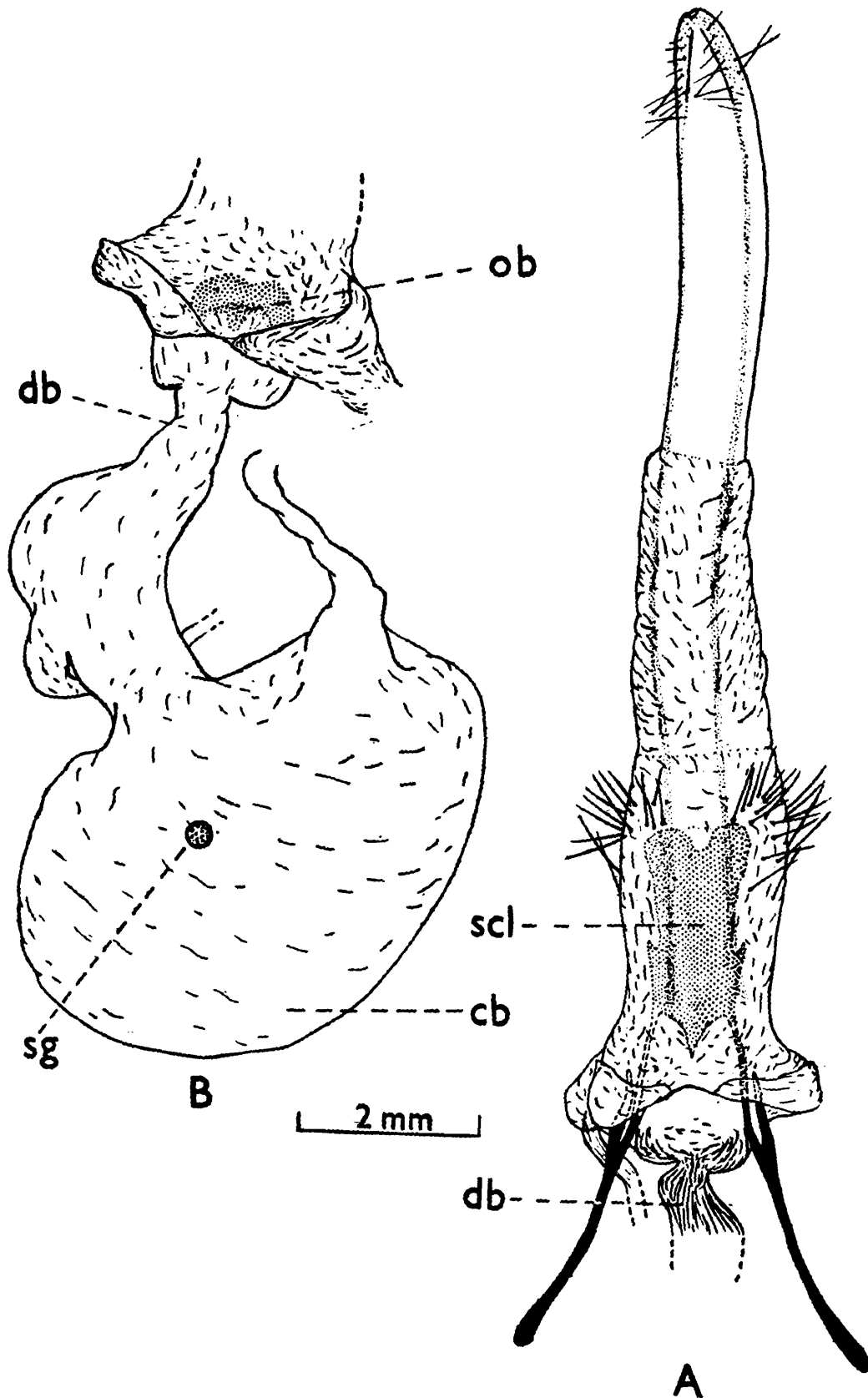
Genitalia.—Male (Text-fig. 29B-D): Uncus about two-and-a-half times as long as its width in middle ; broad at the base, the distal portion narrow, raised into a ridge distally and ending in a fine hooked-point. Gnathos as in *ceramicus*. Tegumen and vinculum not much different from *ceramicus*. Saccus short. Claspers a little less than three times as long as the width in middle ; with generally long and clubbed hair on the outside and fine setae on the mesal side along the dorsal and on ventral margins. Juxta short



Text-fig. 29. *Xyleutes persona* (Le Guillou) : (A) A portion of male antenna showing pectinations. (B) Male genitalia in a lateral view, without claspers. (C) Claspers in inner view, with juxta. (D) Aedeagus. (B & C of the same magnifications).

and reduced ; with a short median lobe and two lateral anellus lobes, the latter rounded at apex. Aedeagus well built and clearly differentiated into a short base and a large vesica, the latter slightly sclerotised and striated ; cornutal process present, not extending beyond veisca. Female (Text-fig. 30) : Ostium bursae sclerotised, the sclerotisation horse-shoe shaped ; ductus bursae short and sclerotised ; corpus bursae irregular, slightly striated, with rounded signum which is depressed into a slight cavity and beset with fine black spines ; ductus bursae connected by a duct with a globular, translucent sac-the recep-

taculum seminalis ; another fine duct arises from the corpus bursae and enters into the genital tube ; genital plate sclerotised only dorsally.



Text-fig. 30. *Xyleutes persona* (Le Guillou) : (A) and (B) Dorsal and ventral views, respectively of the parts of female genitalia.

Measurements.—Expanse : Fore wing : Male, 65-133 mm. ; female, 80-194 mm. Length : Fore wing : Male, 28-61 mm ; female, 37-88 mm. Hind wing : Male, 19-39 mm. ; female, 25-57 mm. Abdomen : Male, 21-39 mm. ; female, 21-50 mm. Whole body : Male, 32-62 mm. ; female, 30-73 mm.

Material examined.—43 examples as follows : India : Bengal : Calcutta, 2 ♀ ♀, 2 ♂ ♂, -ix-1903 (ex. colln. F.R.I.) 1 ♂, 1 ♀, -iii.1885 (*S. Thomas* coll.); 8 ♂ ♂, 9 ♀ ♀, 22.ix.1903-10.x.1903 (Reared in Indian Museum) ; 1 ♀, 4.viii.1909 (*B. L. Chowdhury* coll.) ; 1 ♀, -x.1949 (*A. P. Kapur* coll.). Uttar Pradesh ; Chakrata Range ; Haldwani, 1 ♀, 14.vii.1930 (*S. N. Chatterjee* coll.) ; Dehra Dun, Guchhupani, 1 ♀, 19.ix.1925 (*S. Bahadur* coll.), F.R.I. Compound, 1 ♀, 21.ix.1914, 1 ♂, 18.viii.1925 (*C. F. C. Beeson* coll.), 1 ♂, 20.x.1917, 1 ♂, 15.viii.1923 (Student coll.), New Forest, 1 ♂, 15.ix.1939 (*J. C. M. Gardner* coll.) (all. ex. colln. F R. I.) Himachal Pradesh : Simla, 1 ♀, 25.vi.1902 (No further data). Sikkim : 2 ♀ ♀ (no date) (*W. D.* coll.) ; Naga, 1575 m., 1 ♂, 4.viii.1959 (*A. G. K. Menon* coll.).

Ceylon : Peradeniya, 1 ♂, -ix.1900 ; 3 ♂ ♂ (no further data). Kandy, 1 ♀, -vi.1909 ; 2 ♀ ♀ (no further data) (*E. E. Green* coll.).

Distribution.—It is known from India (Kashmir, S. India, Himachal Pradesh, West Bengal, Sikkim), Bangladesh (Sylhet), Burma, Sri Lanka, Indonesia and China.

Remarks.—There had been a lot of confusion in the literature, regarding the validity of this species. Walker (1856) described *Zeuzera leuconota* from Ceylon and since then the species has been referred to by this name by Horsfield and Moore (1954), Moore (1867, 1883), Butler (1886), Cotes and Swinhoe (1887), Swinhoe (1892, 1895), Hampson (1892b), Kirby (1892), Seitz (1912) and so on. Although Dalla-Torre (1923) synonymised *leuconotus* to *persona*, Gaede (1933), Dupont (1937), Sevastopulo (1945), etc., still referred it as *leuconotus*. Recently Roepke (1957) has rightly set aside the controversy by treating it as a synonym of *persona persona*.

Referable to the genus *Xyleutes*, it is one of the largest species of the Indian Cossidae and is close to *Xyleutes strix* (Linn.). It, however, differs from it for having a well marked streak beyond the cell in the fore wing (absent in *strix*) ; thorax and the tip of abdomen whitish (brownish in *strix*) ; and signum in the female genitalia rounded (triangular in *strix*).

33. *Xyleutes strix* (Linnaeus)

(Text-fig. 31)

1758. *Phalaena Noctua Strix* Linnaeus, *Syst. Nat. Regnum Anim.*, 10th ed : 508 (Type loc.-America Merid*).

* see remarks.

1764. *Phalaena Noctua strix* Linnaeus, *Mus. Lud. Ulricae* : 377.
 1767. *Phalaena Noctua strix* Linnaeus, *Syst. Nat. Regnum Anim.*, 12 : 833.
 1779. *Phalaena Noctua strix*, Cramer, *Papil. Exot.*, 77 (Ambon, Java).
 1822. *Xyleutes strix*, Hübner, *Verz. bek. Schmett.* : 195.
 1856. *Cossus strix*, Walker, *List Lep. Brit. Mus.*, 7 : 1521 (Asia).
 1856. *Zeuzera signata* Walker, *List Lep. Brit. Mus.*, 7 : 1537 (Type loc.-N. India) (*Syn.* Hampson, 1892 (b)).
 1859. *Cossus strix*, Horsfield and Moore, *Cat. Lep. Mus. E.I.C.*, 2 : 437 (Java).
 1865. *Cossus strix*, Walker, *List Lep. Brit. Mus.*, 32 : 583 (Java).
 1877. *Cossus strix*, Piepers and Snellen, *Tijdschr. Ent.*, 20 : 22.
 1882. *Xyleutes strix*, Aurivillius, *Sveñska Ak. Handl.*, 19 (5) : 154 (Java).
 1887. *Zeuzera signata*, Cotes and Swinhoe, *Cat. Moths of India* : 234 (North India).
 1892. *Strigoides strix*, Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.* : 281. (Makian, Celebes).
 1892. *Zeuzera signata*, Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.* : 283 (N. India).
 1892. *Xyleutes signata*, Kirby, *Cat. Lep. Het.* : 874 (N. India).
 1892. *Xyleutes strix*, Kirby, *Cat. Lep. Het.* : 874 (Amboina, Java).
 1892b. *Duomitus strix*, Hampson, *Fauna Brit. India, Moths*, 1 : 307 (Sikkim; Sylhet, Java, Nias, New Ireland, New Britain).
 1895. *Duomitus strix*, Swinhoe, *Trans. ent. Soc. Lond.* : 29 (Khasis).
 1899. *Duomitus strix*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 (4) : 645 (Sikkim and Bhutan).
 1900. *Endoxyla strix*, Piepers and Snellen, *Tijdschr. Ent.*, 43 : 39 (Java).
 1916. *Strigomorphus strix*, Houlbert, in Oberthur *Etud. Lep. Comp.*, 11 : 78, 114 (Sikkim, Borneo, Java Celebes, Ternate and Rooh Isl.)
 1923. *Xyleutes strix*, Dalla-Torre, *Lepid. Cat.*, 29 : 54 (New Britain, Nias, New Ireland, Celebes, Ternate, Buru, Formosa, Moluccas, Sikkim and Sylhet).
 1927. *Duomitus strix*, Candeze, *Encycl. Ent.*, (B) III Lep., 2 : 122 (Indo-China).
 1932. *Xyleutes strix*, Jordan, *Mem. Mus. R.d' Hist. nat. Belg.*, 6 : 23.
 1933. *Xyleutes strix*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 817 (Sikkim, Tonkin, Borneo, Celebes, Philippines, Moluccas and New Guinea).
 1955. *Xyleutes strix*, Roepke, *Trans. R. ent. Soc. Lond.*, 107 : 283.
 1957. *Xyleutes strix*, Roepke, *Verh. k. ned. Akad. Wet. Afd. Nat.*, (2) 52 (1) : 19.
 1965. *Xyleutes strix*, Müller, *Dt. ent. Z.*, 12 (3) : 245.

Type : *strix* Linnaeus—? In Ox.Univ.Mus. ; *signata* Walker—
 In B.M.

Head, thorax and abdomen brown to dark brown. Eyes, labial palpi and antennae brown. Fore wings whitish to yellowish-brown; brownish at the base and with brownish patches along the costa ; a few patches and also minute striae present on the outer margin ; the

latter forming a fine net work of lines, some of which coalescing into prominent ones in the postmedial area. Hind wings brown, densely striated with minute lines forming a net work in the area below the cell; anal area unmarked; some dark brown spots present on the outer margin at tips of veins. Abdomen brown or dark brown, with narrow white segmental bands. Underside of wings yellowish brown, with a net work of lines which are prominent and dense beyond the cell in the postmedial area.

Antennae simple (present only in single specimen, damaged in others); the shaft with about 60 segments; basal segments cylindrical but the distal ones laterally flattened. Labial palpi long and slender, nearly upturned. Legs with the spurs (Text-fig. 31A) and spines, and the frenulum and retinaculum as for the genus.

Venation.—Broadly as given in the generic characters.

Genitalia.—Female (Text-fig. 31B-D): Ostium bursae well marked and sclerotised, the sclerotisation being horse-shoe shaped; corpus bursae and receptaculum seminalis smaller than in *X. persona*; signum triangular and not much depressed on the general surface. Male: As no male specimens were available, the description of the genitalia as given by Roepke (1957) is reproduced here: “..... the genitalia very large and heavily chitinized. Uncus triangular, lora rather short. Valve about as long as broad, ligulae rather large, aedeagus strong, curved, apical portion bulbus, densely striate.”

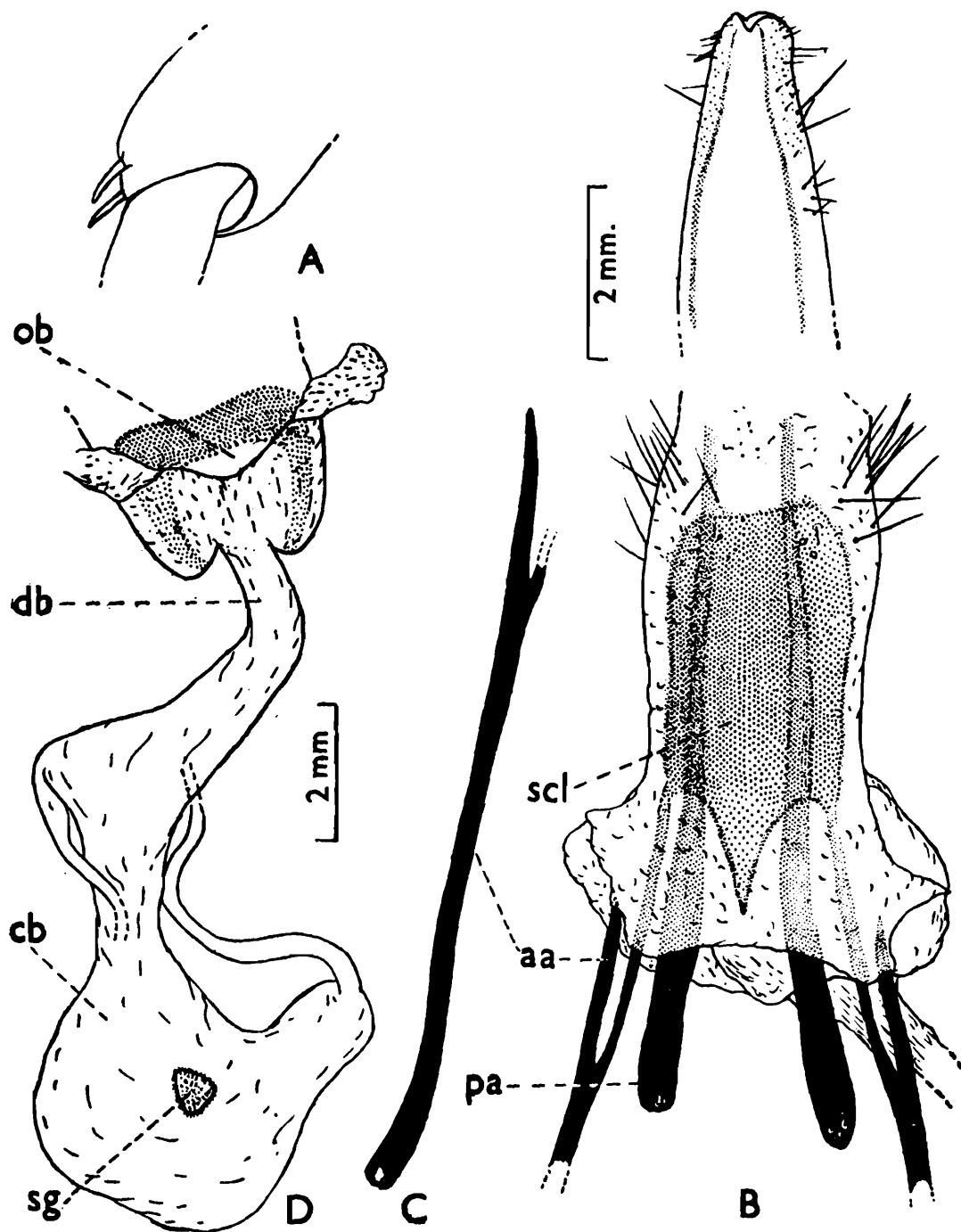
Measurements.—Expanse: Fore wing: Female, 79-188 mm. Length: Female: fore wing, 37-87 mm.; hind wing, 25-61 mm.; abdomen, 23-48 mm.; whole body, 38-65 mm.

Material examined.—Seven examples as follows: India: Assam; Naga Hills, 1676 m., 1 ♀, 5.v.1927 (*O. C. Ollenbach* coll.), Dehra Dun, 1 ♀, 27.vii.1934 (*C. F. C. Beeson* coll.), 1 ♀, 19.vii.1923 (*Student* coll.) (ex. colln. F.R.I.) W Bengal: Calcutta, 1 ♀, 10.x.1903 (Reared in Indian Mus.). Manipur: 1 ♀, -vi.1901 (*Anderson* coll.).

Bhutan: 2 ♀ ♀, 26.v.1895 (*G.C. Dudgeon* coll.).

Distribution.—*X. strix* (Linn.) is also a widely distributed species in the Orient and is known to occur in India (W. Bengal, Manipur, N. India, Sikkim), Bhutan, Bangladesh, Malaya, Indonesia, Indochina, Taiwan and the Philippines. It is also recorded from New Britain and New Ireland in the Australian region.

Remarks.—Linnaeus (1758) while describing this species gave the habitat as “America Meridonali” Swinhoe (1892), however,



Text-fig. 31. *Xyleutes strix* (Linn.) : (A) A portion of the hind leg, with a pair of tibial spurs. (B) Portions of the female genitalia in a dorsal view. (C) An anterior apodeme. (D) A portion of the female genitalia in a ventral view. (A-C of the same magnifications).

cites 'Makian Celebes' as the locality of the 'type' Roepke (1957) states (p.29) "Linnaeus (1758) mixed up two quite different insects, viz., the large South American *Noctua Erebus* (*Thysania*) *agrippina* and the Eastern Cossid under consideration. It is, however, now generally agreed that the name *strix* must be attributed to the last name. The type locality is also uncertain." I am also unable

to give a definite opinion about it, but through citations of Swinhoe (1892) and Roepke (1957) it is certain that the type locality is in the East and possibly Indonesia.

It is the largest and heaviest insect in the Indian Cossidae and is close to *X. persona* (Le Guillou) externally to a great extent. For differences see under that species.

34. *Xyleutes fuscipars* (Hampson)

- 1892b. *Duomitus fuscipars* Hampson, *Fauna Brit. India, Moths*, 1 : 309 (Type loc.—Sikkim).
 1899. *Duomitus fuscipars*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12(4) : 645.
 1923. *Xyleutes fuscipars*, Dalla-Torre, *Lepid. Cat.*, 29 : 51.
 1933. *Xyleutes fuscipars*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 817.

Type : In B. M.

“♂ Head and thorax dark brown, grizzled with grey; abdomen fuscous. Fore wing with the costal half very deep red-brown; the inner area more or less thickly suffused with white scales, the inner margin being white tessellated with black marks. Hind wing pale red-brown; a large white triangular patch tessellated with black on the outer margin between veins 1b and 4.

Hab. Sikkim (Möller). Exp. 44 millim. Type in coll. Elwes.”

Remarks.—As no material of this species was available, the original description has been reproduced above. The photograph of the type, which is present in the British Museum (Nat. Hist.), London, clearly shows that the antennae are bipectinate up to about the basal half and serrate in the distal half; the lower branch of the median cell in the fore wing ends near Cu_{1a} ; the veins M_2 and M_3 arise from a point, but in the hind wing these veins are separate. From the description of the adult, as given by Hampson (1892b) it can be differentiated from the other Indian *Xyleutes* species by the fore wing in having deep red-brown costal half, and whitish suffusion in the inner area.

Genus *Zeuzera* Latreille

1804. *Zeuzera* Latreille, *Nouv. Dict. Hist. Nat.*, 24 : 186 (Type—*pyrina* Linn. from Europe).
 1822. *Zeuzera*, Hübner, *Verz. bek. Schmett.* : 196.
 1822. *Latagia* Hübner, *Verz. bek. Schmett.* : 196 (Type—*aesculi* L.) [*Syn.* Hampson, 1892b].
 1834. *Zeuzera*, Boisduval, *Icon. Hist. Lep. Nouv.*, 2 : 181.

1840. *Zeuzera*, Boisduval, *Gen. et Index-Meth. Eur. Lep.* : 75.
 1854. *Zeuzera*, Herrich-Schäffer, *Samml. Ausser. Schmett.* : 7, 58.
 1856. *Zeuzera*, Walker, *List Lep. Brit. Mus.*, 7 : 1528.
 1858. *Zeuzera*, Westwood, *Nat. Hist. Ins. India* : 83.
 1859. *Zeuzera*, Horsefield and Moore, *Cat. Lep. Mus. E. I. C.*, 2 : 437.
 1883. *Zeuzera*, Moore, *Lep. Ceylon.*, 2 : 153.
 1886. *Zeuzera*, Butler, *Ill. Typ. Lep. Het.*, 6 : 28.
 1887. *Zeuzera*, Cotes and Swinhoe, *Cat. Moths of India* : 232.
 1892. *Zeuzera*, Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.* : 281.
 1892b. *Zeuzera*, Hampson, *Fauna Brit. India, Moths*, 1 : 310 (quotes *Z. aesculi* Latr. as the type of genus).
 1892. *Zeuzera*, Kirby, *Cat. Lep. Het.* : 870.
 1900. *Zeuzera*, Piepers and Snellen, *Tijdschr. Ent.*, 43 : 37, 41, 43.
 1905. *Zeuzera*, Schaus, *Proc. U. S. Nat. Mus.*, 29 : 339.
 1912. *Zeuzera*, Seitz, in *Seitz Macrolepidoptera of the World*, 2 : 428.
 1917. *Zeuzera*, Chapman, *Ent. Rec.*, 29 (3) : 5.
 1918. *Zeuzera*, Turner, *Trans. ent. Soc. Lond.*, 66 : 163.
 1923. *Zeuzera*, Dalla-Torre, *Lepid. Cat.*, 29 : 37.
 1933. *Zeuzera*, Gaede, in *Seitz Macrolepidoptera of the World*, 10 : 811.
 1945. *Zeuzera*, Turner, *Proc. R. Soc. Qd.*, 56 (6) : 47, 63.
 1950. *Zeuzera*, Bryk, *Ark. Zool.*, 42A (19) : 48 (quotes *Z. aesculi* Latr. as the type of genus).
 1951. *Zeuzera*, Viette, *Lambillionea*, 51 (11-12) : 72.
 1955. *Zeuzera*, Roepke, *Trans. R. ent. Soc. Lond.*, 107 : 281.
 1957. *Zeuzera*, Roepke, *Verh. k. ned. Akad. Wet. Afd. Nat.*, (2) 52 (1) : 12.
 1962. *Zeuzera*, Daniel, *Z. Arb. Gem. Öst. Ent.*, 14 (1) : 6.
 1965. *Zeuzera*, Müller, *Dt. ent. Z.*, 12 (3) : 238.

Type species : *Phalaena Noctua pyrina* Linnaeus

(a) *General*

The species of the genus *Zeuzera* Latreille are of great agricultural and forestry importance, some of them being serious pests of coffee plantations, small sapplings in the forestry nurseries and several species of forest plants. From the Indian subregion, only five species of this genus are known, *viz.*, *Zeuzera coffeae* Neitner—the red borer, *Z. indica* Herrich-Schäffer, *Z. multistrigata* Moore, *Z. conferta* Hampson and *Z. postexcisa* Hampson.

After Latreille (1804), Walker (1856) gave the characteristic features of the genus, which though certainly better than those given by several subsequent workers such as Hampson (1892b), Seitz (1912), Turner (1918) and Gaede (1933), still lacked certain important characters of the labial palpi and the legs which have some bearing on the phylogenetic position of the genus. The descriptions, etc., of the Indian forms are also very sketchy and not adequately figured.

In the present study the generic characters are given in detail and three Indian species, *viz.* *coffeae*, *multistrigata* and *postexcisa*,

of which the material was available; are redescribed in detail and figured adequately from the actual specimens. The genitalia, both male and female, wherever available, have also been studied. A new subspecies of *Z. coffeae* Neitner is described from India.

(b) *Characters of the Genus Zeuzera Latreille*

Antennae in male bipectinate up to basal half, the distal part minutely serrate, the pectination large except at both the ends; antennae in female wholly simple. Labial palpi rudimentary to moderately well developed. Hind legs with a pair of extremely short tibial spur; tarsi with spines on all the segments; arolium absent. Frenulum spine single in male, several in female. Abdomen in male generally longer than hind wing; in female either shorter or longer than hind wing.

Fore wing with a moderately long areole, projecting outside the cell angle by one-fourth to one-third of its length; vein R_1 arises from near the tip of areole; R_3 shortly stalked with $R_4 + R_5$; vein M_1 variable, either from above, or from below the angle of cell; median cell always present, short, with its upper and lower branches ending between $M_1 - M_2$ and $Cu_{1a} - M_3$, respectively; veins M_2 and M_3 separate, M_2 arises from above, and M_3 from angle. Hind wing with a cross bar between veins Sc and R_s ; $R_s - M_1$ veins wide apart at origin; median cell with its branches ending as in fore wing.

Gnathos in male genitalia present, either well developed or reduced to mere rudiments; aedeagus either simple or with a well developed cornutal process; juxta well developed and with large anellus lobes.

In female genitalia, signum on corpus bursae present; genital plate generally with sclerotisation both on the dorsal and ventral sides.

(c) *Relationships of the Genus Zeuzera with the Other Allied Genera*

Typically a *Zeuzerinae* genus, it is very important, both economically and phylogenetically. Economically, since it includes one of the well known species, *viz. Zeuzera coffeae* Nietner, which attacks the coffee plants and a variety of other plants. Phylogenetically, it is important since it has bipectinate antennae in male, a moderately long areole in fore wing, ending of the lower branch of median in both wings between veins Cu_{1a} and M_3 , a character found only in the primitive moths, and by the presence of cross vein between veins Sc and R_s in the hind wing, a character not generally present in any

other Indian cossid. The male genitalia, however, show great variation, *i.e.*, gnathos are either very well developed as in *Xyleutes* or reduced.

The genus *Zeuzera* is close to the genus *Xyleutes* Hübner in respect of the antennae which are bipectinate up to about the basal half and in the absence of arolium between the claws, but differs by the presence of a short cross bar, in the hind wing, between veins Sc and Rs (absent in *Xyleutes*), and by the ending of the lower branch of the median between the veins Cu_{1a} and M_3 , in both the wings (variable in *Xyleutes*, but mostly between M_2 and M_3). From the genus *Phragmataecia* it differs in respect of the antennae in the male, which are bipectinate up to basal half (up to two-thirds in *Phragmataecia*) and for the absence of arolium (present in *Phragmataecia*). *Azygophelps* Hampson can be differentiated from *Zeuzera* in having bipectinate antennae in both sexes (bipectinate in basal half in male and simple in female in *Zeuzera*), and for presence of arolium (absent in *Zeuzera*).

(d) *Geographical Distribution of the Genus Zeuzera*

It is cosmopolitan in distribution and in the Oriental region it is fairly widely distributed.

(e) *Key to Indian Species of the Genus Zeuzera*

The following key is based on four Indian species and subspecies of which the material was available for study.

1. Vein M_1 , in the fore wing, arises from angle of cell or above. Gnathos in the male genitalia, reduced ; median lobes absent ; aedeagus slender, without cornuti. Female genitalia with two sclerotised patches on genital plate on ventral surface 2

Vein M_1 , in the fore wing, arises from below the angle of cell. Gnathos well developed ; median lobes present ; aedeagus well developed, with cornuti. Female genitalia without sclerotised patches on genital plate 3

2. Outer margin of fore wing evenly curved. Corpus bursae in the female with signum ; receptaculum seminalis present and well developed

coffae coffae Nietner

Outer margin of fore wing sharply angled at tornus. Corpus bursae without signum ; receptaculum seminalis reduced and indistinct *coffae angulata* ssp. n.

3. Hind wing with the anal angle not incised. Metathorax without medial spot. Abdomen with transverse bands on seven basal segments. Cornutal process, in the male genitalia, extending beyond the apex of aedeagus *multistrigata* Moore

Hind wing with the anal angle deeply incised. Metathorax with a medial spot. Abdomen with a transverse band only on the basal third segment. Cornutal process not extending beyond the apex of aedeagus *postexcisa* Hampson

(f) *Descriptions of Species*

35. *Zeuzera coffae* Nietner

1861. *Zeuzera coffae* Nietner, *Observations on enemies of the Coffee trees in Ceylon* : 21 (Type loc.—Ceylon).
 1883. *Zeuzera coffae*, Moore, *Lep. Ceylon*, 2 : 154.
 1887. *Zeuzera coffae*, Cotes and Swinhoe, *Cat. Moths of India* : 232.
 1891. *Zeuzera coffae*, Hampson, *Ill. Typ. Lep. Het. Brit. Mus.*, 8 : 11.
 1892b. *Zeuzera coffae*, Hampson, *Fauna Brit. India, Moths*, 1 : 312.
 1892. *Zeuzera coffae*, Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.* : 281.
 1892. *Zeuzera coffae*, Kirby, *Cat. Lep. Het.* : 871.
 1899. *Zeuzera coffae*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 (4) : 646.
 1900. *Zeuzera coffae*, Piepers and Snellen, *Tijdschr. Ent.*, 43 : 37, 42.
 1909. *Zeuzera coffae*, Lefroy, *Indian Insect Life* : 495.
 1914. *Zeuzera coffae*, Fletcher, *Some South Indian Insects and Other Animals of Importance* : 446.
 1917. *Zeuzera coffae*, Fletcher, *Rep. Proc. 2nd. Ent. Mtg.*, 1917 : 21, 34, 121.
 1917. *Zeuzera coffae*, Chatterjee, *Rep. Bd. scient. Advice India, 1915-1916* : 1.
 1918. *Zeuzera coffae*, Turner, *Trans. ent. Soc. Lond.*, 66 : 163.
 1919a. *Zeuzera coffae*, Kalshoven, *Meded. Proefstn. Boschw. Batavia*, 4 : 57.
 1923. *Zeuzera coffae*, Dalla-Torre, *Lepid. Cat.*, 29 : 38.
 1933. *Zeuzera coffae*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 812.
 1940. *Zeuzera coffae*, Daniel, *Mitt. münch. ent. Ges.*, 30 : 1016.
 1940. *Zeuzera coffae*, Kalshoven, *Ent. Meded. Ned. India*, 6 (3-4) : 50.
 1940. *Zeuzera coffae*, Ayyar, *Handbook of Economic Entomology for South India* : 307, 360, 362, 472, 3 figs.
 1941. *Zeuzera coffae*, Beeson, *The Ecology and the Control of Forest Insects of India and the Neighbouring Countries* : 581-583, 956.

1941. *Zeuzera coffeae*, Miller, *Bull. ent. Res.*, 32(1) : 3.
 1945. *Zeuzera coffeae*, Sevastopulo, *J. Beng. nat. Hist. Soc.*, 19 : 115.
 1948. *Zeuzera coffeae*, Toxopeus, *Treubia*, 19 : 167.
 1954. *Zeuzera coffeae*, Bhasini and Roonwal, *Forest Bull. Dehra Dun*, 171 (1) : 2, 29, 65, 76.
 1955. *Zeuzera coffeae*, Roepke, *Trans. R. ent. Soc. Lond.*, 107 : 282.
 1957. *Zeuzera coffeae*, Roepke, *Verh. k. ned. Akad. Wet. Afd. Nat.*, (2) 52 (1) : 16.
 1958. *Zeuzera coffeae*, Bhasini, Roonwal and Singh, *Forest Bull. Dehra Dun*, 171 (2) : 60, 80, 85, 88, 96, 99, 105, 107, 113, 117, 121, 125.
 1959. *Zeuzera coffeae*, Insects, in *Wealth of India*, 5 : 205.
 1959. *Zeuzera coffeae*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (4) : 79, 151.
 1960a. *Zeuzera coffeae*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (3) : 6, 13, 16, 27, 36.
 1960b. *Zeuzera coffeae*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (5) : 21, 25, 49, 60.
 1960c. *Zeuzera coffeae*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (6) : 21, 84.
 1960d. *Zeuzera coffeae*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (7) : 12, 13, 17, 23, 75.
 1961a. *Zeuzera coffeae*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (8) : 18, 30, 79, 80.
 1961b. *Zeuzera coffeae*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (9) : 16, 47, 49, 81, 97.

Hosts : *Aberia gardneri*, *Acalypha* sp., *Amherstia nobilis*, *Anona muricata*, *Anona squamosa*, *Camellia sinensis*, *Camellia theifera*, *Cassia fistula*, *Casuarina equisetifolia*, *Cedrela tonna*, *Cestrum nocturnum*, *Chickrassia tabularis*, *Cinnamomum zeylanicum*, *Citrus aurantium*, *Citrus medica*, *Clerodendrum infortunatum*, *Coffea arabica*, *Coffea robusta*, *Crataegus oxyacantha*, *Cryptomeria japonica*, *Eriobotrya japonica*, *Erythroxylon cocoa*, *Filicum decipiens*, *Gossypium* sp., *Grevillia robusta*, *Hibiscus rosa-sinensis*, *Hydnocarpus kurzii*, *Hydnocarpus wightiana*, *Lantana indica*, *Litchi chinensis*, *Melia azedarach*, *Pericopsis moonians*, *Persea gratissima*, *Phoebe hainesiana*, *Phyllanthus emblica*, *Psidium guajava*, *Santalum album*, *Schleichera oleosa*, *Swietenia macrophylla*, *Swietenia mahagoni*, *Tectona grandis*, *Thea sinensis*, *Theobroma cocoa*, *Vitex pubescens*, *Xylia xylocarpa*.

Zeuzera coffeae Nietner is widely distributed in almost whole of the Oriental region and is also known from New Guinea in the Australian region.

It differs from the other Indian species of the genus *Zeuzera*, as follows :

From *Z. multistrigata* and *Z. postexcisa*, in having vein M_1 in the fore wing arising either from the angle of cell or from above it (from below the angle of cell in the other two species); in respect of male genitalia by the reduced gnathos and median lobe of juxta (present in the other two). From *Z. indica* Herr-Schäffer, it differs in having spots on the thorax (absent in *indica*) and from *Z. conferta* Walker, by the absence of lateral spots and ventral bands on the abdomen (present in *conferta*).

Toxopeus (1948) separated the Javanese *coffae* as the subspecies *virens*, and opines about *Z. oblita* Swinhoe (1890) from Rangoon, which was treated as a synonym of *Z. coffae* by Hampson (1892b), that it is more likely to be conceived as a subspecies of *coffae*. He (*loc. cit.*) provisionally included *oblita* in the list of subspecies, for he was doubtful of its status and mentioned that further examination of type of *oblita* was required. Roepke (1957), however, is of the opinion that the question of the subspecies *virens* deserves re-investigation based on fresh and topotypical material of *coffae*, which Toxopeus did not have at the time of describing the subspecies.

I have not included *oblita* in my present work because I had no access to the types and since I feel the question of subspecies *oblita* needs further examination.

I have five examples, both males and females, all from Sri Lanka and I refer them to the typical species. I also have a few examples from different parts of India: These, I find, are very different from the material from Sri Lanka, and require a different and distinct subspecies status. I, therefore, have referred the Indian specimens to a new subspecies, *viz.*, *Zeuzera coffae angulata* ssp.n., which is described below. This new subspecies differs from typical *coffae* in respect of the fore wings which are sharply angled at the tornus, where as in the typical species these are evenly curved at the tornus; by the marginal spots, on the wings, which are round (triangular in the typical *coffae* from Sri Lanka). In respect of female genitalia the new subspecies differs in the absence of signum on corpus bursae, which is present in the ceylonese material of *coffae*. The differences from the other subspecies have been dealt with under the description given for the subspecies.

35a. *Zeuzera coffae coffae* Nietner

(Pl. III, Fig. 34; Text-fig. 32)

For synonymy see under *Zeuzera coffae* Nietner above.

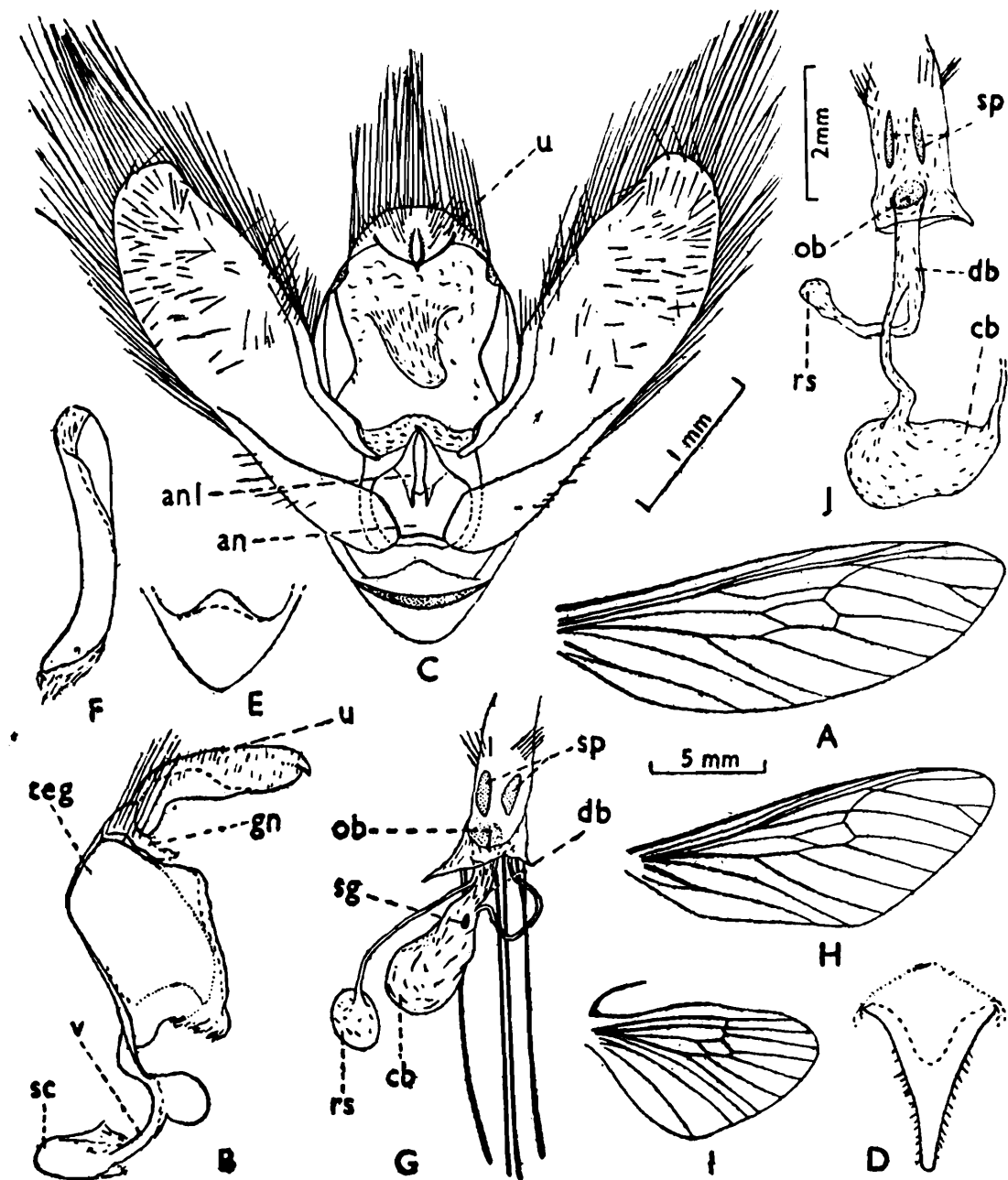
Types : Repository not known.

Frontal tufts whitish above, dark brown below. Antennae brown to dark brown in both sexes, covered with woolly scales above, especially in female. Labial palpi dark brown on sides, and covered with woolly white scales beneath. Thorax whitish, with two steel-blue spots on either side. Fore wings either pale brownish or whitish, with one large spot in the cell and series of spots in and outside the cell, those on the outerside arranged in rows in between the veins; marginal row of triangular spots prominent. Hind wings paler, with fewer rows of spots in between the veins and on the margin, those at the tornal angle large and confluent; the area below the cell unspotted. Legs bluish; femora of fore legs white on underside, dark tan-brown above; middle legs with the femora white; hind legs with the femora and tibiae white. Abdomen brown to dark brown; with a row of spots present dorsally. Underside of abdomen unspotted.

Antennae wholly simple in female; bipectinate up to basal half in male, the distal part serrate; the rami long, the longest ones as long as six middle segments of shaft. Labial palpi extremely minute. Fore wings smoothly curved from the apex to the inner margin, without any angle at the tornus. Abdomen longer than hind wings. Tibial spurs, tarsal spines, frenulum, and retinaculum, as for the genus.

Venation.—Fore wing (Text-fig. 32A): Areole of moderate size, projecting beyond the cell angle by about one-fourth its length; vein R_1 generally arises from near the origin of areole, rarely from the subcostal nervure; R_2 from near the tip of areole; R_3 from areole and either shortly stalked or connate with the stalk of veins R_4+R_5 ; M_1 either from angle or from above the angle; median with the upper and lower branches ending between veins M_1-M_2 and $Cu_{1a}-M_3$, respectively, the lower nearer Cu_{1a} than M_3 ; veins M_2-M_3 separate; M_2 from above the lower angle and M_3 from angle. Hind wings with a cross bar between veins Sc-Rs; vein Rs and M_1 separate; the median with its branches ending as in fore wing.

Genitalia.—Male (Text-fig. 32B-F): Uncus triangular, short and narrow; about thrice as long as its width in middle; broader at base than in distal part; tip produced into a downwardly directed fine point. Tegumen broad, curved laterally; posteriorly produced into thin membranous folds for attachment of membranes inside; ventral portion depressed into a short shallow cavity; vinculum V-shaped, evaginated at the upper end. Saccus short, triangular. Gnathos short, rudimentary and forming a short protuberance. Claspers broadest beyond the middle; costa produced into long and blunt costal prolongations; inner side beset with inwardly directed setae, those on the costal margin are outwardly directed. Juxta cup-shaped and sclerotised; lateral margins extending into narrowly pointed



Text-fig. 32. *Zeuzera coffeae* Nietner : *Zeuzera coffeae coffeae* Nietner. (A) Fore wing venation. (B) Male genitalia in a lateral view, without claspers. (C) Male genitalia in a inner view, with claspers. (D) Uncus in a dorsal view. (E) and (F) Saccus and Aedeagus, respectively. (G) A portion of the female genitalia in a ventral view. *Zeuzera coffeae angulata* ssp.n. (H) and (I) Fore and hind wings venation, respectively. (J) A portion of the female genitalia in a ventral view. (A, H & I; B to F; and G & J of the same magnifications).

anellus lobes. Aedeagus simple; weakly sclerotised throughout, slightly differentiated into a base and the apex, the latter with the vesica reduced. Female (Text-fig. 32G): Ostium bursae weakly sclerotised at base, leading into a bag like corpus bursae through membranous ductus bursae; corpus bursae broad at base, with a

short nearly oval signum ; a fine duct arises from the corpus bursae and enters into the genital tube ; receptaculum seminalis rounded and membranous ; genital tube long and slender, with its posterior apodemes very long, reaching as far as the end of the anterior apodemes ; genital plate wholly sclerotised dorsally but ventrally with two small sclerotised patches.

Measurements.—Expanse : Fore wing : Male, 34-44 mm. ; female, 39-42 mm. Length : Fore wing : Male, 17-20 mm. ; female, 12-15 mm. Abdomen : Male, 13-16 mm. ; female, 15-18 mm. Whole body : Male, 20-23 mm. ; female, 22-25 mm.

Material examined.—Five examples from Sri Lanka as follows : Peradeniya, 1 ♀, —.xii.1902, 1 ♀, —.ix.1907 ; Watagoda, 1 ♂, —.i.1904 ; Kandy, 1 ♂, —.v.1911 ; Madulsima, 1 ♀, —.ii.1906 (all *E. Green* coll.).

Distribution.—Sri Lanka India (?).

Remarks.—Referable to the genus *Zeuzera*, the nominotypical species probably occurs only in Sri Lanka, but its occurrence elsewhere, specially in India, is not completely ruled out. The differences from *coffae angulata* and other subspecies have been given above.

35b. *Zeuzera coffae angulata* ssp. n.

(Pl. III, fig. 35 ; Text-fig. 32)

Head and thorax slightly paler, abdomen somewhat darker than in the typical form. The spots on the wings almost as in *coffae coffae* except that the larger spot in the cell, on the fore wing, is absent, and that the marginal spots on wing are not triangular. The wings are semihyaline and with a sharp angle at the tornus in the fore wing of both sexes. The labial palpi more reduced. Other features as in *coffae coffae*.

Venation (Text-fig. 32H-I) : Almost as in *coffae coffae*.

Genitalia.—Male : As in *coffae coffae*. Female (Text-fig. 32 J) : It differs from *coffae coffae* in the ductus bursae being long and narrow and enters into the corpus bursae at its broader end unlike the case in the latter where it is short and enters into the corpus bursae straight at its narrower end ; the corpus bursae without signum unlike in *coffae coffae* where it is present ; receptaculum seminalis short and narrow as compared to that in *coffae coffae* where it is large and rounded.

Measurements.—Expanse : Fore wing : Male, 36-42 mm. ; female, 34-42. Length : Fore wing : Male, 16-19 mm. ; female, 15-19 mm.

Hind wing : Male, 9-12 mm. ; female, 8-12 mm. Abdomen : Male, 10-13 mm. ; female, 9-12 mm. Whole body : Male, 17-21 mm. ; female, 16-21 mm.

Holotype : A male : India : West Bengal ; Singur, 28.xi.1967 (S.S. & S.R. Coll.), at light. *Paratypes* : India : Arunachal Pradesh : Siang Dist., Kambang, 200 m., 1 ♂, at light, 14.x.1966 (S. K. Tandon & G. S. Arora coll.). Mysore : S. Coorg, Tithimatti, 1 ♂, 13.x.1942. Tamil Nadu : S. Coimbatore, Karian shola, 1 ♀, 2.vii.1938 (R. O. coll.). (All deposited in Z. S. I.).

Distribution.—The new subspecies is recorded from the Indian main-land, viz., Arunachal Pradesh, West Bengal, Mysore and Tamil Nadu. Several other records of the species, occurrence in India possibly refer to this subspecies.

Remarks.—Besides the differences from *coffea coffea*, as given above, *coffea angulata* differs from the other two subspecies as follows :

From *oblita* Swinhoe it differs by the sharply angled fore wing at the tornus (evenly curved in *oblita*) and for bluish green spots on the wings (bluish in *oblita*).

From *virens* Toxopeus it differs in having a series of marginal spots on both the wings (marginal spots not in series in *virens*) and bluish green spots on wings and abdomen (greenish in *virens*).

36. *Zeuzera multistrigata* Moore

(Pl. III, fig. 36 ; Text-fig. 33)

1856. *Zeuzera indica* Walker (nec. Herrich-Schäffer), *List Lep. Brit. Mus.*, 7 : 1536 (*Syn. Cotes and Swinhoe*, 1887).
1881. *Zeuzera multistrigata* Moore, *Proc. zool. Soc. Lond.* : 327 (Type loc.—Darjeeling, India).
1887. *Zeuzera multistrigata*, Cotes and Swinhoe, *Cat. Moths of India* : 233.
1892. *Zeuzera multistrigata*, Kirby, *Cat. Lep. Het.* : 871 (Darjeeling).
- 1892b. *Zeuzera multistrigata*, Hampson, *Fauna Brit. India, Moths*, 1 : 311 (Dharamshala, Nagas, Sikkim).
1892. *Zeuzera multistrigata*, Swinhoe, *Cat. East. & Aust. Lep. Het. Ox. Univ. Mus.* : 282 (Sylhet (Bangladesh), India).
1895. *Zeuzera multistrigata*, Swinhoe, *Trans. ent. Soc. Lond.* : 29.
1899. *Zeuzera multistrigata*, Dudgeon, *J. Bombay nat. Hist. Soc.*, 12 (4) : 646.
1912. *Zeuzera multistrigata*, Seitz, in Seitz *Macrolepidoptera of the World*, 2 : 429.
1923. *Zeuzera multistrigata*, Dalla-Torre, *Lepid. Cat.*, 29 : 39. (Darjeeling, Sylhet, Kashmir, Indian Himalayas to Sikkim, Naga Hills).

1933. *Zeuzera multistrigata*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 812 (N. India).
 1940. *Zeuzera multistrigata*, Daniel, *Mitt. münch. ent. Ges.*, 30 : 1016.
 1941. *Zeuzera multistrigata*, Beeson, *The Ecology and the Control of Forest Insects of India and Neighbouring Countries* : 583, 956.
 1950. *Zeuzera multistrigata*, Bryk, *Ark. Zool.*, 42A (19) : 48 (Kambaiti, Burma).
 1960b. *Zeuzera multistrigata*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (5) : 64.
 1960c. *Zeuzera multistrigata*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (6) : 120.
 1960d. *Zeuzera multistrigata*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (7) : 91, 101.
 1961a. *Zeuzera multistrigata*, Mathur and Singh, *Forest Bull. Dehra Dun*, 171 (8) : 18.
 1962. *Zeuzera multistrigata*, Daniel, *Z. Arb. Gem. öst. Ent.*, 14 (1) : 6.

Type ; In B. M.

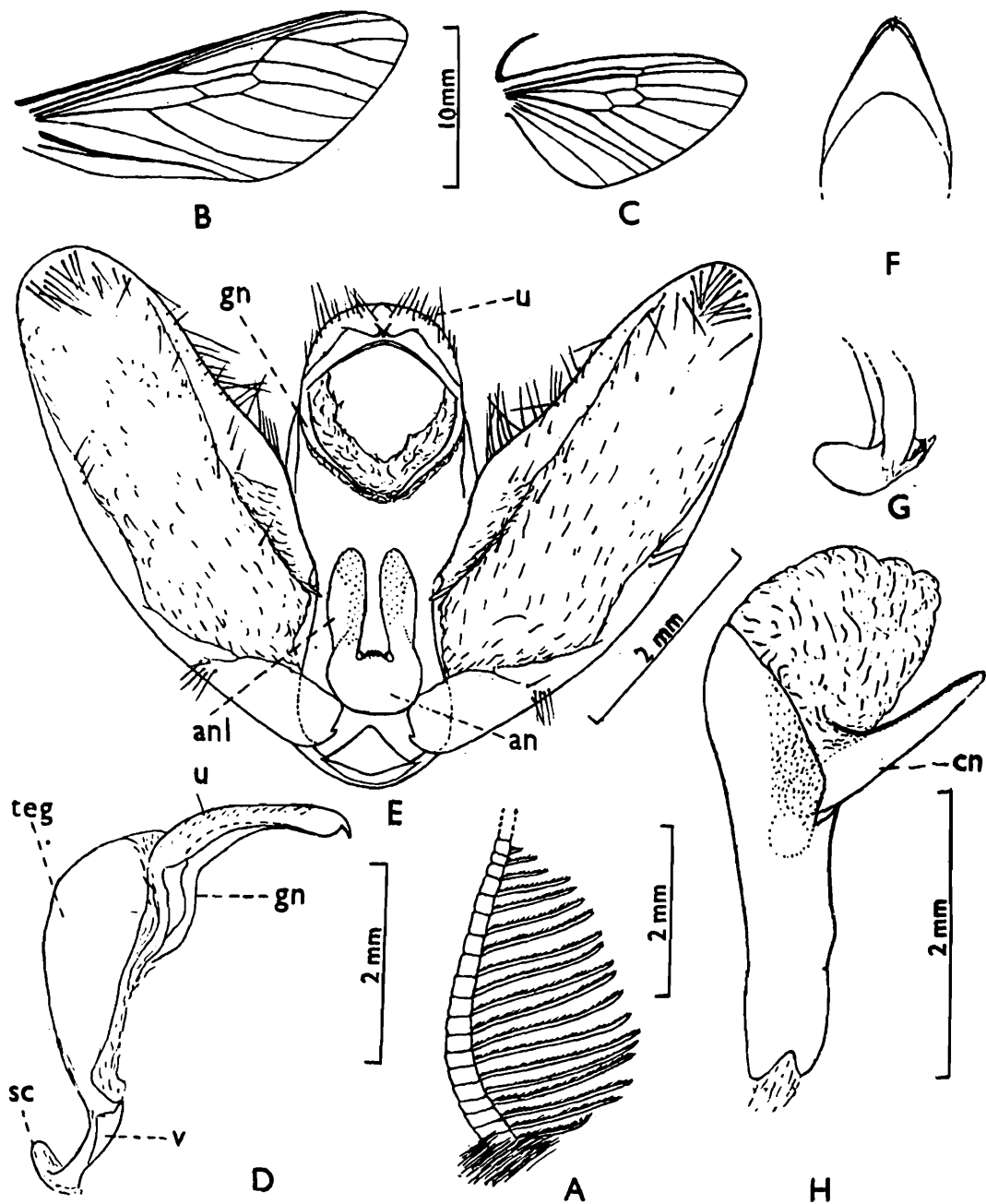
Hosts : *Cryptomeria japonica*, *Ilex* sp., *Mahonia nepaulensis*, *Mussaenda frondosa*, *Pyrus malus*, *Quercus lineata*, *Santalum album*.

Frontal tufts, antennae and labial palpi dark brown to black. Vertex and thorax white, covered with white, woolly hair-scales ; six bluish spots, three on each side of thorax, present. Fore wings whitish ; marked with steel blue spots, in a series of rows, between the veins and in the cell ; those in the cell and on the margins rounded and those in between the veins elongate. Hind wings whitish ; a few small, elongate spots of steel blue colour present in and beyond the cell ; marginal spots only up to vein Cu_2 ; the area below the cell unspotted from base to vein Cu_2 . Abdomen brown, marked with black transverse bands up to seven segments ; with tufts of hair ; the last two segments without any bands, but with only tufts of brownish or whitish scales. Underside of wings as on upperside and that of abdomen without any spots. Legs steel blue, femora whitish beneath.

Antennae, in male (Text-fig. 33A), strongly bipectinate nearly up to basal half, the distal half minutely serrate ; the shaft with 41-49 segments, of which basal 18-23 segments bipectinate, the rami longer in middle, the longest being as long as 7-8 middle segments of shaft ; the last segment simple ; antennae, in female, simple. Labial palpi minute. Legs, hind-tibial spurs, tarsal spines, frenulum and retinaculum, as for the genus.

Venation.—Fore wing (Text-fig. 33B) : Mainly as given in generic characters. Areole projecting a little beyond the cell angle ; vein R_1 generally arises from cell, rarely from the origin of or from the

areole ; R_2 from near the distal end of areole ; R_3 generally shortly anastomosed with $R_4 + R_5$, rarely connate or free ; M_1 from below the cell ; lower branch of median cell ending nearer Cu_{1a} than M_3 . Hind wing (Text-fig. 33C) : As for the genus.



Text-fig. 33. *Zeuzera multistrigata* Moore : (A) A portion of the male antenna. (B) and (C) Fore and hind wing venation, respectively. (D) Male genitalia in a lateral view, without claspers. (E) Male genitalia in inner view, with claspers. (F) and (G) Uncus and saccus, respectively. (H) Aedeagus. (B & C ; E to G of the same magnifications).

Genitalia.—Male (Text-fig. 33D-H) : Uncus more or less triangular, broad at base and in middle ; length about twice the width

in middle, narrowed distally to a fine, downwardly pointed tip. Gnathos long and incurved, not meeting each other but connected by only a thin membrane. Tegumen weakly sclerotised, and without invagination at base. Saccus short, broadly triangular and slightly upturned at tip. Claspers broadest in middle; costal prolongation short and reduced. Juxta sclerotised, nearly rounded, with short median lobes and long and blunt anellus lobes. Aedeagus poorly differentiated into a base and a large vesica, the latter membranous and with a hard cornutal process arising from near the base. Female (incomplete and damaged): Ostium bursae simple, without chitinisation; ductus bursae simple; genital plate sclerotised dorsally but without any sclerotisation ventrally; the posterior apodemes extending a little beyond genital plate; ovipositor simple.

Measurements.—Expanse: Fore wing: Male, 42-74 mm.; female, 66-117 mm. Length: Fore wing: Male, 19-32 mm.; female, 30-48 mm.; Hind wing: Male, 13-20 mm.; female, 20-33 mm. Abdomen: Male, 13-23 mm.; female, 33 mm. Whole body: Male, 20-32 mm.; female, 44 mm.

Material examined.—30 examples as follows: India: Uttar Pradesh: Mussoorie, 4 ♂♂, -vii-viii.1927, 1 ♂, 1 ♀, ix-x.1928 (*C.F.C. Beeson* coll.); Dehra Dun, 1 ♂, -.1931 (*S.A.A. Anvery* coll.) (ex. colln. F R.I.); Lata, Garhwal Dist., 2428.40 m., 6 ♂♂, 6.vii. 1958; Gadera, 2896 m. 1 ♂, 8.viii. 1958 (*B.S. Lamba* coll.). W. Bengal: Darjeeling, 1 ♂, -.1860 (no further data); 1 ♀, 30. xii.1881; 1 ♀, -vii.1912 (no further data); Sanchal range, 1 ♂, 6. iii.1923, Tista range, 1 ♂, 19.viii.1923 (both *J. C. M. Gardner* coll. ex. coll. F.R.I.). Sikkim: 1676.38 m., 1 ♀, 1-5.iv.1888, 1 ♂, -.1891; 1 ♀, 10.ix. 1898 (all *G. C. Dudgeon* coll.); 2133 m., 1 ♂, 1 ♀, -viii.1895 (*J. G. Pilcher* coll.); 1 ♂, 2.viii.1888, 2 ♂♂, 1 ♀ (no date) (*O. Möller* coll.); 2 ♂♂ (no date) (*Jordon* coll.).

Distribution.—India (Kashmir, Himachal Pradesh, Uttar Pradesh, Naga Hills, West Bengal, Sikkim), Bangladesh (Sylhet) and Burma (Kambaiti).

Remarks.—A good species of *Zeuzera*, it can be separated from the other species by the wing spots which are not only prominent on the upper side but also on the under side; by the unspotted inner area of hind wings; by the transverse bands and tufts of hair on the abdominal segments; and by the absence of medial spot on metathorax. In male genitalia, it differs from *Z. coffeae* by the presence of gnathos (absent in *coffeae*), and from *postexcisa* in having weakly developed median lobe of juxta (well developed in *postexcisa*).

Phylogenetically this species serves a very good example to show a close link between the two subfamilies *Cossinae* and *Zeuzerinae*, on one hand, because of the origin of vein R_1 from subcostal nervure, which is a cossinae character and on the other hand, by the presence of single pair of tibial spurs in hing legs, and free gnathos.

37. *Zeuzera postexcisa* Hampson

(Pl. III, figs. 37, 38 ; Text-figs. 34, 35)

- 1892a. *Zeuzera postexcisa* Hampson, *Ill. Typ. Lep. Het. Brit. Mus.*, 9 : 68 (Type loc.—Ceylon).
 1892b. *Zeuzera postexcisa* Hampson, *Fauna Brit. India, Moths*, 1 : 311 (Ceylon).
 1900. *Zeuzera postexcisa*, Piepers and Snellen, *Tijdschr. Ent.*, 43 : 41 (Java).
 1919b. *Zeuzera postexcisa*, Kalshoven, *Meded. Profstn. Boschw. Batavia*, 4 : 69.
 1923. *Zeuzera postexcisa*, Dalla-Torre, *Lepid. Cat.*, 29 : 39 (Ceylon).
 1933. *Zeuzera postexcisa*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 812 (Ceylon).
 1941. *Zeuzera postexcisa*, Beeson, *The Ecology and Control of Forest Insects of India and the Neighbouring Countries* : 583.

Type ; In B. M.

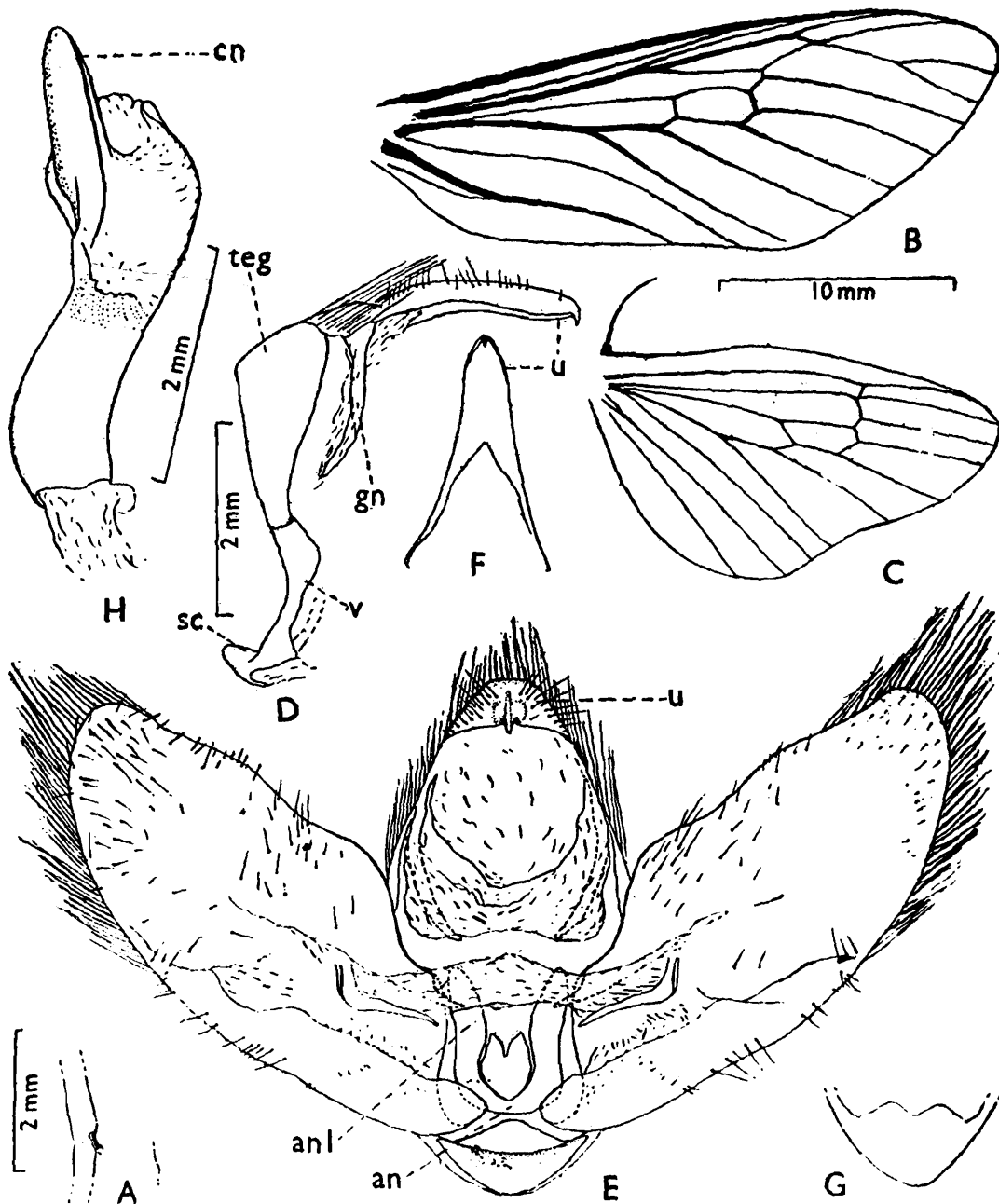
Host ; *Phoeba excelsa*.

Frontal tufts and labial palpi dark brown. Vertex covered with white woolly hair-scales. Antennae dark brown, mixed with whitish scales, some of which giving metallic-blue shine. Thorax pale brown, with three lateral, shining bluish-black spots and a median one on metathorax. Fore wings whitish to pale brown, with rows of shining, bluish-black spots in between the veins ; those on the costa, along the outer margin and on the inner margin, prominent. Hind wings deeply incised at the tornal angle, generally with fewer spots ; sometimes with indistinct ones and with marginal row of blue-black spots on the outer margin, the one at the tornal angle large and prominent. Legs (damaged in the specimens available), appear to have whitish to pale brown femora ; the remaining portion with bluish tinge. Abdomen white to pale brown ; a series of large or small spots present on the dorsal and lateral sides, except the third segment which has a transverse band, and the last which has three elongate spots, which are broad basally but narrow distally. Underside of wings as on the upperside but that of abdomen without any spots.

Antennae, in male, bipectinate nearly up to the basal half, the distal part minutely serrate ; the shaft with about 50 segments, of which about 23 bipectinate ; the rami longer in the middle, the longest ones as long as 7 middle segments of shaft ; the antennae in female, wholly

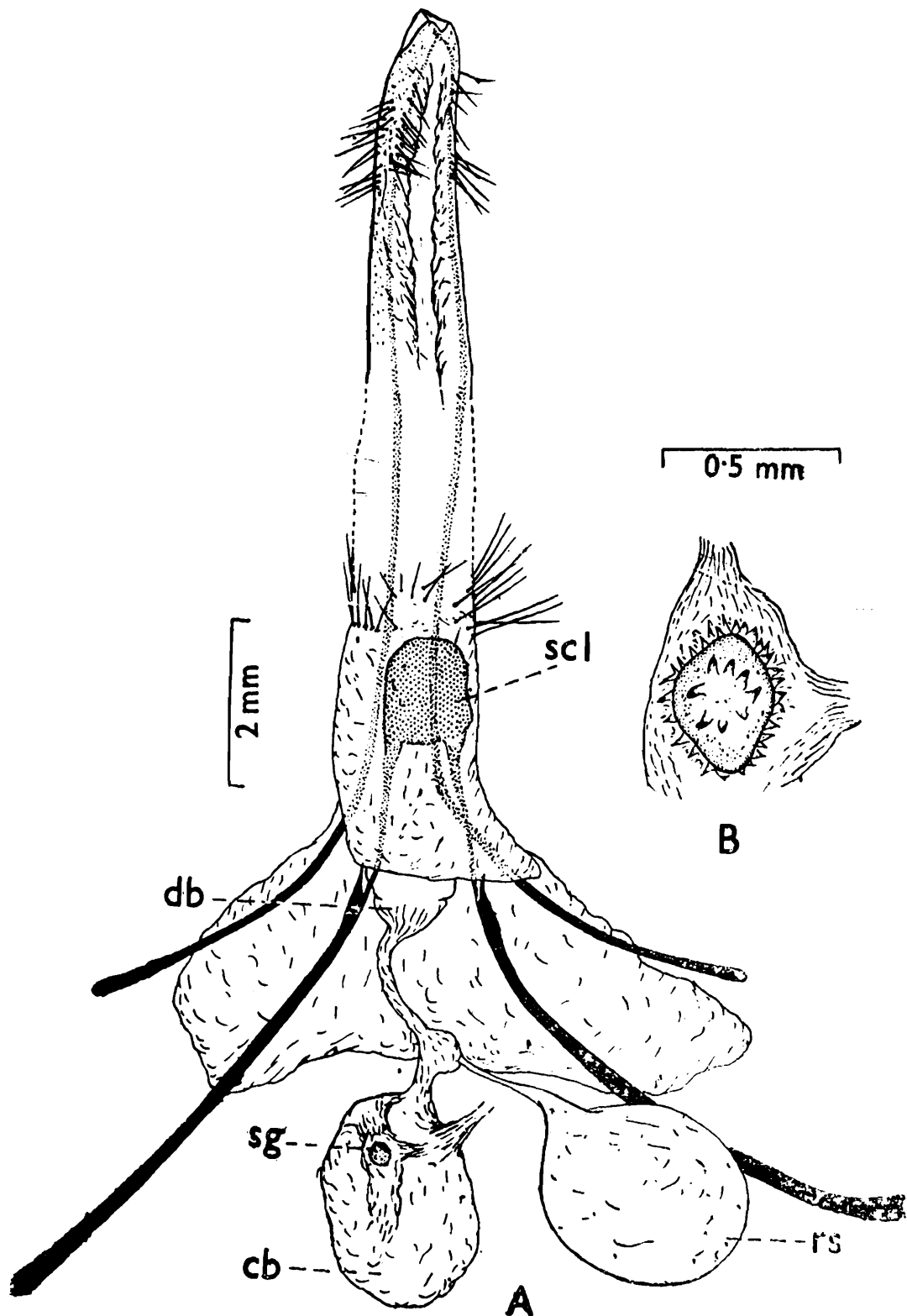
simple, with a few flattened distal segments. Labial palpi minute. Hind tibial spurs (Text-fig. 34A) tarsal spines, frenulum and retinaculum, as for the genus.

Venation.—Fore wings (Text-fig. 34B) : Areole in fore wing slightly more produced outside the cell angle than in the preceding species ; vein R_1 arises generally from the cell, rarely from areole ;



Text-fig. 34. *Zeuzera postexcisa* Hampson : (A) A portion of the hind leg with a single pair of tibial spurs. (B) and (C) Fore and hind wing venation, respectively. (D) Male genitalia in a lateral view, without claspers. (E) Male genitalia in inner view. (F) and (G) Uncus and saccus, respectively. (H) Aedeagus. (B & C ; D, F-G and E & H of the same magnifications).

R_3 shortly stalked with $R_4 + R_5$; M_1 from below the cell angle; the median cell with the lower branch ending between veins $Cu_{1a} - M_3$, nearer Cu_{1a} than M_3 . Hind wing (Text-fig. 34C) : As for the genus.



Text-fig. 35. *Zeuzera postexcisa* Hampson : (A) and (B) Portions of the female genitalia.

Genitalia.—Male (Text-fig. 34D-G) : Uncus broadly triangular, long, narrow and pointed distally ; strongly sclerotised ; about thrice as long as its width in middle. Gnathos long, incurved and not meeting with each other. Tegumen without membranous folds and invagination at its base. Saccus small, blunt and upturned. Claspers simple, broader in the middle ; costal process short. Juxta well developed, sclerotised ; median lobes thick and blunt apically ; anellus lobes long, narrow and pointed distally. Aedeagus well developed, with the short base differentiated from the large vesica, the latter sclerotised and striated at base and membranous distally ; the cornutal process extending far beyond the vesica. Female (Text-fig. 35) : Ostium bursae simple, weakly sclerotised ; ductus bursae short ; corpus bursae nearly rounded ; signum on the corpus bursae semicircular and blackish, due to the presence of short tubercles ; receptaculum seminalis also rounded and membranous ; genital plate sclerotised only on the dorsal side.

Measurements.—Expanse : Fore wing : Male, 52-75 mm. ; female, 68-97 mm. Length : Fore wing : male, 25-34 mm. ; female, 32-46 mm. Hind wing : Male, 15-21 mm. ; female, 26-30 mm. Abdomen : Male, 19-25 mm. ; female, 22-28 mm. Whole body : Male, 27-36 mm. ; female, 34-40 mm.

Material examined.—Fourteen examples as follows : India : Uttar Pradesh : New Forest, Dehra Dun, 1 ♀, 4 .viii. 1928, 1 ♂, 6.viii. 1928, 1 ♂, 1 ♀, 9. viii. 1928, 2 ♀ ♀, 12-13. viii. 1928, 1 ♂, 14.viii. 1928, 1 ♀, 16. viii. 1928. (*G. D. Bhasin.* coll.) ; 1 ♂, 11.vii. 1948 (*K. M. Subhaya* coll.) ; 1 ♂ (no date) (All ex. colln. F. R. I.). Sikkim, 1 ♂ (no data).

Ceylon : Diyatalawa, 2 ♂ ♂, 1 ♀, 1.xii.1900 (*E. E. Green* coll.).

Distribution.—India, Sri Lanka and Java.

Remarks.—Referable to the genus *Zeuzera*, it is characterised by its stout body, with an additional spot on the collar, tegulae and the metathorax ; a dorsal and lateral series of markings on the abdomen ; and a well-developed free gnathos. The specimens from Uttar Pradesh with somewhat semihyaline wings.

It is close to *multistrigata* Moore, for differences see under that species.

38. *Zeuzera indica* Herrich-Schäffer

1854. *Zeuzera indica* Herrich-Schäffer, *Samml. Ausser. Schmett.* : 58, fig. 166 (Type loc.—not given).

1856. *Zeuzera paucipunctata* Walker, *List Lep. Brit. Mus.*, 7 : 1537 (Type loc.—Silhet, Bangladesh) (*Syn.* Cotes and Swinhoe, 1887).
 1859. *Zeuzera indica*, Horsfield and Moore, *Cat. Lep. Mus. E. I. C.*, 2 : 437.
 1865. *Zeuzera indica*, Moore, *Proc. zool. Soc. Lond.* : 822.
 1867. *Zeuzera paucipunctata*, Moore, *Proc. zool. Soc. Lond.* : 686.
 1881. *Zeuzera paucipunctata*, Moore, *Proc. zool. Soc. Lond.* : 327.
 1887. *Zeuzera indica*, Cotes and Swinhoe, *Cat. Moths of India.* : 233 (Sikkim, Simla, Sylhet).
 1892. *Chalcidica indica*, Kirby, *Cat. Lep. Het.* : 873 (N. India).
 1892b. *Zeuzera indica*, Hampson, *Fauna Brit. India, Moths*, 1 : 311 (Simla, Sikkim and Sylhet).
 1895. *Zeuzera indica*, Swinhoe, *Trans. ent. Soc. Lond.*, 29.
 1923. *Zeuzera indica*, Dalla-Torre, *Lepid. Cat.*, 29 : 38.
 1933. *Zeuzera indica*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 812 (Java, New Guinea, Simla and Sikkim).
 1955. *Zeuzera indica*, Roepke, *Trans. R. ent. Soc. Lond.*, 107 : 281.
 1957. *Zeuzera indica*, Roepke, *Verh. k. ned. Akad. Wet. Afd. Nat.*, (2) 52 (1) : 13 (from Himalayas through S. E. Asia the Archipelago, the Philippines, New Guinea and Australia).

Types ; *indica* in Paris Mus.

paucipunctata in B. M.

As no specimens of this species were available for study, a revised description of the species, given by Hampson (1892b), is given below. The description of male genitalia is quoted from Roepke (1957).

Thorax unmarked. The basal and terminal segments of abdomen each with three dorsal blue-black streaks ; each of the other segments with one dorsal streak, those on the second and third segments triangular. Fore wings with the spots fewer and large, the most conspicuous being a spot at centre of the cell, one near the apex, and those on each side of vein 1A. Hind wing with three large spots below the end of cell ; one between vein 1A and Cu_2 , the largest between Cu_2 and Cu_{1b} , the smallest between Cu_{1a} and Cu_{1b} ; with a marginal series of spots, the one nearest to the anal angle large.

Genitalia.—Male : “Uncus straight and long, the lora [gnathos] elongate and narrow, about as long as uncus. Valvae [claspers] of normal shape, about thrice as long as broad. Aedeagus short and thick, with some complicated structure projecting from its orifice.”

Measurements.—Expanse : 96-114 mm.

Distribution.—This species is known from India (Simla, Sikkim), Bangladesh (Sylhet), throughout South-Eastern Asia, the Archipelago, the Philippines in the Oriental region, and New Guinea and Australia in the Australian region.

Remarks.—The largest of Indian *Zeuzeras*, it is characterised by the absence of spots on thorax. Hampson (1892) placed this species along with *Z. conferta*, under his first category, *i.e.*, vein M_1 in the fore wing arising from the angle, and the hind wing with the outer margin evenly curved. It can, however, be differentiated from *conferta* by the thorax being unmarked.

39. *Zeuzera conferta* Walker

1856. *Zeuzera conferta* Walker, *List Lep. Brit. Mus.*, 7 : 1536 (Type loc.—Sylhet, Bangladesh).
 1867. *Zeuzera conferta*, Moore, *Proc. zool. Soc. Lond.* : 686.
 1886. *Zeuzera conferta*, Butler, *Ill. Typ. Lep. Het. Brit. Mus.*, 6 : 28.
 1887. *Zeuzera conferta*, Cotes and Swinhoe, *Cat. Moths of India* : 233.
 1892b. *Zeuzera conferta*, Hampson, *Fauna Brit. India, Moths*, 1 : 311.
 1892. *Zeuzera conferta*, Kirby, *Cat. Lep. Het.* : 872.
 1923. *Zeuzera conferta*, Dalla-Torre, *Lepid. Cat.*, 29 : 38 (Sylhet, Bangladesh, and Luzon, Philippines).
 1933. *Zeuzera conferta*, Gaede, in Seitz *Macrolepidoptera of the World*, 10 : 811 (Sylhet, and Labuan).

Type : In B. M.

As no material of this species was available, the original description by Walker (1856) is reproduced here : "Female. Whitish. Antennae black. Thorax with two interrupted green stripes. Abdomen with three rows of green spots. Legs mostly green. Wings with very numerous minute transverse green or aeneous streaks, and with green dots along the border ; parts of the disk of the fore wings without streaks. Length of body 13 lines ; of wings 28 lines. a. Silhet."

Distribution.—The species is known from Bangladesh (Sylhet) and the Philippines (Labuan and Luzon), in the Oriental region.

Remarks.—It is close to *Z. indica* Herr.-Sch., in respects of the origin of vein M_1 in the fore wing and in the evenly-rounded outer margin in the hind wing. It is separable by the presence of spots on thorax, as mentioned by Hampson (1892b).

V. DISCUSSION

(a) *Some Important Taxonomic Characters*

The taxonomic study of the Indian species of the family Cossidae is based on certain important characters like the pectination of antennae, the size and shape of labial palpi, the hind tibiae & tibial spurs, tarsal spines and the wing venation. In respect of the male genitalia the important characters are the gnathos-whether meeting

in the middle below the uncus or free, if present, or absent completely; the structure of claspers—whether simple or with some well-defined areas; the shape of juxta; and the aedeagus—whether simple and without cornuti or highly sclerotised and with cornuti.

The family Cossidae has been divided into two subfamilies, viz. Cossinae and Zeuzerinae, as proposed by Neumoegen & Dyer (1894). The basis of division has, however, been modified by taking into account several characters, as mentioned above, instead of taking any single character as done by Neumoegen & Dyer himself and several others. While Neumoegen & Dyer (1894) based his classification on the basis of presence or absence of a cross bar between veins Sc and Rs in the hind wing (This character among the Indian fauna is present only in the genus *Zeuzera* Latreille of Zeuzerinae, with the result that all the other genera, viz., *Azygophelps* Hampson, *Phragmataecia* Newman and *Xyleutes* Hübner, are excluded from Zeuzerinae). Barnes & McDunnough (1911) and Dyer (1937) proposed the origin of vein R_1 in the fore wing as the basis of division between the two subfamilies (This is quite a good character and generally helpful, except in certain species of Zeuzerinae, viz., *Xyleutes pardicolor* (Moore) and *Xyleutes kapuri* sp. n., where the vein R_1 does not arise from the areole—a characteristic feature of the subfamily, but from the cell), and Essig (1951) proposed the origin of veins Rs and M_1 in the hind wing, as being connate or stalked in Cossinae unlike in Zeuzerinae where it is free (This again is generally helpful, except in the genus *Paracossus* Hampson and in some specimens of Cossinae where these veins are either wide separate or tend to separate). Thus, it is evident that no single character is sufficient to divide the family. By taking into account the characters proposed by Barnes & McDunnough, Dyer, and Essig along with a few more characters as that of antennae, hind tibiae and the gnathos in male genitalia, it would not be difficult to separate the Cossinae from Zeuzerinae, e.g., the genus *Cossus* is typically characterised by the presence of antennae which are pectinate up to tip, the dilated hind tibiae and two pairs of hind-tibial spurs, the origin of vein R_1 from the cell, veins Rs and M_1 connate in the hind wing and the gnathos meeting below the uncus, unlike the typical genus *Zeuzera* of the latter subfamily, wherein the antennae are pectinate up to the basal half, the hind tibiae are not dilated and with single pair of spurs, the vein R_1 arises from the areole, veins Rs and M_1 in the hind wing are wide separated and the gnathos, if present, either rudimentary or free. A few more characters of taxonomic importance have also been used here for this study, e.g., the presence or absence of ocelli, the tarsal spines and arolium, etc, which hitherto have not been used among the Cossidae. A brief resume of these characters, with their bearing on the taxonomy, is as follows :

Although Seitz (1937) was of the opinion that antennae were not good characters for separation of various genera in the two

subfamilies, which may be true as far as the world fauna is concerned, the present study of the Indian fauna shows that the antennae generally constitute a fairly constant character and can be profitably used in classification, e.g., the antennae are generally pectinate up to the tip in Cossinae (except in the genus *Holcocerus* where these are simple) and not up to tip in Zeuzerinae. While in other genera of Cossinae the antennae are bipectinate, in the genus *Cossus* these are unipectinate, probably leading to a stage found in the genus *Holcocerus*. The ocelli had been unknown in the Cossidae till Clench (1959 a) recorded these from a Madagascan genus *Pseudocossus*. Ocelli have also been recorded among the Indian Cossidae, especially in the two species, viz. *Catopta cashmirensis* (Moore) and *Catopta sikkimensis* (Arora), which differ distinctly from the other Cossids.

The legs have proved to be quite useful in the study. The hind-tibial spurs are present in all the cossids, though varying in length and number. There are two pairs of tibial spurs in the subfamily Cossinae, and a single pair in Zeuzerinae. While the hind tibiae are dilated distinctly in the former, in the latter these are simple. The tarsal spines have also been found useful in the study, as these are present on all the tarsal segments in Cossinae, unlike in Zeuzerinae where these are either not present on all the segments in any of the genera studied, or not present at all as in the genus *Phragmataecia* Newman. The arolium is generally present in Cossinae, either weak or strong, but in Zeuzerinae it may be either present, as in *Azygophelps* Hampson and *Phragmataecia* Newman, or absent in *Xyleutes* Hübner and *Zeuzera* Latreille. The species of *Azygophelps* and *Xyleutes* were often confused because of the male antennae pectination and the wing venation. The study of the legs, however, distinctly separates these two genera.

In the male genitalia the gnathos is always present in Cossinae and meeting below the uncus, but in Zeuzerinae it is either completely absent as in the genus *Phragmataecia* Newman, or free if present, either weak or strong, as in *Azygophelps*, *Xyleutes* and *Zeuzera*. Besides, other characters as that of clasper, juxta, aedeagus, etc., have also been described in detail.

(b) Phylogeny

Some generic characters which have been noted also seem to have a bearing on the phylogeny of the family Cossidae. Turner (1918) traced the phylogeny on the basis of wing-venation. According to him the family Cossidae has retained the primitive-type of neurotation and claimed that all the other families of Lepidoptera could be derived from this subfamily in so far as the venation was concerned. He used the origin and location of various veins in the evolution of different genera.

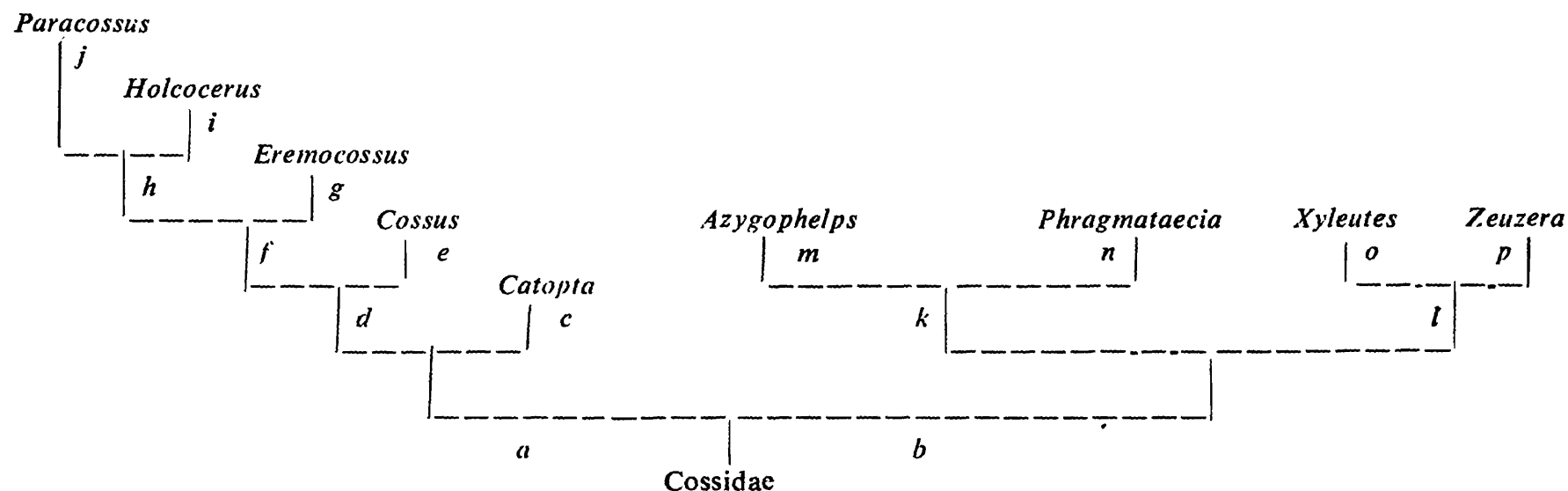
As pointed out by him the most primitive genera are the *Cossodes* and *Dudgeonea*, which have the long and well developed tibial spurs and rather long palpi. Their neuration, according to him, also confirms this conclusion. The genus *Dudgeonea*, however, has recently been separated into a distinct family Dudgeonidae by Berger (1957) on the basis of the presence of tympanum.

The Indian group of Cossids seem to have diverged into two lines : one having the characters of Cossinae, *i.e.*, antennal pectination up to the tip, dilated hind tibiae, and the gnathos which are fused, and the other having the characters of Zeuzerinae, *i.e.*, antennae partly pectinate, the hind tibiae normal, and the gnathos free. In the Cossinae group of genera the genus *Catopta*, appears to have got separated into an independent line which retains the primitive characters, *i.e.*, presence of ocelli and pectination of antennae up to the tips. The other group of genera got diverged on the line, with the antennae which are either pectinate or simple and where the ocelli are obsolete. From the latter the genus *Cossus* seems to have evolved and is characterized by unipectinate antennae in the male. The other line of development leads to bipectinate or simple antennae. The genus *Eremocossus* seems to have diverged further on account of the presence of stalked veins Rs-M₁; the other two genera, *viz.*, *Holcocerus* and *Paracossus* have free or connate veins. The genus *Holcocerus* is easily separated by the characters of simple antennae in the male and by the forked median vein in both the wings. The genus *Paracossus* is characterised by bipectinate antennae and unforked median vein and constitutes a group by itself.

The Zeuzerine group of genera appears to have evolved in two lines, *i.e.* one with the pectination in antennae up to more than the basal half and having distinct arolium, as in the two genera *Azygophelps* and *Phragmataecia*, which again are separated into two different lines of development, one having well developed gnathos in the male genitalia and well developed palpi as in the genus *Azygophelps*, as compared to the other being without gnathos and with reduced or obsolete palpi as in *Phragmataecia*. The genera *Xyleutes* and *Zeuzera* appear to diverge from the common stalk, with the pectination of antennae only up to basal half and without arolium. The genus *Xyleutes* constitute the line of development, which is characterized by the hypertrophied areole in the fore wings and the absence of cross bar between Sc-Rs in hind wings, as compared to the moderately large areole and a cross bar between the veins Sc-Rs in the hind wing in the genus *Zeuzera* which constitutes the other line of development.

Thus, it will be seen that the family Cossidae has evolved from the taxa related to the genus *Dudgeonea* which is perhaps the most primitive among the superfamily Cossoidea. As pointed out by Turner (1918), the genus *Dudgeonea* possessed certain characters

Scheme of evolution in the Indian Cossidae



a, antennal pectination up to the tips, dilated hind-tibiae, fused gnathos; *b*, antennae pectination in part, normal hind tibiae, free gnathos; *c*, ocelli present, antennae bipectinate up to tips; *d*, ocelli absent, antennae bipectinate, or unipectinate or simple; *e*, antennae unipectinate; *f*, antennae bipectinate or simple; *g*, veins R_s and M_1 stalked; *h*, R_s and M_1 either connate or free; *i*, antennae simple, median forked in both wings; *j*, antennae bipectinate, median unforked; *k*, antennal pectination for more than basal half, arolium present; *l*, antennae pectination up to basal half, arolium absent; *m*, labial palpi and gnathos well developed; *n*, labial palpi reduced or obsolete, gnathos absent; *o*, areole hypertrophied, cross bar between Sc and R_s in hind wing absent; *p*, areole moderately large, cross bar between Sc and R_s in hind wing present.

which were typical of his hypothetical family, Protocossidae, *i.e.* the long and well developed palpi, the bipectinate antennae up to tips, the veins R_2 - R_5 arising separately from the areole and the well developed tibial spurs. The genus *Catopta* possesses most of these characters, and appears to be the primitive genus among the Indian Cossids whereas the genera *Paracossus* and *Zeuzera* are at the specialised stage of development, especially the genus *Paracossus*, which although peculiar due to the unbranched median vein in both the wings and in the absence of areole, has still retained the Cossid characters, and has led to the origin of higher group of moths, especially those having no areole and median cell.

(c) Zoogeography

The Cossidae in the Indian subregion (India, Bangladesh, Pakistan, Burma, Sri Lanka, and Bhutan) is represented by 40 species and subspecies belonging to nine genera, *viz.*, *Catopta* Staudinger (2 species), *Cossus* Fabricius (5 species), *Eremocossus* Hampson (one species), *Holcocerus* Staudinger (2 species), *Paracossus* Hampson (2 species), *Azygophelps* Hampson (4 species), *Phragmataecia* Newman (10 species), *Xyleutes* Hübner (8 species) and *Zeuzera* Latreille (5 species and one subspecies).

The genus *Catopta* is known only from the Palaearctic and the Oriental regions, but is mainly Palaearctic. Out of 16 species known so far 14 occur in that region and two in the Oriental region (India; Kashmir and Sikkim). Out of the two Oriental ones, one is common with the Palaearctic region. This distribution shows that the origin of the genus was probably in the Palaearctic region.

The genus *Cossus* is cosmopolitan and is mainly either Palaearctic or Ethiopian. Out of a total number of 87 species, eighteen are represented in the Oriental region, of which five are Indian.

Only two species of the genus *Eremocossus* are known, out of which one is from Pakistan (Karachi) and the other from Aden.

Holcocerus is again a Palaearctic genus, and 36 of the 37 species occur in that region. Two species are known from India (Gt. Nicobar, Assam and Sikkim), out of which one is common with the Palaearctic region.

The genus *Paracossus* Hampson is endemic to the oriental region and is represented by only two species, which come from Sri Lanka and Burma.

The genus *Azygophelps* Hampson is represented in the Oriental region by four species which occur in India and one of these also

occurs in China. Twenty of the 27 species are known from Ethiopian and 3 from the Australian regions. The origin of this genus seems to be Ethiopian and its distribution seems to have extended to the Oriental and the Australian regions.

Of the thirty known species of the genus *Phragmataecia*, 13 occur in the Oriental region, of which 10 are known from the Indian subregion. This genus is mainly Oriental, but has an almost world-wide distribution except in the Nearctic region.

The genus *Xyleutes* is represented by 29 species from the Oriental region, 8 of which are occurring in the Indian region. The genus is mainly Australian and out of the total of 154 species about 84 are known from this region. It is also known from all the other Zoogeographical regions except Palaearctic. The origin of the genus is possibly in Australia from where it has spread to India and other Oriental regions, probably the ancient Papuan connections.

The genus *Zeuzera* is represented by 14 species in the Oriental region. Out of the total number of 52 species from the world, only 5 occur in the Indian region.

Thus, out of the total of 407 species of nine genera, which are present in the Indian region, only 85 occur in the Oriental region, with only 40 species from the Indian region. While some of these species are endemic, several other species are well represented in the oriental as well as other regions.

VI. SUMMARY

The present study deals with taxonomic revision of forty species & subspecies, belonging to nine genera, viz. *Catopta*, *Cossus*, *Eremocossus*, *Holcocerus*, *Paracossus*, *Azygophelps*, *Phragmataecia*, *Xyleutes* and *Zeuzera*.

Two species and a subspecies are described as new to science: *Cossus greeni* from Sri Lanka; *Xyleutes kapuri* from Andaman Is; and *Zeuzera coffeae angulata* from W. Bengal.

Five new combinations have been proposed: *Catopta sikkimensis* (Arora); *Phragmataecia pallidulae* (Hampson); *Phragmataecia clara* (Bryk); *Phragmataecia obliquifascia* (Bryk); and *Phragmataecia stigmaticus* (Moore). The latter has been referred to various genera by different workers but the present study reveals that it belongs to the genus *Phragmataecia* Newman.

The following new distributional records, including those from India, are being reported:

<i>Cossus</i> Fabricius	From Sri Lanka
<i>Cossus cadambae</i> Moore	From Sri Lanka
<i>C. acronyctoides</i> (Moore)	From Delhi
<i>Holcocerus arenicola</i> (Staudinger)	From India (Great Nicobar)
<i>H. rufidorsia</i> (Hampson)	From Assam
<i>Phragmataecia terebrifer</i> Fletcher	From Assam and Bengal
<i>P. parvipunctus</i> (Hampson)	From Sri Lanka
<i>P. clara</i> (Bryk)	From India (Sikkim) and Bhutan
<i>P. obliquifascia</i> (Bryk)	From India (Assam)

Types of the following species (the repositories given in the square brackets) were examined : *Catopta cashmirensis* (Moore) [Ber. Mus.]; *Azygophelps albofasciata* (Moore) [Ber. Mus.]; *Phragmataecia saccharum* Moore and *P. minor* Moore [Ber. Mus.]; *Phragmataecia clara* (Bryk) and *P. obliquifascia* (Bryk) (Rm. Stockholm); *Phragmataecia purpureus* Fletcher and *P. terebrifer* Fletcher [N. P. C., New Delhi]; and *Xyleutes pardicolor* [Ber. Mus.]. The types of *P. purpureus* and *P. terebrifer*, examined at N. P. C. have been described for the first time, as these were only figured by the original author who gave only the characters of their larvae and did not designate any type. Accordingly, the present author has selected the Lectotypes and Paralectotypes from the original series.

Some characters such as pectination of antennae, presence or absence of tibial spurs, tarsal spines and arolium, have been found to be of considerable taxonomic importance, specially in the classification of subfamilies of Cossidae and in the identity of different genera.

Some of the species, viz. *Xyleutes persona*, *X. ceramicus* and *Zeuzera coffeae*, etc., are of economic importance as these are serious pests of agriculture and forestry.

The relationships of the Indian genera and their allies, their taxonomic status, phylogeny and zoogeography have been discussed.

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