KFRI Research Report No. 361

Taxonomy of Microlepidoptera

George Mathew

Kerala Forest Research Institute

An Institution of Kerala State Council for Science, Technology and Environment (KSCSTE)

Peechi – 680 653, Thrissur, Kerala, India

March 2010

KFRI Research Report No. 361

Taxonomy of Microlepidoptera

(Final Report of the Project KFRI/ 340/2001: All India Coordinated Project on the Taxonomy of Microlepidoptera, sponsored by the Ministry of Environment and Forests, Government of India, New Delhi)

George Mathew
Forest Health Division

Kerala Forest Research Institute
Peechi-680 653, Kerala, India

March 2010

Abstract of Project Proposal

Project No. KFRI/340/2001

1. Title of the project: Taxonomy of Microlepidoptera
2. Objectives:
   - Survey, collection, identification and preservation of Microlepidoptera
   - Maintenance of collections and data bank
   - Development of identification manuals
   - Training of college teachers, students and local communities in Para taxonomy.

3. Date of commencement: March 2001
4. Scheduled date of completion: June 2009
5. Project team:
   Principal Investigator (for Kerala part): Dr. George Mathew
   Research Fellow: Shri. R.S.M. Shamsudeen
6. Study area: Kerala
7. Duration of the study: 2001- 2010
8. Project budget: Rs. 2.4 lakhs/ year
9. Funding agency: Ministry of Environment and Forests, New Delhi

CONTENTS

Abstract

Intensive survey of Microheterocera was made from different parts of Southern western Ghats viz., Silent Valley, Mukkali, Muthanga, Sultan Bathery, Amarambalam, Meenmutty, Vellimuttam, Nilambur, Peechi, Vazhani, Sholayar, Thekeddy, Rajamalai, Ranni, Thenmala, Arienkavu, Rosemala, Kattlapara, Achenkovil, Neyyar and Peppara. Sampling of insects was done by light trapping using a lighted sheet. Altogether, 67 species of Microheterocera belonging to the families Psychidae, Tineidae (Tineoidae); Oecophoridae, Ethmiidae, Lecithoceridae, Gelechiidae, Blastobasidae, Cosmopterigidae (Gelechioidea); Plutellidae, Yponomeutidae, Lyonetiidae, Glyphipterigidae and Heliodinidae (Yponomeutoidea) have been recorded in this study. A major share of moths collected in the study belonged to Gelechiidae, Tineidae, Oecophoridae and Cosmopterigidae. The faunal elements were interesting in that they contained several new records for the region- six species as new records for Kerala; 44 species as new records for Southern India and two species as new records for India.

Studies on the morphology of various species with special reference to head appendages, wings and external genitalia have shown that characteristics of the labial palpi, wing venation and parts of external genitalia such as uncus, saccus, gnathos, juxta, tegumen of the male as well as corpus bursae, ductus bursae and signum of the female have diagnostic value in species identification.

An identification key for the various species using wing venational and external genitalial characters was prepared for easy segregation of species studied here. In addition, an inventory of species recorded in this study along with details of collection localities, distribution and hosts is also given.

1. INTRODUCTION

The order Lepidoptera, comprising of moths (Heterocera) and butterflies (Rhopalocera), are among the most familiar insects. The Heterocera comprises of two groups- the Macroheterocera,or larger moths and the Microheterocera, or smaller moths. Usually, moths of 5-12 mm wing expanse are treated as very small, 9-20 mm as small and 18-50 mm or more as large (Robinson and Tuck, 1996). However, this classification of moths into Macro and Microheterocera is an arbitrary one based on the relative size of the moths. More than one-quarter of the world's 1, 65,000 named Lepidoptera species are Microheterocera. The group Microlepidoptera is essentially a paraphyletic assemblage of primitive or ancestral Ditrysian Lepidoptera.

1.1. Classification of Microheterocera

The widely accepted and more recent classification of Microheterocera is that of Heppner (1998) in his work on 'Holarctic Lepidoptera'. In this work, he followed the classification by Minet (1991) with minor changes. The important super families included under this group are the ditrysian 'microlepidoptera' superfamilies Tineoidea, Yponomeutoidea, Sesioidea, Immoidea, Gelechioidea, Pyraloidea, Alucitoidea, Pterophoroidea and Tortricoidea. Brief accounts of the major microlepidoptera families are given below.

Superfamily Tineoidea

Family Psychidae

Psychids are important as defoliators of forest trees in the tropics. They are dimorphic, males being alate and the females, larviform. The larva and the adult female are confined to a bag made of fragments of leaves, twigs or other materials that are often cut into regular shapes. As the larva grows, additional pieces are added on and the case gets enlarged. On attaining maturity, the larva undergoes pupation within this case. The family is divided into two subfamilies: Psycheoidinae (primitive) and Psychinae (specialized) (Plate 1). The former are mostly restricted to temperate regions where they often occur in large concentrations on the bark of trees or on walls of buildings,

sometimes causing a minor nuisance. The latter are generally much larger and are well represented in the tropics where some species have periodic outbreaks and cause indiscriminate defoliation of forest / ornamental trees and plantation crops, such as tea, coffee, oil palm and cocoa. Larvae are usually polyphagous, feeding on the leaves or bark of a variety of plants.

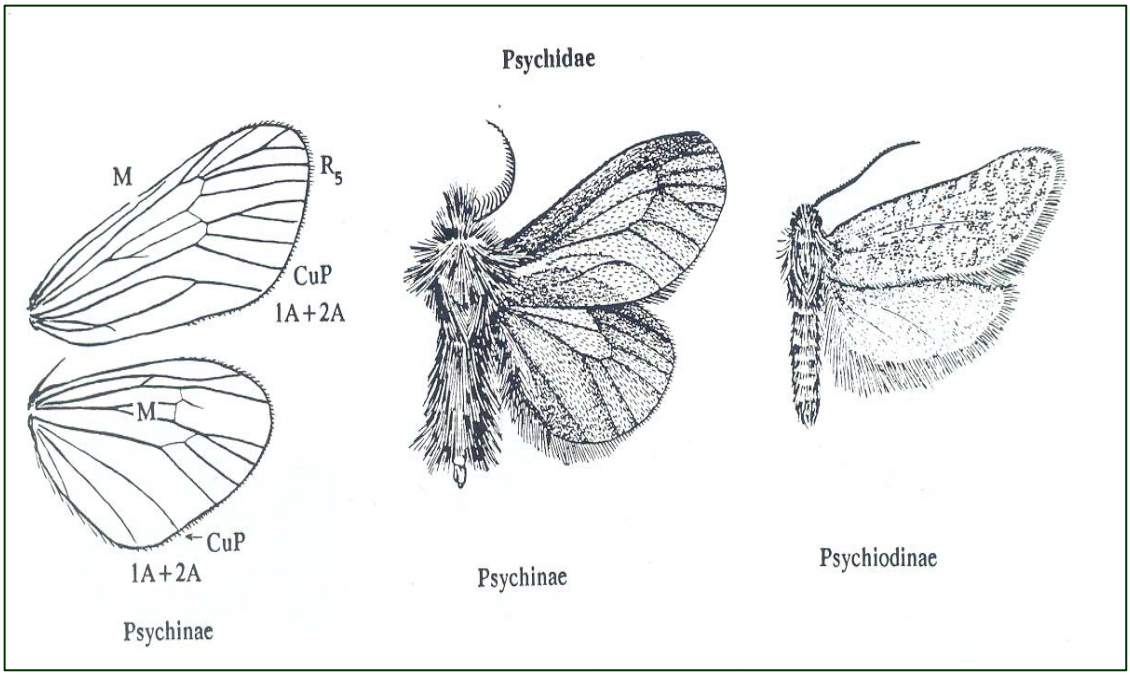


Plate 1. General features of Psychinae (Holloway *et.al.*1987)

Psychinae can be easily distinguished by the characteristic of the external genitalia.The male genitalia are relatively simple: tegumen broad, elongated, hood-shaped; uncus vestigial or absent, sometimes represented by memberanous pads; gnathos absent; valva simple and elongate; succulus developed and distally often separated; aedeagus simple and usually with out cornuti.The female genitalia are generally simple and without internal diagnostic characters.

Family Tineidae

Members of this family are keratin-feeders (Tineinae), fungus-feeders or scavengers on dried vegetable and animal matter. Larvae feed mostly on dried or decaying plant or animal matter, especially fungi and keratinous material; some are inquilines in nests of

social insects, e.g. termites and ants, and some live in vacated nests of birds or in burrows made by mammals. They usually live inside a prortable case, or beneath silken webbing, or in tunnels made in the substrate.

Adults are generally small, dull colored moths having a wing span of less than 30 mm. The forewing pattern is often intricate. When at rest, wings are held in tectiform or tent-like position. Although tineids are generally feeble fliers, they are fast, furtive runners.
The characteristic features of this group (Plate II) include the roughened head, presence of a stiff pecten of bristles on tongue, simple antennae (usually finely pubescent, very rarely ciliate or pectinate), and rough-scaled hind tibiae. The adult wing venation is often unstable: variation occurs especially in the position and branching of veins arising from the cell in both fore and hindwing. Vein Cu2 is present in both fore and hind wings and in the forwing, often M and chorda are present or indicated in cell, and R5 extending either to costa or to apex.

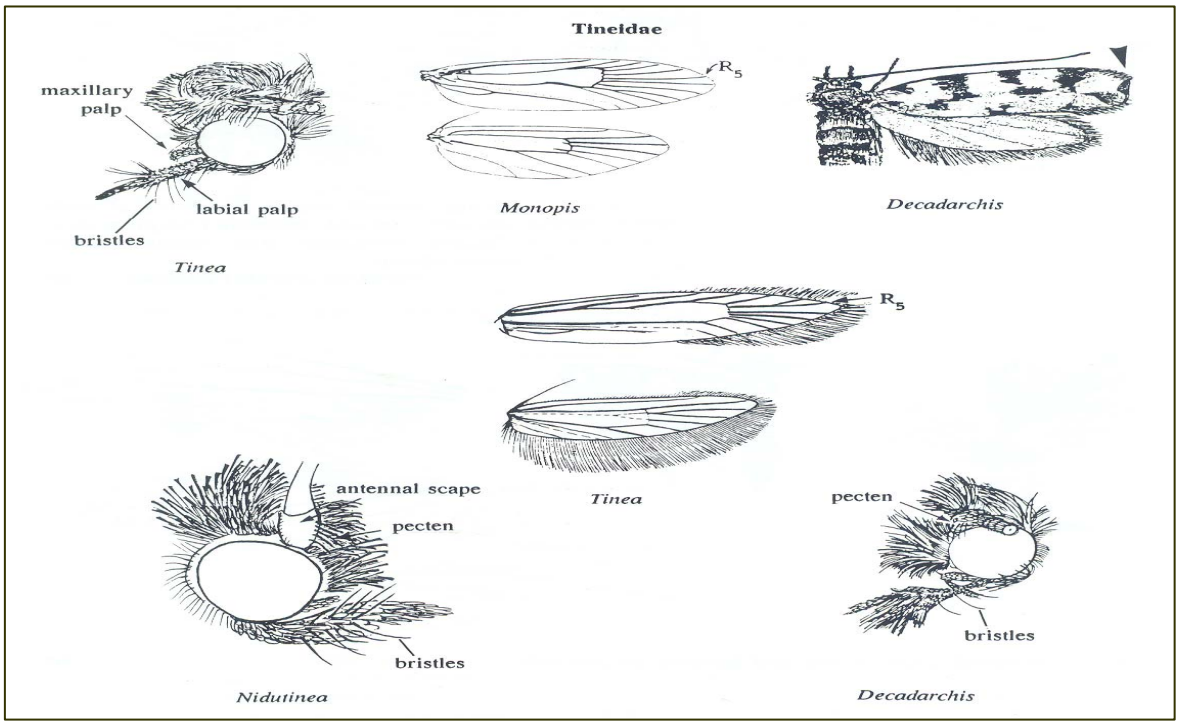


Plate II. General features of Tineidae (Holloway *et.al.*1987)

The male genitalia provide wide difference in structure to distinguish the subfamilies, but differences between related species are often subtle, e.g. comparative shape of valvae, denticulation of aedeagus. In the female genitalia, the ovipositor is usually long and extensile; ostium, usually with well sclerotized lamella antevaginalis (lower lip); ductus bursae and bursa copulatrix membranous, ductus usually thin and narrow, bursa often lacking signum or with multiple signa.

Family Gracillariidae

The family includes a number of species of considerable economic importance mainly as miners on the leaves and fruits of trees and shrubs. Larvae are miners (at least up to the second or third instar), usually in leaves, fruits and are mostly host-specific (monophagous), but some times oligophagous. The gracillariid larva has two distinct stages or morphs (hypermetamorphosis): a sap-drinking stage and a tissue-feeding stage. Generally, the Gracillarid larvae leave the mine after completing the sap-feeding stage and live externally in a rolled leaf, while the Lithocolletine larvae continue to feed and remain within the mine. In the Phyllocnistinae, the second morph does not occur until after feeding has finished; the mouth parts are atrophied and it exists solely for cocoon-spinning. Pupation occurs either in the mine or outside, usually beneath a glossy membrane spun on the substrate; the pupa is protruded at eclosion.

Adults are typically brightly coloured or shining with long-fringed lanceolate wings. The forewings are often intricately patterned.The antennae are distinctly longer than the forewings.Gracillarids have a peculiar resting posture with the head raised high above the conspicuously ornamented fore and middle legs. Three rather contrasting subfamilies *viz.*, Gracillariinae, Lithocolletinae and Phyllocnistinae have been are recognized (Plate III). Lithocolletinae adopt a horizontal resting posture, the head being kept low and the abdomen being slightly lifted and supported by the hind legs, the front and middle legs stretched forward. The antennae are about as long as the forewing. Phyllocnistinae are smaller and more delicate than most lithocolletines.They have characteristic shining white background coloration on the forewings.They also adopt a horizontal resting posture, have the antennae shorter than the fore-wing and but.

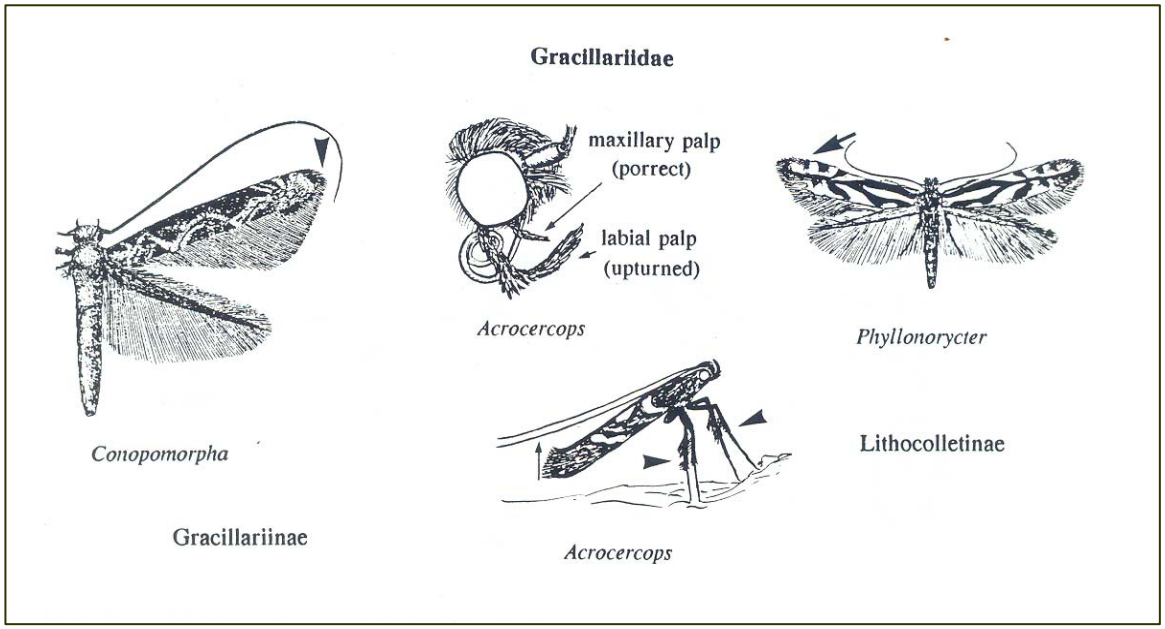


Plate III. General features of Gracillaridae (Holloway *et.al.*1987)

Male genitalia: Tegumem elongated, broad or narrowed apically, often weak and memberanous; uncus rudimentary; gnathos absent; valvae relatively simple, very slender to broad, sometimes asymmetrical (Lithocolletinae); or with small comb(s) on the inner surface; vinculum V- or U- shaped; saccus short when developed, or indeterminate; aedeagus long, with linear rows of small cornuti, or without cornuti. Eighth sternite produced into a wide flap covering genitalia.

Female genitalia: Ovipositor short, weak; ostial plate usually sclerotized, Ostium well defined, sometimes projecting, or membraneous (Phyllocnistinae); signum single or double minute points, or small sigmoid or cornute structures, or diversely-shaped plates, often unequal. The important subfamilies are listed below.

Super Family Yponomeutoidea

Family Yponomeutidae

Yaponomeutidae is a heterogeneous family group comprising of the subfamilies Acrolepiinae, Argyresthiinae, Plutellinae and Yponomeutinae. The Yponomeuitid adults which are small to medium-sized are narrow–winged, often brightly coloured micro

moths which keep their wings in tectiform or involute position with the antennae pointed forward holding the body horizontal or with the rear end raised while resting (Plate IV).

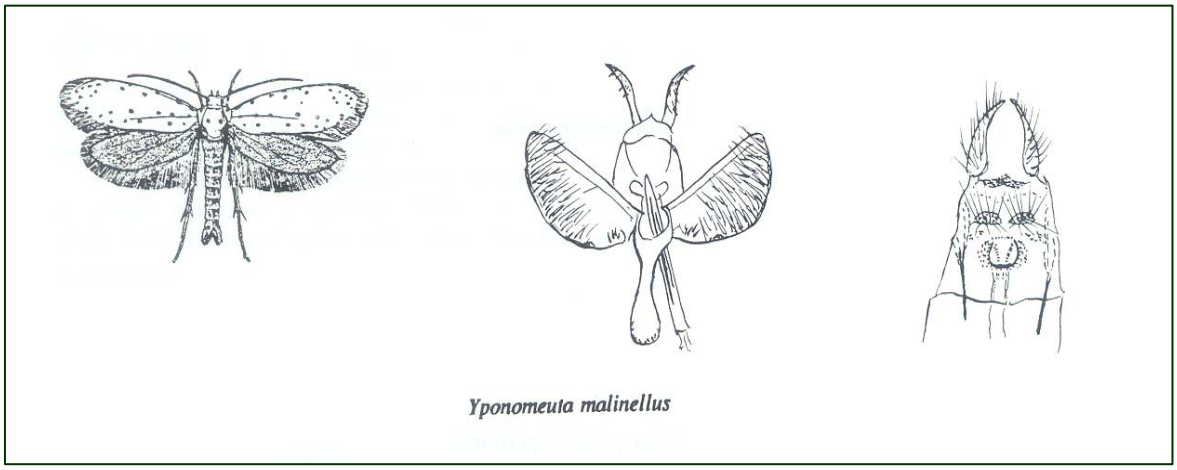


Plate IV. General features of Yponomeutidae (Holloway *et.al.*1987)

The feeding habits of larvae differ according to the subfamily. They may feed exposed (*Plutella,* Plutellinae), or live gregariously in a communal web or nest (*Yponomeuta,* Yponomeutinae) or tunnel in fruits and shoots (*Argyresthia,* Argyresthiinae), or live between the leaves (*Acrolepiopsis,* Acrolepiinae). Larvae of *Yponomeuta malinellus* feed on apple leaves, living and pupating in a communal web. In the subfamily Plutellinae, *Plutella xylostella* Linnaeus, is the diamond-back moth which is almost a cosmopolitan and migratory pest on crucifers.

The structure of the male genitalia varies greatly in the different subfamilies. Tegumen is usually narrow, weak; uncus reduced; socii strongly developed, prominent and setose, often erect (Yponomeutinae), sometimes with specialized scales on the internal surface (Argyresthiinae); gnathos usually present, tongue– like (Yponomeutinae), or recurved and with spines at the tip (Argyresthiinae), or absent (Acrolepiinae); anellus present as sclerotized ring (Plutellinae), or membraneous; vinculum narrowly rounded, or rectangular, usually with slender saccus, which is W- shaped or nearly so in ventral aspect (Argyresthiinae); sternite 8 sometimes divided, forming two lobes enclosing genitalia (*Zelleria,*Yponomeutiinae).

In the female, ovipositor is partially extensile with lobes short or reduced; sternite 8 often with spinulose pads on either side of ostium; signum single or absent; coremata sometimes present. The structural differences between the subfamilies are less marked in the female genitalia than in the male.

Super Family Sesioidea

Family Sesiidae

Sesiids (clearwing moths) include numerous borers causing damage to various fruit trees and shrubs. Larvae are borers in bark and wood of a wide range or trees and shrubs, sometimes causing serious damage to fruit trees. Pupation usually occurs in the borer hole, with or without a cocoon. The sesiid pupa has rows of dorsal spines which aid movement along the tunnel to the exit hole, through which the exuviae protrude on eclosion.

The adults are remarkable for their mimicry to Hymenoptera, which they resemble not only in coloration and markings but also in form, the wings being narrowed, the abdomen often constricted basally (wasp-like), and the hind tibiae clothed with long bushy scales resembling a pollen sac (Fig. 1). Most species have a wing expanse below 35 mm, but some larger tropical species have a span of 50 mm or more.

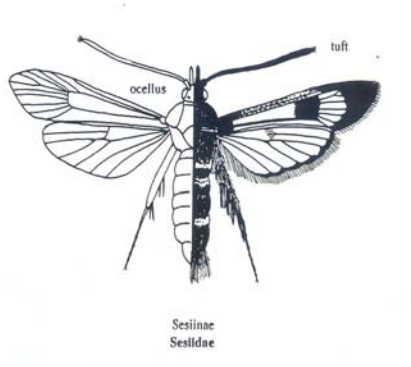


Fig. 1. General features of Sessid moth (Holloway *et.al.*1987)

Male genitalia: Tegumen long and slender or short and moderately broad, with uncus distinctly demarcated or fused; tuba analis often prominent, with ventral sclerotisation (subscaphium); gnathos usually present, sometimes with paired flap-like lateral processes; with dense specialized setae and a saccular ridge, or simple; vinculum usually with distinct, sometimes long saccus; aedeagus slender, usually with bulbose base; internal cornuti often present but external spined, spurs, etc. in apical portion are usually of greater taxonomic significance.

Female genitalia: Ostium bursae on sternite 8 or on intersegmental membrane between sterna 7 and 8, or on posterior margin of sternite 7; signum usually absent, but sometimes present or represented by folds or bands.

Family Immidae

Immids are not known to be of much economic importance. They are restricted to the tropics and subtropics with majority of the species being distributed in the Indo-Australian region, Oceania and the Neotropics. Little is known about the life history of various species although the larvae are apparently external feeders, living on the foliage of various tropical trees and shrubs. Pupa is not spined dorsally (spined in Tortricids) and not protruded on eclosion.

The moths are mostly small to moderate-sized (wingspan 15-30mm), broad- winged, usually having dull brown and yellow coloration. In general they resemble tortricids in appearance. The tongue is naked and chaetosemata are present as in tortricids, but ocelli are usually absent.

The male genitalia are varied; uncus simple, sometimes bifid, or absent; socii sometimes present; gnathos present or absent; tuba analis sometimes prominent; valva simple or complex, sometimes bifurcate; vinculum strong; aedeagus curved or straight, usually without cornutus.

In the female genitalia, the ovipositor lobes are setose; ostium broad, usually on intersegmental membrane between segment 7 and 8; ductus bursae often coiled; bursa copulatrix usually globular, with or without signum.

Super Family Gelechioidea

Family Oecophoridae

This large and heterogeneous family is well developed in most regions, especially in Australia and Central America, but contains comparatively few species of significant economic importance. Larvae are foliage-feeders, borers in stem, trunk, bark or root, or general feeders and scavengers. Adults vary from small micro-moths to large, noctuid-like moths; sometimes exceeding 60 mm in wing-span (Plate V). While resting, they keep the wings folded flat over the body or hold tent-like keeping the body parallel to the surface. The hind legs are typically held up in the air, projecting between the front and mid-legs antennae often held along the sides of body below the wings, but pointing forwards (Plate VI).

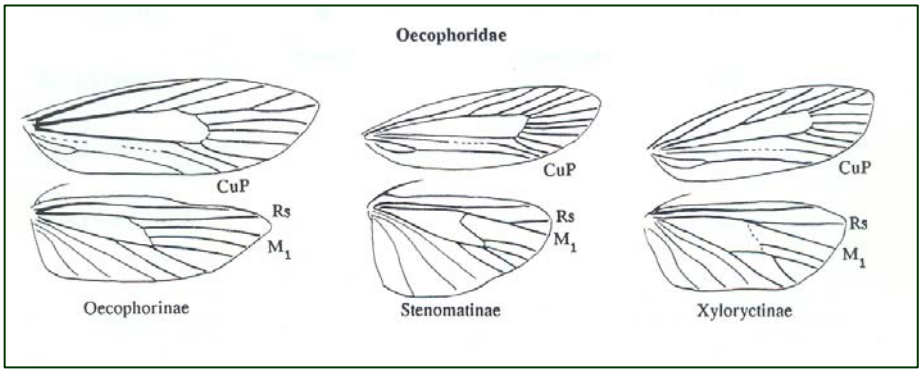


Plate V. Wing venation in Oecophoridae (Holloway *et.al.*1987)

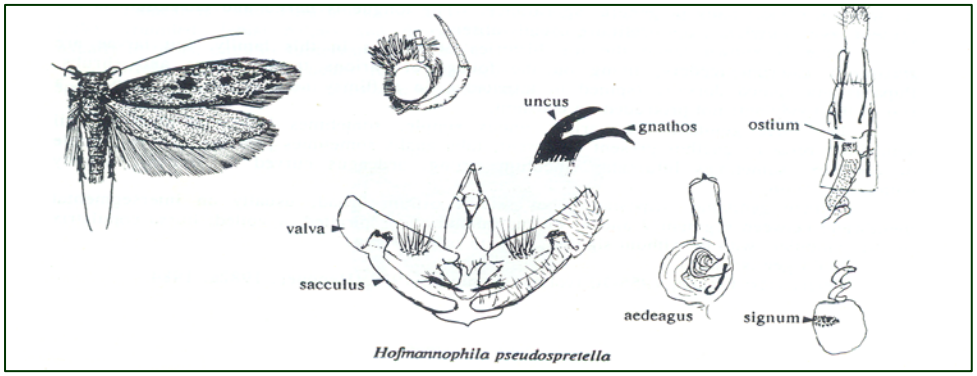


Plate VI. General features of Oecophoridae (Holloway *et.al.*1987)

Male genitalia are usually symmetrical: uncus-socii variously developed; gnathos usually present, single or double, spined or unspined; tegumen and vinculum strong; saccus not usually developed; valva simple or with some combination of costal, medial and/or saccular lobes; juxata usually present and often with a pair of lateral lobes; transtilla present or absent; aedeagus cylindrical, often bulbose basally, loosely attached by membrane, often with a group of minute thorn-like cornuti.

Female genitalia: Ostium on sternite 8 or on membrane between sternites 7 and 8; walls of ductus bursae membranous or spiculose; signum usually stellate/dentate, sometimes double or multiple, or absent.

Family: Coleophoridae (Eupistidae)

They are narrow-winged insects, recognizable by the antennae being held in a porrect position in repose. The maxillary palpi are rudimentary (Plate VII). The hind wings are narrower than their fringe with vein Rs close to Sc+R1. The fore wing has R1 arising from the discal cell well before its upper angle. They are leaf-mining in habits during early stages but, afterwards inhabit in a portable case which is attached to a leaf withg the larva boring into the interior. In the case of leaves, a pale blotch is usually produced, with a distinctive round whole in one membrane.

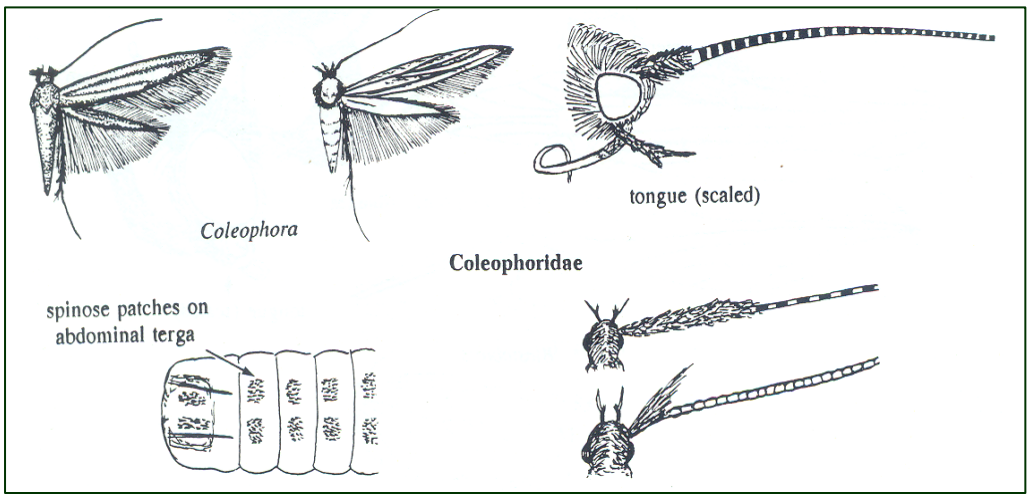


Plate VII. General features of Coleophoridae (Holloway *et.al.*1987)

Family Blastobasidae

Mostly tropical and subtropical in distribution. The adults usually rest with the body held nearly horizontal to the substratum, with the wings in an involute position and the antennae kept along the sides of the body. Larvae are mostly general scavengers on decaying vegetable matter, boring into twigs, berries, fruits and seeds.

Adults are typically drab micro-moths of 10-25 mm wingspan. The forewings are generally grey or brownish with an indication of the gelechioid triad of dark brown stigmata, and usually with a strongly developed pecten of long, hair-like scales, male usually with a notch at the base of flagellum; labial palpus long and recurved, second segment often showing sexually dimorphic specific characters. Abdominal tergites have transverse caudal bands of spines, as in some oecophorids.

Family Cosmopterigidae

Cosmopterigids having a wingspan of 6-12 mm are world-wide in distribution with a number of economically important species. They have long, pointed wings having long fringes. The forewings are bright metallic in coloration. Head is smooth–scaled; labial

palpi slender and recurved; tongue well developed and scaled at the base; abdominal tergites not spined. Body held horizontal while resting (Plate VIII).

Male genitalia: valvae range from strongly asymmetrical to nearly symmetrical, simple or complex, sometimes with basal or anellar lobes; uncus absent and arms (brachia) of gnathos asymmetrical (Cosmopterigidae).

Female genitlaia: ostium on sternite 7; bursa copulatrix often double or with an accessory sac; signa usually double but sometimes single or absent. Larvae are mostly miners in leaves, buds, seeds, stems (sometimes causing galls) and roots, or scavengers on dried or decaying plant material. Pupa not protruded on eclosion.

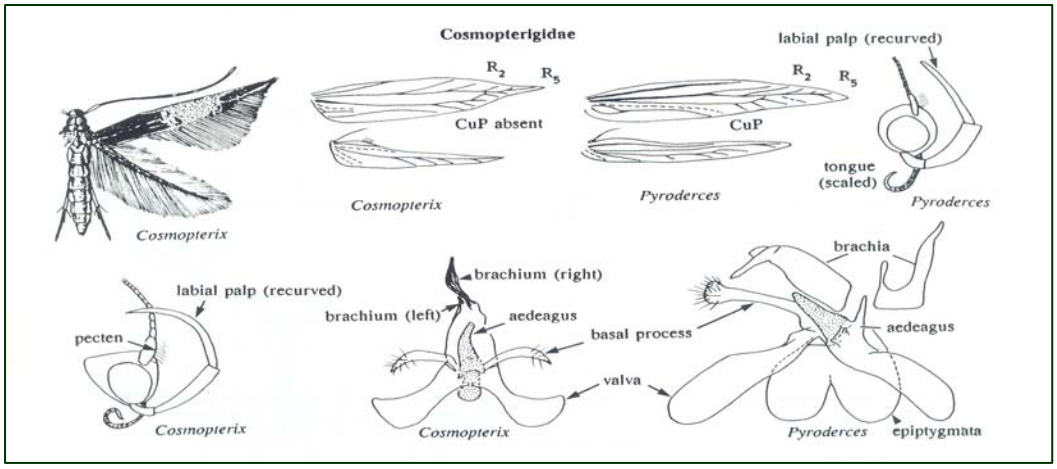


Plate VIII. General features of Cosmopterigidae (Holloway *et.al.*1987)

Family Gelechiidae

They are mostly moderately broad-winged micro-moths. Includes a number of important pest species in tropical and temperate regions. Larvae are live in rolled leaves or shoots. Pupation takes place inside a silken cocoon. The wings are well fringed and generally with inconspicuous coloration. They rest with the wings kept involute or flat, folded over the body, with the anterior end of the body slightly raised, the forelegs pointing backward and the antennae held against the wings. Antennae are usually simple, labial palpi slender and stout, usually upturned or recurved, rarely porrect (Plate IX). Head is smooth or with loosely appressed scales, tongue present and densely scaled at base; antennae usually

simple, scape seldom with pecten; labial palpus usually upturned or recurved, rarely porrect, second segment rough-scaled or tufted beneath, third segment usually slender; ocelli present or absent; chaetosema absent. Forewing with veins R4 and R5 usually stalked, R5 to costa, vein CuP obsolescent or absent; hindwing generally trapezoid, the apex prominent, veins Rs and M1 usually approximate at base or stalked, CuA sometimes with basal pecten, CuP present or absent.

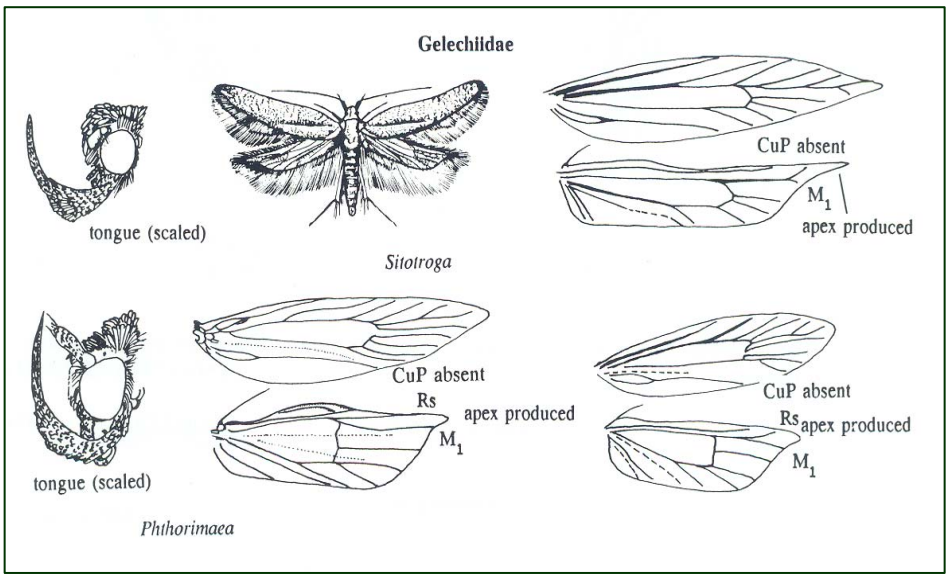


Plate IX. General features of Gelechidae (Holloway *et.al.*1987)

The male genitalia is variable in structure and form, rarely asymmetrical, varying from simple and reduced to modified and partially anchylosed; 8th sternite sometimes divided into distal lobes covering genitalia; tegumen elongated with uncus usually short and squat; gnathos well developed, usually hook-like; valvae generally narrow or rod-like, costa sometimes separate and sacculi developed as basal, saccular process, sometimes fused medio-ventrally; aedeagus usually strong and loosely attached by membrane, cornuti usually present.

In the female genitalia, ostium varies from membranous to strongly sclerotized, sometimes with elaborate foam-like cellular structure; signum single or double, of various shapes and often of generic significance.

Super Family Pyraloidea

Family Pyralidae

Pyralids are small to medium-sized moths. They are of great economic importance as pests of various agricultural, horticultural, forest and garden crops. Some are pests of stored commodities (Plate X).

Larvae are usually concealed feeders, living under a web, or bore into stems and fruits. Some are scavengers, and few (Phycitinae) are predaceous e.g. *Laetilia coccidivora* (Comstock) in N. America, *Euzophera coccidiphaga* Hampson in India and *Cryptoblabes proleucella* Hampson in the oriental reigon, all on coccids, and *Issuria aphidovora* (Meyrick) (=*Cryptobalbes aphidivora* Yoshiyasu & Ohara) in the Malay- Papua region on aphids, while *Dicymolomia julianalis* (Walker) (Glaphyriinae) parasitise larvae of psychids in N. America. Larvae of many Numphulinae and some Pyraustinae and Schoenobiinae are aquatic or semi-aquatic. Pupation is usually in a silken cocoon.The important characters that distinguish a pyralid moth form other Leipidoptera are the presence of paired tympanal organs directed anteroventral of the basal sternum of the abdomen and the fusing in the hindwing of veins Sc+R1 and Rs for a short distance beyond the cell, except in the subfamily Pyralinae in which it is some times only approximated (Plate XI). The tongue is usually developed and strongly scaled at the base, but is sometimes obsolescent. The maxillary palpi are usually well developed and prominent, but are sometimes obsolescent or absent, and the labial palpi are often modified and sexually dimorphic.

Pyralid subfamilies may be divided into two main groups depending on the presence or absence of praecinctoruim in the tympanal organs. This is a small memberanous or sclerotized structure situated medially in front of the opposed tympanic bullae on the sternum of the first abdominal segment, and hangs down in to cavity between the thorax and abdomen.

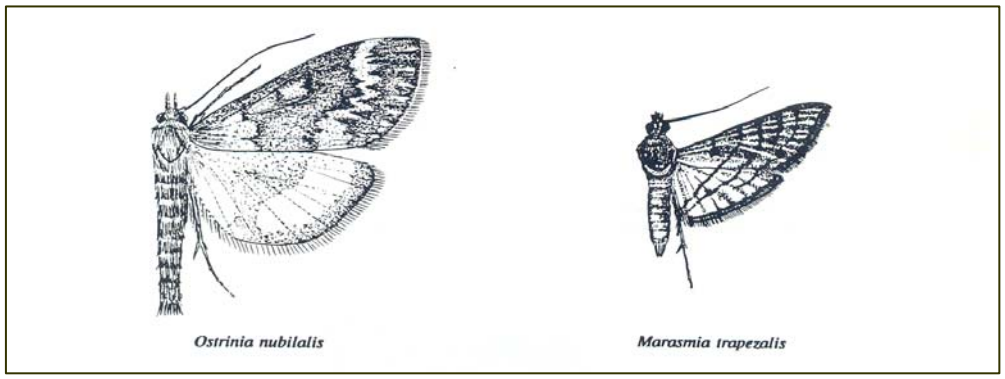


Plate X. General appearance of Pyraloidea (Holloway *et.al.*1987)

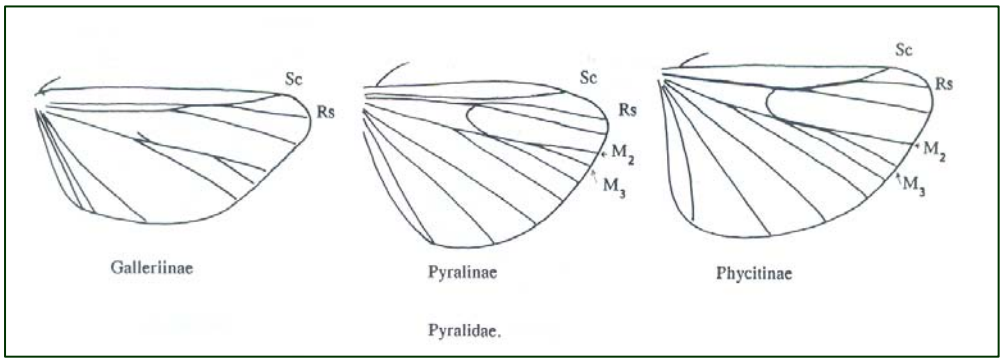


Plate XI. Wing venation in Pyraloidea (Holloway *et.al.*1987)

In male genitalia, the tegument is simple, generally broad, but sometimes narrow (Crambinae) or elongated (Phycitinae), articulating pleurally with the vinculum; Vinculum U- or V- shaped; saccus weakly developed (shallow) or absent; uncus present and usually simple and articulating with gnathos, or absent (Galleriinae); gnathos usually present, strong and hook-like, but sometimes weak or absent; valva simple or complex; anellus usually well developed; juxata present; coremata often present on 7^{th}–8^{th} abdominal segments, sometimes strongly developed and complex (Phycitinae).

In female genitalia, the ovipositor varies from short and simple to long and extensile, sometimes specialized and with blade-like or serrate lobes for cutting; Ostium varying from memberanous and simple to sclerotized and complex (Crambinae); signum usually

present, either single, double or multiple, varying from simple and thorn-like, plate-like, scobinate, serrate or stellat or with spines or denticulations (Phycitinae).

Family Thyrididae

Moths are small to medium-sized measuring about 50mm in wing expanse. The wing pattern is reticulate and varies from subdued to bold and silvery translucent, sometimes with hyaline patches or 'windows' and generally produces a leaf-like effect (Fig. 2). They differ from pyralids in lacking an abdominal tympanum and in having the tongue, which is unscaled at the base; in the hindwing Sc+R1 is only approximated and not fused with Rs beyond the cell. About 600 species have been reported most of which are of little economic importance except as casual leaf rollers or stem borers.

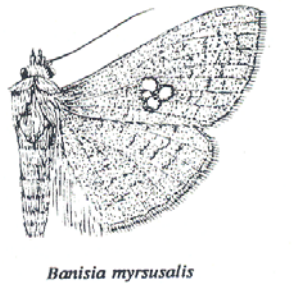


Fig. 2. General appearance of Thyrididae (Holloway *et.al.*1987)

Family Hyblaeidae

This family which was originally placed near Noctuidae, comprises of about 20 species (*Hyblaea*) in the Indo-Australian region and one sexually dimorphic species (*Torone*) from tropical America. Larvae are foliage-feeders, spinning the leaves, and pupate in a cocoon near the feeding place. *Hyblaea puera* Cramer, belonging to this family is widespread in the Indo-Australian tropics is a serious pest of teak (*Tectona grandis*) and *Vitex* (both Verbenaceae), and also *Catalpa* (Bignoniaceae)

Moths are typically with brown forewings having subdued pattern and with black hindwings having conspicuous yellow or orange patches (Fig. 3). Hyblaeids can be readily distinguished from noctuids by the presence of well developed maxillary palpi

and the absence of metathoracic tympanal organs. They also lack the abdominal tympanal organ present in Pyralidae, but they have pyralid-like larvae and pupae.

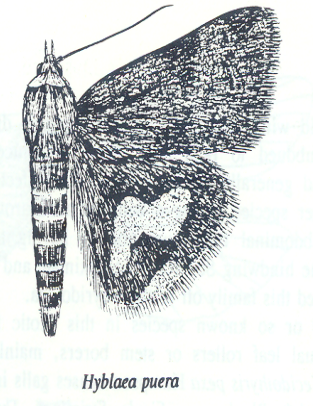


Fig. 3. General appearance of Hyblaeidae (Holloway *et.al.*1987)

Super Family Pterophoroidea

Family Pterophoridae

This distinctive family of 'plume–winged' moths can be readily distinguished from their narrow, plume-like wings, slender body, the long-spurred legs and their habit of resting with the wings rigidly stretched out at right angles to the body. Larvae are usually hairy and live externally on flowers and leaves belonging to Compositae, Vitaceae, Convolvulaceae and Cucurbitaceae. In most species the forewing is cleft into two plumes and the hindwing in to three plumes. Maxillary palpi, ocelli and chaetosemata are absent.

Super Family Tortricoidea

Family Tortricidae

Tortricids are generally moderately robust, micro-moths with a wing expanse seldom over 40 mm. Tortricid larvae are external feeders, constructing shelters by rolling leaves, and often are polyphagous or Oligophagous. Some are borers in stems, roots, seeds or fruits. Pupation occurs in a cocoon spun in the larval feeding place or near by sometimes amongst surface debris or in the earth.

The typical wing venation of Tortricidae is given in Fig. 4. The diagnostic characters include the unscaled tongue; presence of ocelli and chaetosem; the beak-like form of the labial palpi and the presence of a costal fold on the forewing of the male (Plate XII).

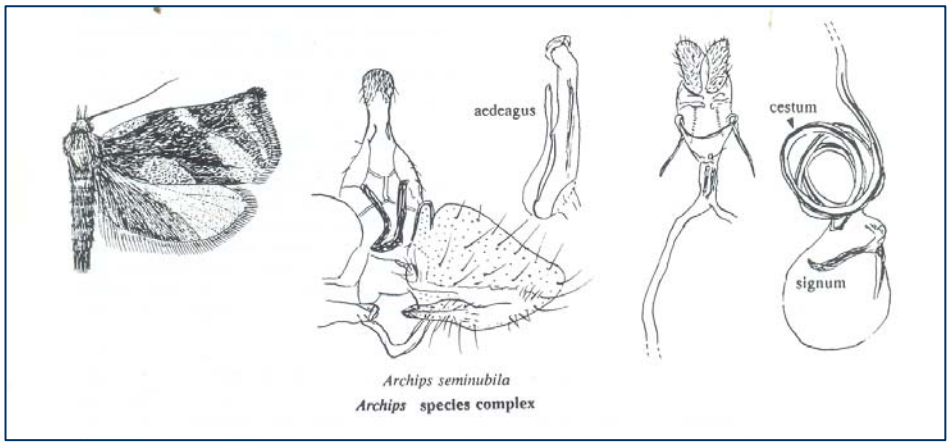


Plate XII. General features of Tortricidae (Holloway *et.al.*1987.)

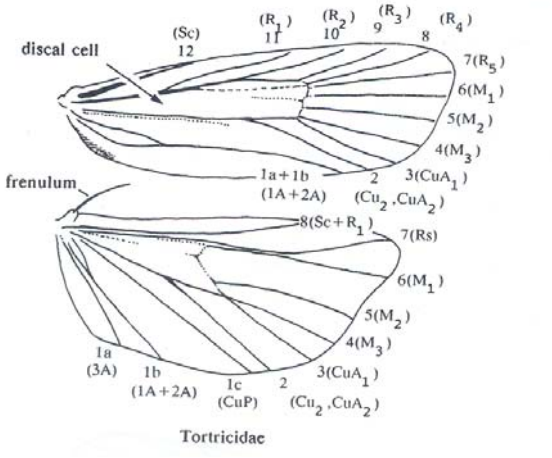


Fig. 4. Wing venation in Tortricidae (Holloway *et.al.*1987)

Male genitalia: Uncus long and hood-shaped or narrow (Tortricinae), deeply bifid (Tortricinae, Cochylini), sometimes bifid at the tip or weak (Olethreutinae), or obsolescent (Olethreutinae, Grapholitini); gnathos well developed or weak and

obsolescent (some Olethreutinae); socii often large and prominent, erect or drooping (pendulous), but sometimes small (e.g. *Adoxophyes*, *Archips*). Valvae are relatively simple, but usually with the sacculus and costa differentiated (especially in Cochylini) and cucullus often demarcated (Olethreutinae); transtilla usually present, often sclerotized and spined, or memberanous; vinculum U- or V- shaped, saccus seldom developed; aedeagus very characteristic, usually short and curved, loosely attached by membrane and easily dissected out (Tortricinae) or hinged to sclerotized juxata and usually best left *in situ* (Olethretuinae); vesica often with deciduous internal spine –like cornuti.

In the female genitalia, the ovipositors are usually short with flattened setose lobes. Signum usually present and often diagnostic for tribe or genus.

1.2. Biology and Behavior

Larvae of many species of microlepidoptera are specialized to specific host plants. The mode of larval feeding is often characteristic. Internal feeders may mine leaves for the whole of their larval stage or restrict mining to the first two or three instars. Other forms of internal feeding include mining in leaf petioles, stem and bark, boring in stem, bark or wood or formation of galls. External feeders may web flower-heads or roll the leaves within which the larvae feed. Detritus feeding larvae often web together scraps of dead plant material in the cervices of bark, while fungivorous larvae bore in dead wood or in bracket fungi. A few species of Microheterocera are predators of scale insects (Coccoidea). Larvae of most Psychidae and Tineidae make a portable case from fragments of their food substrate held together with silk. Most Macrolepidoptera have a well-developed proboscis. Many microlepidopterans visit flowers and sap exudations at night, with a few species feeding at flowers by day. Females locate host-plants for egg laying by using scent, but touch and vision may play an important part in the choice of the final location. Eggs may be glued to the plant or inserted into the plant tissue. The eggs are usually covered with hair-like scales from the tip of the abdomen. Detritus-feeding groups such as Tineidae find host- substrates and then oviposit in the same fashion as phytophagous species. Eggs and larvae of most Microheterocera are

parasitised by Hymenopterans (mainly Ichneumonoidea and Chalcidoidea) and Diptera (mainly Tachnidae and Sarcophagidae).

1.3. Economic importance of Microheterocera

As has been stated earlier, the larvae of most Microheterocera are associated with vegetation. In the family Gelechiidae, larvae are concealed feeders, living in folded leaves or mining in leaves or boring in stems, seeds, fruits and tubers. Larvae of *Sitotroga cerealella* (Oliver) which feeds on stored grain is always a sporadically major pest. *Dichomeris ianthes* Meyrick (pest of Medicago, Cyamopsis and Indigo), *D.evidantis* Meyrick (which rolls the leaves of *Dalbergia sisso*), *Pectinophora gossypiella* Saunders (pest of cotton), *P.operculella* Zeller (pest of potato and tomato), *Ephysteris cheraea* Meyrick (pest of vegetables), *Anarsia veruta* Meyrick (pest of Leguminosae), *Hypatima haligramma* Meyrick and *H.spathota* (pests of Mango) and *Brachmia effera* Meyrick (pest of Potato) have been reported to infect various host plants as indicated in parenthesis (Fletcher 1920; Metcalfe and Flint 1962; Kulkarny 1967; Nayar et al. 1976; Srivastava 1996).

In the family Cosmopterigidae, *Anatrachyntis simplex* Walsingham, *Pyroderces rileyi* Meyrick, *Cosmopteryx mimetis* Meyrick and *Limnaecia peronodes* Meyrick feed on sorghum grain, cotton, apple tree, lablab and leaf sheaths of bamboos respectively. Larvae of the Tineid *Setomorpha rutella* (Zeller) feed on dried or decaying plant or animal matter or on keratinous materials like animal horn. Larvae of *Tinea pellionella* Meyrick, *Trichophaga abruptella* Wollaston and *Monopis crocicapitella* (Cleans) destroy clothes and carpets. *Tinea columbariella* Wocke, *T. flavescentella* Haworth, *T. murariella* Stainton and *Tineola bisselliella* (Hummel) damage wollen materials. *Monopis rusticella* (Hubner) is known to attack leather, fur, skin, woolen fabrics and museum specimens. *Plutella xylostella* Linnaeus (Plutellidae) is a major pest of cruciferous plants, the larvae skeletonising the leaves. Members of the family Yponomeutidae usually feed externally on leaves, flowers buds, fruits or twigs and some species live in a communal web. *Yponomeuta padella* (Linnaeus) and *Arygesthia thujella* (Packard) infest apple trees and *Atteva fabriciella* (Swed.) damage seeds and

inflorescence of Ailanthus triphysa. Larvae of Oecophoridae are varied in habits and include foliage feeders, stem, trunk, bark and root borers, general feeders and scavengers on plant or animal detritus, decaying bark and wood, fungi, lichens, mosses, seeds and fruits. *Tonica niveferana* Meyrick infest *Bombax malabricum* and *Promalactis semantris* Meyrick infest Sal (*Shorea robusta*), and *Eugenia jambolana*. Celary and related plants are infested by *Depressaria heraclamia* (Linnaeus) and citrus by *Tonica zizyphi* Stainton (Kulkarny, 1967). In the family Xyloryctidae, *Nephantis serinopa* Meyrick is a minor pest of coconut damaging the leaves. Larvae of Blastobasidae are mostly general scavengers on matured decaying vegetable matter or borers in berries, fruits and seeds. *Blastobasis decolor* Meyrick, *B.crassifica* Meyrick and *Prosintis florivora* Meyrick infest *Ficus glomerata, Crotalaria juncea* and *Mangifera indica* respectively. In Lyonetiidae, the larvae are generally leaf miners, making blotch or serpentine mines, or sometimes skeletonise leaves. Larva of *Leucoptera sphenograpta* Meyrick make minor blotches in the leaves of *Dalbergia sisso*. In the family Oecophoridae, larvae of *Stathmopoda theoris* Meyrick feed on the flower heads of sun flower (Helianthus) and cholam. Larvae of Glyphipterigidae feed in seeds or shoots. Larvae of *Phycodes minor* Moore have been reared from shoots of *Ficus carica* and *F. heterophylla.*

1.4. General external morphology

Wing venation

In all the families of Microheterocera, the forewing and the hindwing venations differ. There are potentially 12 veins that reach the wing margin in the forewing and 10 in the hindwing. The veins of the forewing are: the subcostal vein (Sc), the radius with five branches (R1-R5), the media with three branches (M1-M3), and the cubitals- the anterior cubital with two branches (CuA1 and CuA2), and the posterior cubital composed of two veins close to the wing base. Then there may be one or two veins, the anal veins (An1 and An2). In the hindwing, subcosta (Sc) and the first branch of radius (R1) are fused, forming the first fused vein Sc+R1; the radius is not divided further and the second vein is the radial sector (Rs) which may be fused for part of its length with Sc+R1. The remaining veins are as in the forewing except that 1A+2A is usually entirely fused and a third anal vein (3A) is sometimes present. Fore and hindwings contain a cross-vein, the

discocellular vein, which encloses the wing cell between R and Cu. The costa of the wing extends from the base to the tip. The margin posterior to the apex is called termen and its limits are clear in a rectangular wing. The forewing and hindwing are linked together by means of a jugum or, much more commonly, a retinaculam and frenulum.

The form of the retinaculam and frenulum is usually different in males and females, and is useful to differentiate the sexes when other external evidence, such as a protruding ovipositor, is not apparent.

Genitalial morphology

The genitalia consist of both external and internal parts. Morphological details of the external genitalia have been recently considered as important tool for species identification (Tuxen, 1970). The general structure of male and female external genitalia is discussed below:

Male: The important parts of male genitalia are Uncus, Socii, Gnathos, Tegumen, Vinculum, Saccus, Valvae, Transtilla, Juxta and Phallus (Fig. 5).

Uncus: It is a mid-dorsal process attached to the caudal margin of the tegumen. It is typically in the form of a large, strongly sclerotized tapering arm, arising from a broader base. The anterior edge of this is attached to the caudal margin of the tegumen, while the other end is attached to the anterior end of the dorsal part of the anal tube.

Socii: Situated ventrally on either side of the base of the uncus, is a hairy pad or lobe-like structure the socii. It may be weakly chitinised or memberanous.

Gnathos: It is a structure similar to the uncus on the ventral side of the anal tube. It is typically in the form of a pair of arms which are attached at their bases to the lateral edges of the base of the uncus and the caudal margin of the tegumen which extend around the anal tube to meet in the mid-ventral line, where they are expanded as a plate and produced posteriorly into one or two spines or arms or otherwise modified and ornamented.

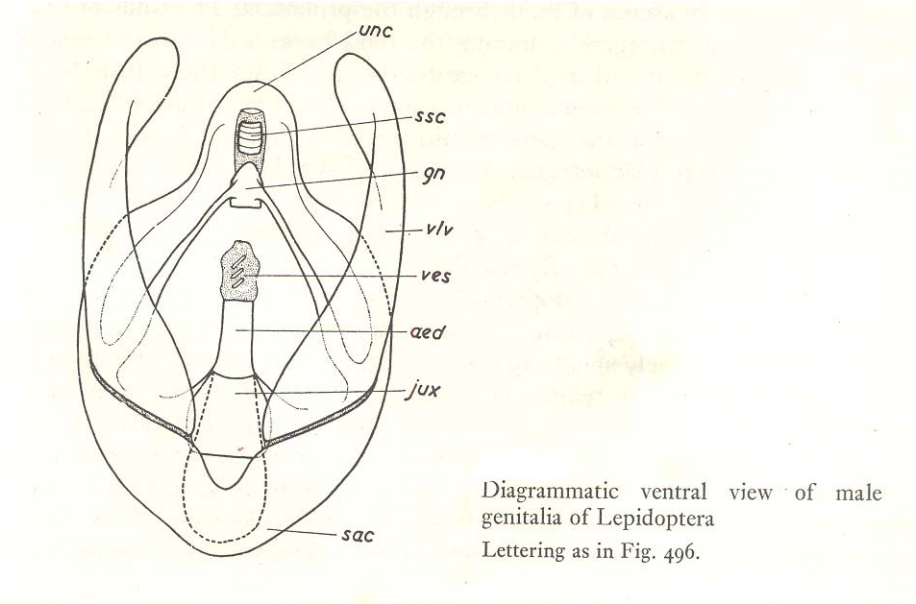


Fig. 5. Diagramatic view of male genitalia of Lepidoptera (O.W Richard & R.G Davies, 1977)

Tegumen: This is a more or less ring like structure derived from the sclerites of the 9th segment, together with parts derived from the 10th segement and serves for the attachment of other parts of the genitalia. It is in the form of a plate, usually tapering caudally and more or less emarginated in the middle of its anterior edge over the genitalia.

Vinculum: Vinculum appears typically in the form of a flattened V, the bottom of the V being situated on the ventral portion of the tegumen to complete the ring formed by the tegumen on the dorsal side.

Saccus: Saccus is a mid-ventral pocket, tubular or trough-shaped, extending cephaled from the vinculum. The vinculum is expanded ventrally and often produced anteriorly as a broad and tapering plate, which because of its size and position of the vinculum extends anteriorly above the 8th sternum. As a result of this, the inter-segmental membrane, which extends from the anterior edge of the vinculum to the posterior edge of the 8th sternum, is folded inwards above the 8th sternum into a sac-like pocket and this constitutes the saccus.

Valvae: These are the chief clasping organs of the male. They are typically in the form of a pair of large, flattened double walled lobes usually more or less tapering and bluntly pointed apically. They are always adorned with hairs and scales. They articulate with the

ring formed by the tegumen and vinculum. Different portions of the valvae are known by different names.

Costa: Upper or dorso-proximal sclerotized margin of the valvae.

Sacculus: The area along the lower margin of valvae is differentiated into a expansion or sac like portion, the sacculus. It appears to be formed of the outer wall of the valvae which has been expanded and folded inward so as to form part of the inner surface, the inner wall not being continued to the lower edges of the valva, but meeting the edge of the folded part of the outer wall.

Valvula: Conical part of the valva lying between the costa and sacculus. Generally, valvula is united to the costa and sacculus, but sometimes it projects free.

Cucullus: This is the dorso-distal part of the valvae and is usually hairy or setose.

Harpe: This is a strongly sclerotized arm usually in the form of a curved spine provided with independent musculature and arising from the inner surface of the valva, usually near the base or towards the middle and always quite distinct from the sacculus and extending outwards and upwards as a free arm.

Transtilla: From the base of the valvae arises a cross bar called transtilla. This bar is often simple but may be incomplete when the opposing arms do not unite.

Juxta: This is a sclerotized shield shaped structure ventral of the aedeagus in most cases; the base of the sacculus of the valvae is attached to the juxta. A scelerotized structure of juxta termed furca, consisting of a median, furcated process or a pair of diverging arms, which are sometimes asymmetrical, may also be present.

Phallus: The phallus is the intromittent organ and passes through the funnel-like sac called anellus. Its basal walls are heavily sclerotized in the form of a tube, which is open at its apex, but closed and round at its basal end. The sclerotized tubular part is the phallus. The apical part of the phallus is memberanous, usually withdrawn within it, but it is eversible, and is called vesica. It frequently has spines or sclerotized plates in its walls, the cornuti, which because of the vesica being withdrawn, often appears to be attached to the inside of the aedeagus. The ductus ejaculatorius enter the aedeagus dorsally near its base and passes through it upon the tip.

Seventh segment: This is sometimes highly developed, being produced on either side of the genitalia and attached to the vinculum as an extensive pouch or bag with hairs and

bearing a spiracle, called coremata. The hairs are variously arranged and there may be present large spatulate spines.

Eighth segment: This segment bears no spiracles. The anal edge of the sternum may be scalloped and is often modified. Sometimes it may be hardened and produced into a single occasionally scobinate protuberance, or into a pair of protuberance termed octavals.

Female: In the female, the important parts are Ovipositor, Apophyses, Ductus bursae, Ostium, Corpus bursae and Receptaculum seminis (Fig. 6).

Ovipositor: The segments 8^{th} to 10^{th} may become comparative long, narrow and telescopic to function as an egg inserting apparatus. Distally it bears two bean-shaped or elongate lobes, fringed with hairs called ovipositor lobes.

Apophyses: From the cephalo-dorsal or lateral edges of the 8^{th} and 9^{th} tergites arise long, slender apodemes directed anteriorly. Those of the 8^{th} segment are referred to as the anterior apophyses and those of the 9-10^{th} segments from the posterior pair.

Ductus bursae: This is usually developed in the form of a tube of varying length leading from the Ostium to the bursae. Its walls are lightly sclerotized and may possess sclerotized patches, corrugations etc.

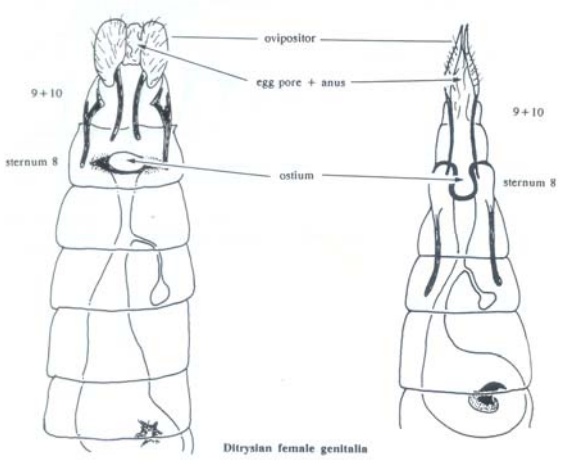


Fig. 6. Diagramatic view of female genitalia of Lepidoptera O.W Richard & R.G Davies

Ostium: It is the external opening of the ductus bursae. It is directly attached to the segmental ridges, which are sometimes dorsally united by a hard chitinous band.

Colliculum represents the sclerites of the proximal part of the ductus bursae, often tubular or funicular, which forms a continuation of Ostium bursae.

Corpus bursae: Typically, this is a globular or ovoid structure lying in the abdominal cavity. Its walls are lightly sclerotized and bear sclerotized patches, spines etc., and is referred to as the signum.

Receptaculum seminis: From somewhere along the bursae or from the ductus bursae springs a narrow duct, the ductus seminalis that opens into a sac like structure, the receptaculum seminis.

1.5. Taxonomic key for segregating higher taxa

The family key adapted from Heppner (1998) with slight modifications is presented here.

Super Family Tineoidea

Vertex and frons dressed with erect scales; forewing with vein R4 usually terminating on costa or apex.

1. Forewing with basal fork of A_{1+2} long extremely long and,
prominent and A_{1+2+3} never present …….. Psychidae
2. Antenna filiform; maxillary palpus usually 5-segmented;
Fore wing with vein R_5 terminating on costa or apex…… Tineidae

Super Family Gelechioidea

Vertex and frons decorated with smooth scales; labial palpus
3 segmented and upturned, forewing with veins $R_4 + R_5$ stalked;
scaled haustella.

1. Hind wing somewhat quadrate, trapezoidal or broad, termen,
fringed with small cilia……....2
- Hind wing elongated, apically acute, termen fringed with long
cilia…….....5
2. Antenna less than ¾ th long of forewing; Hindwing with
vein R_1 and Sc united from base of wing of R_1 running in to Sc beyond
base of wing;……. Gelechiidae

- Antenna equal or longer than ¾ th length of forewing; hindwing not as above……3

3. Male genitalia with uncus thorn-shaped, slender, somewhat acute or narrowed at base than broader, bilobed apically…… Lecithoceridae

- Male genitalia with uncus not as above ……..4

4. Forewing without distinctive pattern of black spots on cream yellow or silver grey background; hindwing not as below; Male genitalia with gnathos broader basally, unarticulated, tapering to slender or rounded apex…….. Oecophoridae

- Forewing with distinctive pattern or black spots on cream yellow or silver grey background; hindwing yellow with black margin in some species; Male genitalia without Gnathos fused broadly with tegumen, shield like, apex with stout tooth like projection…… Ethmiidae

5. Hindwing with Rs and M1 separate; forewing without Pterostigma…….. Cosmopterigidae

- Hindwing with Rs and M1 separate; forewing with pterostigma present. Maxillary palpi 4 segmented……... Blastobasidae

Super Family Yponomeutoidea

Vertex and frons mostly covered with erect scales, sometimes erect; forewing with vein R_4 terminating on termen, pterostigma and chorda may be present or absent, M-stem cell usually vestigial or absent.

Key to families

1. Forewing usually elongated and narrow in relation to length; Forewing with pterostigma present; usually colourful moths often with spotted fore wings…… Attevidae

2. Vertex and frons beset with erect or sometimes semi-erect scales; hindwing not as above, vein M_1 and M_2 stalked……. Plutellidae

-Forewing usually elongated; Hindwing with apex somewhat emarginated; FW and HW usually with M_2 absent…….. Lecithoceridae

1.6. Current status of taxonomy of the group

In spite of high economic importance attached to this group, proper identity and nomenclature of several taxa belonging to this family are still shrouded with confusion and it is well known that classification that we follow today is far from satisfactory. Taxonomic segregation in this group of moths was based mainly on the wing venation, size and shape of palpi and frons for generic and general colouration and wing pattern for specific determination. No consideration was given for inter-generic and inter-specific variations or aberrations with the result that there have been too many synonyms.

Secondly, with recent advances in the taxonomic techniques, there has been a shift in the selection of characters for specific identification. More recently, emphasis is given to the morphological details of the external genitalia for understanding intrinsic variations between species and for breaking complex species groups.

The necessity for a revision of this group has been keenly felt all over the world for which extensive work has already been started in full earnest with rapid progress. There have been several instances of species transfers from one taxon to another. In addition to the transfer of species from one higher category to another, there have also been several transfers at lower taxonomic levels.

Different species of insects differ in their biology, their biotic associations, and survival values with regard to different eco-climatic conditions as well as susceptibility to their different pesticides. The establishment of the correct identity as well as the relative responses of the various species to the above mentioned different factors would therefore, be of tremendous importance in economic pest control.

In biological methods of pest control too, the establishment of the correct identity of the pest and the biological control agent used are of primary importance. A lack of preliminary survey and misidentification of species involved, may lead to wasted effort rendering evaluation of results difficult.

Since publication of the faunal treatise on Microheterocera fauna of India in the Exotic Microheterocera series by Meyrick from 1912 to 1936, no comprehensive study has been made on this group of moths from the Indian region. It was in this context that the present studies on the taxonomy of the Microheterocera of Kerala were undertaken.

2. REVIEW OF LITERATURE

2.1. Contributors on Microheterocera

Work on Microheterocera has started with the erection of genus *Tinea* by Linnaeus (1758). Subsequently, Hubner (1816, 1818, 1822) Duponchel (1838), Herrich-Schaffer (1853), Newman (1856), and Walker (1863, 1864) described several taxa and classified them. Common (1970) revised the taxonomy of this group. During the first half of the 19th century, considerable work have been accumulated on Microheterocera fauna of the world and among the workers of this period, special mention may be made of Hampson (1892) and Meyrick (1905, 1907, 1908a, 1908b, 1909, 1910, 1911). Workers in different countries are Turner (1913) from Australia, Bradley (1965), Walsingham (1881, 1891,) from Ethiopia; Chamber (1878), Keifer (1927-37) and Schaffner (1959) from the Nearctic; Walshingham (1892, 1897) from the Neotropical; Clarke (1965) and Zimmerman (1978) from the Oceanic; Diakonoff (1968), Fletcher (1909, 1920, 1933) and Robinson (1976, 1979, 1988) from the Oriental region have worked to straighten up the taxonomic tangle of the Microheterocera moths.

2.2. Microheterocera fauna of the world

Major contributions in the first half of the 20th century were by Meyrick (1912-1916, 1916-1923, 1923-1930, 1930-1936), Clarke (1941, 1955, 1963, 1965, 1969a, 1969b, 1971, 1976, 1986), Minet (1991), Robinson *et al*. (1994) and Heppner (1991, 1998). Walshingham (1897) published an account of 108 species of Microheterocera referable to 48 genera, out of which 17 belong to the family Gelechiidae, 12 Yponomeutidae, 9 Elastidae, 1 Aegiidae and the remaining Oecophoridae. Walshingham (1907) gave notes on 100 species belonging to 18 genera of the family Gelechiidae, 22 of Yponomeutidae, 3 of Blastobasidae and the remaining Oecophoridae. Butler (1883) described four species of Microheterocera from Karachi out of which two were named as new. During the later half of the 20th century, a lot of literature has been accumulated on the Microheterocera fauna of the world. Among these, special mention may be made of the works by Carter, Bradley, Gaden Robinson, Becker, Kyu-Tek Park, Sakamaki, Adamski, Brown, Davis, Hogue, Robinson and Tuck.

Gaede (1937) compiled a catalogue of about 5000 species referable to 482 genera of the family Gelechiidae from different parts of the globe. Clarke (1941) furnished an account of 117 species referable to 22 genera of family Oecophoridae from North America (18 new species). In a series of publications, Clarke (1955, 1965, 1969a, 1969b) selected the lectotype from Meyrick's collection of Microheterocera in BMNH, London and gave photograph of adults. As many as 900 species of Gelechiidae (Clarke, 1965, 1969a, 1969b) have been dealt within the 5th, 6th and 7th Volumes respectively. Common (1958) made studies on Australian moth fauna referable to the family Gelechiidae and revised the genus *Pectinophora* Busck with description of new species.

While reviewing Lecithoceridae of Taiwan, Park (1999) reported four species of *Homaloxestis* and 22 species of *Lecithocera*. Park and Ponomarenko (1999) reported several new species of the genus *Hypatima* Hubner. In addition to this, they reported six species belonging to the genus *Hypatima* and allied genera: *H. anguinea* (Meyrick), *H. iophana* (Meyrick), *H.arignota* (Meyrick), *H.haligramma* (Meyrick), *Faristenia polemica* (Meyrick), and *Dendrophilia hetaeropsis* (Meyrick), for the first time from Thailand. In the second part of review of the subfamily Lecithocerinae in Taiwan, Park (2000a) identified fourteen species belonging to *Lecithocera* Herrich-Schaffer, *Frisilia* Walker, *Lecitholaxa* Gozmany, *Spatulignatha* Gozmany, *Synersaga* Gozmany, *Carodista* Meyrick, *Dinochares* Meyrick, and *Tisis* Walker. Three new species, *Carodista montana sp. nov., C. cultrata sp. nov.*, and *Dinochares notolepis sp. nov*., were also described. In the course of study by Sakamaki (2000), two new species (*Apatetris elaeagnella* and *A. elymicola*) belonging to the family Gelechiidae were reported from Japan. While dealing with Lecithoceridae, Park (2002a) revised the genus *Nosphistica* with the synonimization of *Philoptila* Meyrick and descriptions of five new species- *N. acriella sp. nov.* and *N. undulata sp. nov*. from Thailand and *N. bisinuata sp. nov., N. fuscolepis sp. nov.*, and *N. tarokoensis sp. nov*. from Taiwan. Previously known species of *Philoptila* Meyrick were transferred to *Nosphistica* Meyrick: *N. metalychna* Meyrick, *comb. nov., N. effrenata* (Meyrick) *comb. nov*., and *N. fenestrata* Gozmany, *comb. nov*. *Athymoris praemecola* Wu was also transferred to *Nosphistica* Meyrick.

2.3. Progress of work on Indian Microheterocera

Moore (1867) has furnished a list of 1616 species of Microheterocera from Bengal, out of which, 35 species belonged to Tineines. While preparing an inventory of 274 species of moths from the Andaman and Nicobar Islands, Swinhoe (1885) listed 11 species of Tineidae from Bombay. Warren (1888) described two species: *Hapsifera seclusella* Walker and *Alovona barbarella* Walker from Western India. Hampson (1892) gave an account on 17 species referable to nine genera *viz*., *Clania* Walker, *Amatissa* Walker, *Acathopsyche* Heylaerts, *Mahasena* Moore, *Diabasis* Heylaerts, *Eurycyttarus* Hampson, *Dasaratha* Moore, *Psyche* Schrank and *Barandra* Moore of family Psychidae. Out of these, *Acanthopsyche himalayana* Moore and *Psyche fumate* Moore, *Psyche pileatus* Hampson and *Psyche nigra* Hampson were reported from Kashmir and *Mahasene hockingi* Moore from Kangra. Meyrick (1905) gave a brief account of two new species *Thiotricha orthiastis* and *Torodora xerastis* of the family Gelechiidae from Punjab. In (1907), he reported 20 new species from Northwest India. Meyrick (1908a) reported 27 species of Gelechiidae from Palani Hills, 28 Gracillarids from Khasi Hills, nine Elachistids from Khasi Hills, five Tineids from Khasi Hills and two Plutellidae from Northern Hills. In the same year, Meyrick (1908b) reported two new species of family Graciilaridae from (Calcutta). Meyrick (1909) also described nine new species of family Cosmopterigidae from Nilgiris. Robinson (1976) reported four species of *Tinissina* from Khasi Hills, Sikkim and Mysore. Robinson *et al*. (1994) compiled the smaller moths of South East Asia listing 647 species of Microlepidoptera.

On the basis of works by Meyrick (1905, 1907, 1908a, 1908b, 1909, 1910, 1911, 1912-1916, 1913, 1914, 1916-1923, 1923-1930, 1930-1936), Clarke (1965) and Park (1999, 2000a), Pathania and Rose (2003a) identified 9 species of Lecithocerinae belonging to the family Lecithoceridae based on a study of the male genitalic structures and wing venation.

Based on the works of Gaede (1937), Diakonoff (1952), Clarke (1965), Gozmany (1971, 1972, 1973), Park (1999, 2000b) and Park and Heppner (2000), *Torodora* complex was segregated into nine species *viz*., *Torodora parasema* (Meyrick) *comb. nov., T.*

neodeltospila sp. nov., T. ponomarenkoae sp.nov., T. fortis (Meyrick) *comb. nov.,T. nyctiphoron* (Meyrick) *comb. nov., T. neodeltospila sp. nov., T. ponomarenkoae sp. nov., T. pubesensovalvata sp. nov., T. fuscoptera sp. nov.* and *T. parafuscoptera sp. nov.* from North-west India (Rose and Pathania, 2003a). Besides key to the species, an illustrated account of the new species and genitalia of the already known species were represented. Other than wing venation, the congeneric status of these species has been established based on an evaluation of the male genitalic characters.

The genus *Hygroplasta* was represented by only two species i.e., *lygaea* Meyrick and *monodryas* Meyrick from India (Gaede, 1937; Clarke, 1965). During the course of survey on Lecithoceridae fauna of Himachal Pradesh and Uttaranchal, species belonging to the genus *Hygroplasta* Meyrick were collected (Pathania and Rose, 2004). Mehta (1978) described 37 species of Gelechiidae from Chandigarh and prepared an inventory (Pajni and Mehta, 1986). Bradley (1981) redescribed *Anarsia achrasella* Meyrick infesting flower buds and leaves of Sapodilla in North India. Bradley *et al.* (1973) reported a new species *Mompha ludwigiae* of the family Momphidae from Assam. While dealing with seven species of family the Scythrididae from India, Bengtsson (1995) furnished an account of three new species. A summary of species recorded from India and Sri Lanka is given in Appendix 1.

2.4. Microheterocera records from Kerala

Eventhough a good number of Microheterocera belonging to superfamilies Gelechioidea (2109); Tineoidea (1047); and Yponomeutoidea (184); are recorded from the Oriental region (Heppner, 1991), only 31 species have thus been recorded to occur in Kerala (Mathew, 2004). An inventory of species so far reported from this area is given in Table1.

Table 1. List of Microlepidoptera reported from Kerala

FAMILY/Species	DISTRIBUTION	SOURCE
GELECHIIDAE		
Anarsia epotias Meyrick	Kerala	Rai (1984)
Anthistarchia binocularis Meyrick	Kerala	Rai (1984)
Aproaerema modicella Devanter	Kerala	Nair (1978)
Brachmia convolvuli Walshingam	Amarambalam	Nair (1978); Roonwal (1956)
Hypatima haligramma Meyrick	Kerala	Rai (1984)
Desmophylex barymochla (Meyrick)	Amarambalam	Roonwal (1956)
Dichomeris petalodes (Meyrick)	Amarambalam	Roonwal (1956)
Gaesa biignella (Snellen)	Amarambalam	Roonwal (1956)
Gaesa decusella (Walker)	Amarambalam	Roonwal (1956)
Onebala lamprostoma Zeller	Kerala	Nair (1978)
Sitotroga cerealella Oliver	Kerala	Wang Haojie *et al.* (1998)
YPONOMEUTIDAE		
Aestherastis circulata Meyrick	Kerala	Nair (1978)
Atteva fabriciella Swederus	Kerala	Varma (1986, 1991)
Comocritis pieria Meyrick	Kerala	Nair (1978)
Ethmia hilarella (Walker)	Nilambur	Roonwal (1956)
PLUTELLIDAE		
Plutella maculipennis (Curtis)	Palakkad	Roonwal (1956)
Hilarographa caminodes Meyrick	Kerala	Nair (1978)
XYLORYCTIDAE		
Opisina arenosella Walker	Kerala	Mohammed (1977-80)
OECOPHORIDAE		
Aeolonthes dicraea (Meyrick)	Peechi	Mathew and Mohanadas

		(1989)
Psorosticha zizyphi (Stainton)	Amarambalam	Roonwal (1956)
Tonica laganopis (Meyrick)	Nilambur	Roonwal (1956)
Tonica niviferana Walker	Thrissur	KFRI (1999)
Comocritis pieria Meyrick	Kerala	Nair (1978)
Ethmia hilarella (Walker)	Nilambur	Roonwal (1956)
TINEIDAE		
Drimylastis telamonia (Meyrick)	Nilambur	Roonwal (1956)
Hapsifera rugosella (Stainton)	Palakkad	Roonwal (1956)
Setomorpha rutella (Zeller)	Kerala	Roonwal (1956)
Tinea pellionella (Linnaeus)	Kerala	Roonwal (1956)
COSMOPTERIGIDAE		
Cosmopteryx phaeogastra Meyrick	Kerala	Nair (1978)
Labdia molybdaula (Meyrick)	Nilambur	Roonwal (1956)
Limnaecia peronodes Meyrick	Silent Valley	Mathew *et al.* (1998)

3. MATERIALS AND METHODS

3.1. Study area

Kerala State, located between 8 ^{0} 4$^{/}$ and 12 ^{0} 48$^{/}$ N and 74 ^{0} 52$^{/}$ and 77 ^{0} 37$^{/}$ E is known for its rich biological resources on account of availability of a variety of ecological niches and habitats ranging from high forests, valleys, plains and coastal areas . Geographically, the State can be broadly divided into three zones *viz.*, highland (area lying above 75 m ASL); midland (area lying between 75 to 8 m ASL) and lowland comprising of areas situated below 8 m ASL. The highlands are formed by the Sahya Mountains of the Western Ghats along the eastern boundary, which are almost continuous except for a few gaps of varying width at certain locations. The Palakkad gap, which is the largest, has a width of 24-30 km. On its north are the Nilgiri Mountains and in the south are the Anamalais, which has the highest peak, Anamudi, situated at a height of 2695 m.

Kerala is bordered along its western side by the Arabian Sea. As a result, the State has a long shore area. This region, which constitutes the lowlands, is roughly about 10% of the total geographical area of the State. The population of lowlands is very high compared to the other areas. The area lying between the highland and the shoreline is the midland, which roughly constitutes about 42% of the total geographical area. The valleys of the hill ranges, which have an altitude ranging from 300-600 m ASL, belong to this. In the north, the Chaliyar River and the Nilambur valley separate the Kunda-Niligiri Mountains from Wayanad plateau located north to the Palakkad gap. Areas north to Palakkad gap belongs to Malabar comprising of the Districts Malappuram, Kozhikkode and Kannur. These areas are characterised by laterite belts, which are 10 to 60 m in altitude. South of Palakkad gap are the areas extending from Kochi to Thiruvanathapuram.

The climate of Kerala is generally tropical with high rainfall and humidity, which in turn supports a luxuriant flora and fauna. The important vegetation types of this region are the tropical rain forests, tropical moist deciduous forests, tropical dry deciduous forests, montane shola forests, riparian forests, forest plantations, grasslands as well as agro ecosystems comprising of paddy, banana, vegetables, plantation crops such as arecanut, coconut, rubber etc.

Out of the total area of 38863 km^2, 10336 km^2 are forests. Incidence of fire, invasion by weeds, indiscriminate lopping of trees for fodder and firewood, introduction of plantations of exotics, establishment of hydro-electric and irrigation projects, encroachment as well as cattle grazing are the major disturbances to the forest ecosystems in this region. The agro ecosystem is also subject to changes due to conversion of paddy fields, wetlands, shifting to modern agricultural practices, which involve frequent application of chemical fertilizers and pesticides, from the conventional cropping pattern. For the conservation and sustainable utilisation of biodiversity, data pertaining to local biota is very important. Because of the large variety of species and diversified roles, insects have great significance both ecologically and economically. Although several surveys have been made on insects found in various ecosystems in Kerala, data generated for several groups still remains to be compiled.

3.2. Collection and preservation of Microheterocera specimens

Microheterocera moths being positively phototropic are attracted towards light and these settle usually on the ceiling, walls or other objects near the light. These could be easily collected in a tube directly. Collection using light traps was found to be unsatisfactory for Microlepidoptera due to trampling of small moths by larger insects. Moreover, Microlepidoptera generally flutter around the lamp and tend to remain on the outer surface of the trap rather than falling inside the collecting chamber. Based on these observations, it was found that the best method of collecting Microlepidoptera was to attract them at night to an illuminated vertical white sheet. For this, a sheet measuring 70 cm x 55 cm was fixed in such a way that the bottom touches the ground where it was anchored with stones. An 18-watt CFL (Compact Fluorescent Lamp) powered by a 12-

watt car battery was used as the light source. Microheterocera, found resting over the white sheet were collected and freezed in a chiller for about 12 to 14 hrs. The material were then sorted out and tentatively identified to the species level by comparison with identified material in the reference insect collection or processed for determination with the help of literature.

3.3. Processing and preparation of slide mounts

Hampson's classification of these moths was based mainly upon the details of the wing venation. Subsequent workers have used other morphological characteristics as well. Hence, for wing venation, leg, antennal and genitalial structure etc. regular processing and preparation of definite part mounts were found quite necessary. Special slide preparations of the wings to show the outlay of the veins were prepared. The wings from one side of the moth studied were carefully detached by means of a micro needle. The detached wings were placed in a watch glass containing a little alcohol (50%), acetic acid, or even water. It was then gently pressed for the removal of scales with a paper pencil made by tightly rolling a piece of paper. After descaling, the wings were mounted on slide.

For a study of the details of the head, antenna, legs and genetalia, a modified technique was employed. The materials to be mounted was detached by means of micro needle and dropped in to the watch glass containing acetic acid. From this it was transferred to the test tube containing the small quantity of about 10% potassium hydroxide (KOH) and gently boiled over a spirit lamp flame. The heating time depends on the sclerotization of the parts. When the material looked clear enough in transmitted light the boiling was stopped. When cooled, the KOH with the material boiled in it was removed into a watch glass. The material was then gently sponged with the tip of a paper pencil and the scale removed. Clearing and extrusion of the genital armatures was accomplished with the help of paper pencils. It was then transferred to water or acetic acid, stained with acid fuschin treated with carbol-xylol, and mounted in Canada balsam. In the case of the genetalia, the tip of the abdomen was cut, and boiled in the KOH. Illustrations of slide mounts were made with use of a camera lucida fitted to a Stereomicroscope.

4. RESULTS

4.1. Records of Microheterocera of Kerala

Intensive survey of Microheterocera was conducted in different parts of Kerala. Major locations covered included Silent Valley, Mannarkkad, Mukkali, Muthanga, Sultan Bathery, Amarambalam, Meenmutty, Vellimuttam, Nilambur, Peechi, Vazhani, Sholayar, Thekkady, Rajamalai, Ranni, Thenmala, Arienkavu, Rosemala, Kattlapara, Achenkovil, Neyyar and Peppara. Altogether, 67 species of Microheterocera belonging to Psychidae, Tineidae, Oecophoridae, Lecithoceridae, Gelechiidae, Blastobasidae, Cosmopterygidae, Plutellidae, Yponomeutidae, Attevidae, Lyonetiidae, Ethimidae, Glyphipterigidae and Heliodinidae have been recorded (Table 2).

Table 2. Summary of Microlepidoptera recorded in this study

Family	**No. of genera recorded**	**No. of species recorded**
Psychidae	4	4
Tineidae	7	15
Oecophoridae	7	9
Ethmdae	1	1
Lecithoceridae	3	6
Gelechiidae	8	13
Blastobasidae	3	5
Cosmopterygidae	5	8
Glyphipterygidae	1	1
Plutellidae	1	1
Yponomeutidae	1	1
Attevidae	1	1
Lyonetidae	1	1
Heliodinidae	1	1
Total	**40**	**67**

4.2. Details of moths collected in this study

Data pertaining to moths recorded in this study are given below under their respective families.

Superfamily: Tineoidea

Family: Psychidae

Subfamily Psychinae

1. *Brachycyttarus subteralbata* Hampson

Hampson 1892, *The Fauna of British India including Ceylon and Burma*- Moths Vol. I, (ed.) Blanford, W.T., Published by Taylor and Francis, London, p. 296.

Collection data: Arienkavu; April, 2001 (1 ex.)

Distribution: All over Kerala.

Host: Unknown.

Remarks: Adults were collected at light.

2. *Eumeta crameri* Westwood (Plate A, Fig. 1)

Clania crameri Hampson, 1892, *The Fauna of British India including Ceylon and Burma*- Moths Vol.I, (ed.) Blanford, W.T., Published by Taylor and Francis, London, p. 291.

Collection data: Arienkavu; April, 2001 (1 ex.).

Distribution: All over Kerala.

Host: Unknown.

Remarks: Adults were collected at light.

3. *Metisa plana* Walker

A field guide to smaller moths of South East Asia. Malaysian Nature Society, Malaysia. 1994: 38.

Collection data: Rosemala; March, 2001 (2 ex.).

Distribution: All over Kerala.

Host: Oil palm.

Remarks: Serious pest in plantations of oil palm.

4. Pteroma plagiophleps Hampson. (Plate A, Fig. 2)

Hampson, 1892, *The Fauna of British India including Ceylon and Burma- Moths* Vol.I, (ed.) Blanford, W.T., Published by Taylor and Francis, London, p. 296.

Collection data: Peechi; November, 2002 (2 ex.).

Distribution: All over Kerala.

Hosts: *Casuarina equestifolia*

Remarks: Occasionally serious pest.

Family: Tineidae

Subfamily Perissomastictinae

5. Edosa glossoptera Rose and Pathania (Plate A, Fig.3)

Rose and Pathania, 2003, *Uttar Pradesh J. Zool.* 23 (3): 201-211.

Collection data: Peechi; November, 2003 (2 ex.).

Distribution: Himachal Pradesh.

Host: Unknown.

Remarks: New record for South India and new allotype to science. Male genitalia of this species have been described.

6. Edosa opsigona Meyrick (Plate A, Fig. 4)

Tinea opsigona Meyrick, 1911. *J. Bombay Nat. Hist. Soc.* 21: 213.

Collection data: Peechi; November, 2003 (2 ex.).

Distribution: N. Coorg, Ceylon

Host: Unknown

Remarks: First report from Kerala.

Subfamily Tineinae

7. Monopis monachella Hubner (Plate A, Fig-5)

Hubner, *Life histories of Indian Insects, Microlepidoptera. Mem. Dep. Agric., India.* Vol. VI, No. 1: 194.

Collection data: Nelliyampathy; October 2002 (2 ex.).

Distribution: Northern Himalayas.

Host: Collected from Tiger scat.

Remarks: New record for Southern India.

8. *Monopis* sp. 1

Collection data: Wayanad, Jul. 2002 (2 ex.).

Distribution: Sri Lanka

Host: Collected from Tiger scat.

Remarks: New record for Southern India.

9. *Monopis* sp. 2

Collection data: Wayanad, Jul 2002 (2 ex.).

Distribution: Sri Lanka

Host: Collected from Tiger scat.

Remarks: New record for India.

10. *Tinea ixitis* Meyrick

Meyrick,1894, *Trans. Ent. Soc. London,* 1894: 27.

Collection data: Peechi; November 2003 (2 ex.).

Distribution: Bengal, Pusa

Host: Unknown

Remarks: New record for Southern India.

11. *Tinea pellionella* Linnaeus (Plate A, Fig. 6)

Linnaeus, 1758, *Syst. Nat.* (edn. 10) 1: 536.

Collection data: Peechi; November, 2003 (2 ex.).

Distribution: Nilgiri Hills, N. Coorg, Ceylon.

Host: Unknown.

Remarks: Household pest, larva feeding on fur, feather, carpets, woolens etc.

12. *Tinea platyntis* Meyrick. (Plate A, Fig. 7)

Meyrick,1894, *Trans. Ent. Soc. London,* 1894: 28.

Collection data: Wayanad, Jan 2002 (2 ex.).

Distribution: Northern Himalayas

Host: Unknown

Remarks: New record for Southern India.

13. *Tinea synaema* Meyrick (Plate A, Fig. 8)

Meyrick, 1905, J. *Bombay. Nat. Hist. Soc.* 16: 617.

Collection data: Peechi, November 2003 (4 ex.); Rosemala, Feb 2002 (2 ex.).

Distribution: Northern Himalayas.

Host: Unknown.

Remarks: New record for Southern India.

Subfamily Setomorphinae

14. *Setomorpha rutella* Zeller (Plate A, Fig. 9)

Zeller, *A field guide to smaller moths of South East Asia. Malaysian Nature Society, Malaysia.* 1994: 38.

Collection data: Parambikulam; Rosemala 2002 (5 ex.).

Distribution: Pantropical: Brunei, Java, Malaysia, India. Distributed in lowland.

Host: Larva reported to feed on a wide range of detritus and stored products such as dry tobacco leaves, stored coriander seeds, wheat flour, etc.

Remarks: Pest of stored food products. This species is characterized by its head-scales broader than other Tineidae. Of the three species of *Setomorpha*, only *S. rutella* occurs in S.E. Asia.

Subfamily Erechthiinae

15. *Erechthias platydelta* Meyrick

Meyrick, 1907, *Journ. Bombay. Nat. Hist. Soc*. 17: 751.

Collection data: Achenkovil, May 2002 (2 ex.); Rosemala, June 2002.

Distribution: A widely distributed species recorded from Ceylon.

Host: Unknown

Remarks: Moths collected from light trap. New record for southern India.

Subfamily Hieroxestinae

16. *Opogona lamprocrossa* Meyrick (Plate B, Fig. 1)

Meyrick, 1914, *Supplementa Entomologica,* No. 3, p. 59.

Collection data: Mukkali, Dec., 2000 (2 ex.).

Distribution: Sri Lanka; Orissa and Pusa.

Host: Unknown.

Remarks: Moths collected from light trap. New record for southern India.

17. *Opogona xanthocrita* Meyrick (Plate B, Fig. 2)

Meyrick, 1911, *Journ. Bombay. Nat. Hist. Soc.* 21: 111.

Collection data: Silent valley; Dec., 2000 (2 ex.).

Distribution: Pusa

Host: Bred from dead wood.

Remarks: New record for Southern India.

18. *Opogona* sp.

Collection data: Silent valley; Dec., 2000 (2 ex.).

Distribution: Northern India

Host: Unknown.

Remarks: New record for southern India.

19. *Pyloetis mimosae* Meyrick. (Plate B, Fig. 3)

Meyrick, 1916, *Journ. Bombay Nat. Hist. Soc.* 16: 224.

Collection data: Muthanga, March 2001 (2 ex.).

Distribution: Distributed in most of the northern States and in Karnataka.

Host: Unknown

Remarks: New record for Kerala.

Superfamily: Gelechioidea

Family: Oecophoridae

Subfamily Xyloryctinae

20. *Nephantis serinopa* Meyrick

Meyrick, 1905, *Journ. Bombay. Nat. Hist. Soc.* 16: 603.

Collection data: Mannarkkad, Dec., 2000 (2 ex.).

Distribution: Batticaloa, Sri Lanka

Host: Unknown

Remarks: Pest of coconut.

Subfamily Statmopodinae

21. *Stathmopoda balanarcha* Meyrick (Plate B, Fig. 4)

Meyrick, 1921, *Exotic Microlepidoptera*. 2: 416.

Collection data: Peechi; November, 2003 (2 ex.).

Distribution: Himachal Pradesh

Host: Unknown

Remarks: New record for Southern India.

22. *Stathmopoda theoris* Meyrick (Plate B, Fig. 5)

Meyrick, 1906, *Journ. Bombay. Nat. Hist. Soc.* 17: 410.

Collection data: Peppara, March 2002 (2 ex.).

Distribution: Eastern Himalayas

Host: Larva reported to feed on flower heads of sun flower (*Helianthus*), cholam ear heads and from refuse.

Remarks: New record for Southern India.

Subfamily Oecophorinae

23. *Eucleodora coronis* Meyrick (Plate. B, Fig. 6)

Meyrick, 1914, *Exotic Microlepidoptera*. 1: 258.

Collection data: Punalur, November 2002 (3 ex.)

Distribution: Assam, Khasis

Host: Unknown.

Remarks: New record for Southern India.

24. *Periacma plumbea* Meyrick. (Plate B, Fig. 7)

Meyrick, 1919, *Exotic Microlepidoptera*. 2: 238.

Collection data: Kattlapara (Kollam District); Feb., 2002 (3 ex.)

Distribution: Kumaon, Bhim Tal

Host: Unknown

Remarks: New record for Southern India. It is mentioned that this species was collected at 5000-6000 feet, (Meyrick 1916-1923) but during this survey, this species was collected from Moist Deciduous Forest at 100 –300 m altitude.

25. *Promalactis semantris* Meyrick (Plate B, Fig. 8)

Meyrick, 1906, *Journ. Bombay. Nat. Hist. Soc.* 17: 409.

Collection data: Kattlapara; Feb, 2002 (3 ex.).

Distribution: Punjab and Rajasthan.

Host: Bred out from *Shorea robusta* and *Eugenia jambolana.*

Remarks: New record for Southern India.

26. *Promalactis thiasitis* Meyrick

Meyrick, 1908, *Journ. Bombay. Nat. Hist. Soc.* 18: 807.

Collection data: Muthanga, October 2001 (2 ex.).

Distribution: Bihar, Orissa, U.P.

Host: Sal (*Shorea robusta*), *Eugenia jambolana*

Remarks: New record for Southern India.

27. *Tonica niveferana* Walker (Plate B, Fig. 9)

Walker, *Life histories of Indian Insects, Microlepidoptera. Mem. Dep. Agric., India.* Vol. VI, No. 1: 106.

Collection data: Peechi, April- June 2001 (2 ex.); Rosemala, July 2001 (1 ex.).

Distribution: Recorded in northern and southern parts of India.

Host: Larva bores in the stem of *Bombax malabaricum.*

Remarks: Only female specimens could be collected.

Subfamily Hypertrophinae

28. *Eupselia isacta* Meyrick (Plate C, Fig. 1)

Meyrick, 1910, *Journ. Bombay Nat. Hist. Soc.* 20: 154.

Collection data: Peppara, Feb., 2002 (2 ex.).

Distribution: Bihar and Orissa

Host: Unknown

Remarks: New record for Southern India.

Family: Ethmidae

Subfamily Ethmiinae

29. *Ethmia acontias* Meyrick (Plate C, Fig. 2)

Meyrick, 1906, *Journ. Bombay. Nat. Hist. Soc.* 17: 409.

Collection data: Achenkovil, May 2002 (2 ex.); Rosemala, June 2002.

Distribution: Sri Lanka.

Host: Bred from *Cynoglossum lanceolatum*.

Remarks: New record for Southern India.

Family: Lecithoceridae

Subfamily Lecithocerinae

30. *Timyra pastas* Meyrick (Plate C, Fig. 3)

Meyrick, 1908, *Journ. Bombay. Nat. Hist. Soc.* 18: 448.

Collection data: Peechi, November 2001 (6 ex.); Thenmala, Aug., 2002 (5 ex.).

Distribution: Northern India.

Host: Unknown.

Remarks: New record for Southern India.

31. *Timyra xanthaula* Meyrick (Plate C, Fig. 4)

Meyrick, 1908, *Journ. Bombay. Nat. Hist. Soc.* 18: 444.

Collection data: Peechi, May and November 2001 (2 ex.); Ranni, June and July 2002 (4 ex.).

Distribution: Northern India

Host: Unknown

Remarks: Collections were made only from moist deciduous forest (Rosemala and Peechi only). New record for Southern India.

32. *Lecithocera* sp.

Distribution: Wayanad, Peechi

Host: Unknown

Remarks: Probably a new species.

Subfamily Torodorinae

33. *Hygroplasta lygaea* Meyrick (Plate C, Fig. 5)

Meyrick, *Pachnistis lygaea* Meyrick, 1911, *Journ. Bombay. Nat. Hist. Soc.* 20: 707.

Collection data: Peechi, April 2002 (2 ex.)

Distribution: Dalhousi, Kashmir, Himachal Pradesh, Uttaranchal

Host: Unknown

Remarks: New record for Southern India.

34. *Hygroplasta spoliatella* Walker (Plate C, Fig. 6)

Walker, *Gelechia spoliatella* Walker, 1864, *List Specimens lepid. Insects Colln.* Br. Mus., 29: 659.

Collection data: Nilambur, October, 2001 (2 ex.).

Distribution: Himachal Pradesh from India.

Host: Unknown.

Remarks: New record for Southern India.

35. *Hygroplasta* sp.

Collection data: Neyyar, March 2002 (1ex.).

Distribution: North India.

Host: Unknown.

Remarks: Only one specimen was collected during the study. New record for South India.

Family: Gelechiidae

Subfamily: Gelechiinae

36. *Anarsia patulella* Meyrick

Meyrick, *Gelechia patulella* Walker, 1864, List Specimens lepid. Insects Colln. *Br. Mus.*, 29, p. 635.

Collection data: Peechi; Sep., 2004 (2 ex.).

Distribution: India, Sri Lanka, Taiwan

Host: Unknown

Remarks: New record for Kerala.

37. *Anarsia isogama* Meyrick

Meyrick, 1913, *Journ. Bombay. Nat. Hist. Soc.* 22: Meyrick, 1925: 153; Caradja and Meyrick, 1935: 69; Gaede, 1937: 402; Clarke, 1969: (6) 245, f. 4.

Collection data: Peechi; April 2003 (2 ex.).

Distribution: India, Sri Lanka, Taiwan, Japan

Host: Unknown.

Remarks: New record for Kerala.

38. *Anarsia* sp. (Plate C, Fig. 7)

Collection data: Peechi; April 2003 (2 ex.).

Distribution: North India, Sri Lanka, Taiwan

Host: Unknown

Remarks: New record for Southern India.

39. *Hypatima haligramma* Meyrick

Chelaria haligramma 1926, *Exotic Microlepidoptera*, 3: 282.

Collection data: Peechi; Sep., 2003 (2 ex.).

Distribution: Northern India

Host: *Mangifera indica.*

Remarks: New record for Southern India.

40. *Sitotroga cerealella* Olivier, Clerck (Plate C, Fig. 8)

Olivier, C. 1969, Catalogue of type specimens of Microlepidoptera *in Br. Nat. Hist. Mus.* 5: 375.

Collection data: Neyyar, March 2002 (1 ex.).

Distribution: Pantropical and subtropical.

Host: Larvae of *Sitotraga cerealella* feed on stored grain (rice, maize, etc). It is a sporadically major pest.

Remarks: Adults collected from light trap. *Sitotroga* contains three more species, from the old world tropics and subtropics.

Subfamily Dichomeridinae

41. *Dichomeris evidantis* Meyrick (Plate C, Fig. 9)

Meyrick, 1969, Catalogue of type specimens of Microlepidoptera in *Br. Nat. Hist. Mus.* 5: 20.

Collection data: Peechi; Sep., 2003 (2 ex.).

Distribution: Bihar and Orissa.

Host: The larva rolls the green leaves of *Dalbergia sisso.*

Remarks: In view of the above distribution mentioned, this species is a new record for Southern India.

42. *Dichomeris ianthes* Meyrick (Plate D, Fig. 1)

Meyrick, 1887, *Trans. Ent. Soc. London,* 1887: 273

Collection data: Peechi; Sep, 2003 (2 ex.).

Distribution: Northern India

Host: Feeds on Medicago, Cyamopsis and Indigo.

Remarks: New record to Southern India.

43. *Dichomeris* sp.

Collection data: Rosemala, May, 2003 (2 ex.).

Distribution: Eastern Himalayas

Host: Unknown

Remarks: New record for Southern India.

Subfamily Anacampsinae

44. *Fresilia* sp. (Plate D, Fig. 2)

Collection data: Muthanga; March, 2001 (2 ex.).

Distribution: Wyanad (Kerala)

Host: Unknown.

Remarks: Probably a new species.

45. *Idiophantis acanthopa* Meyrick (Plate D, Fig. 3)

Meyrick, 1916, *Exotic Microlepidoptera*, 1: 566

Collection data: Peppara, April 2002, (2 ex.).

Distribution: Himachal Pradesh

Host: Unknown.

Remarks: New record for Southern India.

46. *Onebala hibisci* Stainton. (Plate D, Fig. 4)

Stainton, *A field guide to smaller moths of South East Asia.* Malaysian Nature Society, Malaysia, 309.

Collection data: Achenkovil, Aug, 2002, (2 ex.).

Distribution: Pusa

Host: Unknown

Remarks: New report for Southern India.

47. *Onebala hoplophora* Meyrick, Clerck (Plate D, Fig. 5)

Meyrick,Clerk, 1969, Catalogue of type specimens of Microlepidoptera in *Br. Nat. Hist. Mus.* 5: 264.

Collection data: Vellimuttam, March, 2001 (1 ex.).

Distribution: Eastern Himalayas, Punjab, Sikkim.

Host: Unknown.

Remarks: New record for Southern India.

48. *Stegasta* sp. (Plate D, Fig. 6)

Collection data: Amarambalam; May 2001 (3 ex.).

Distribution: Oriental region.

Host: Unknown.

Remarks: New record for Kerala.

Family: Blastobasidae

Subfamily Symmocinae

49. *Symmoca signetella* Meyrick (Plate D, Fig.7)

Meyrick, 1968. *The genitalia of the Tineid families of British Islands,* 1968:23.

Collection data: Meenmutty; May 2001 (2 ex.).

Distribution: Bihar, Orissa, Punjab.

Host: Unknown.

Remarks: New record for Western Ghats.

50. *Symmoca* sp. (Plate D, Fig.8)

Collection data: Meenmutty; May 2001 (2 ex.).

Distribution: Collected from Meenmutty (Kerala).

Host: Unknown

Remarks: Probably a new species.

Subfamily Blastobasinae

51. *Blastobasis pulverea* Meyrick (Plate D, Fig. 9)

Meyrick, 1907, *Journ. Bombay Nat. Hist. Soc.* 20: 154.

Collection data: Mannarkkad; Dec., 2000 (2 ex.).

Distribution: Eastern Himalayas.

Host: Unknown.

Remarks: The family and species are new records for Southern India.

52. *Blastobasis* sp. (Plate E, Fig. 1)

Collection data: Mukkalli; Dec., 2000 (2 ex.).

Distribution: Eastern Himalayas.

Host: Unknown.

Remarks: New record for Southern India.

53. *Cladobrostis* sp.

Collection data: Meenmutty: June, 2001 (2 ex.).

Distribution: Eastern Himalayas

Host: Unknown.

Remarks: New report for Southern India.

Family: Cosmopterigidae

Subfamily: Cosmopteriginae

54. *Cosmopterix mimetis* Meyrick (Plate E, Fig. 2)

Meyrick, 1897, *Proc. Linnean Soc. N.S. Wales*, 22: 339.

Collection data: Peppara; March, 2002 (3 ex.).

Distribution: Sri Lanka, Pusa.

Host: Casuarina

Remarks: New record from Southern India.

55. *Labdia semicoccinea* Stainton (Plate E, Fig. 3)

Stainton, *Life histories of Indian Insects, Microlepidoptera*. *Mem. Dep. Agric., India*. Vol. VI, No. 1: 100.

Collection data: Neyyar; Aug, 2002 (2 ex.).

Distribution: Calcutta, Pusa, Shevaroys and Pollibetta (South Coorg).

Host: Reared from the stems of *Cajanus indicus.*

Remarks: New record for Kerala.

56. *Labdia stibogramma* Meyrick (Plate E, Fig. 4)

Meyrick, *A field guide to smaller moths of South East Asia. Malaysian Nature Society, Malaysia*. 1994: 70.

Collection data: Thekkady, Feb 2003 (1 ex.).

Distribution: Lowland of Thailand and W. Malaysia.

Host: Larva is generalized feeders on plant detritus.

Remarks: *Labdia* contains about 160 described species, mostly from the indo-Australian region and with a handful of afrotropical species. This species is a new record for India.

57. *Labdia xylinaula* Meyrick

Meyrick, 1935, *Exotic Microlepidoptera*, 4: 605.

Collection data: Achenkovil; Aug., 2002 (2 ex.)

Distribution: Orissa, Puri

Host: Larva mines in the leafless pendent shoots of *Casuarina*.

Remarks: New record for Southern India.

58. *Limnaecia chromaturga* Meyrick (Plate E, Fig. 5)

Meyrick, *A field guide to smaller moths of South East Asia. Malaysian Nature Society, Malaysia*. 1994:71.

Collection data: Muthanga; Jan., 2001 (2 ex.).

Distribution: Sri Lanka, W. Malaysia. Hill forest to lower montane forest.

Remarks: New record for Southern India. There are over hundred named species, mostly from the Indo-Australian region.

59. *Limnaecia peronodes* Meyrick. (Plate E, Fig. 6)

Meyrick, 1915, *Exotic Microlepidoptera.* 1: 318.

Collection data: Vazhani; Nov., 2003 (2 ex.)

Distribution: Bengal, Pusa

Host: Bred from larvae feeding in leaf sheaths of bamboo.

Remarks: Larva is fruit borer of *Carya arboria* collected from Vazhani. New record for Southern India.

Subfamily: Chrysopeleiinae

60. *Eumenodora tetrachorda* Meyrick

Meyrick, 1924, *Exotic Microlepidoptera,* 3: 91.

Collection data: Meenmutty; Jan., 2002 (2 ex.)

Distribution: Bihar and Orissa

Host: *Casuarina equistifolia* needles

Remarks: New record for Southern India.

61. *Stagmatophora faceta* Meyrick

Meyrick, 1917, *Exotic Microlepidoptera,* 2: 38.

Collection data: Meenmutty; May 2001 (2 ex.)

Distribution: Eastern Himalayas

Host: Casuarina

Remarks: New record for Southern India.

Superfamily: Yponomeutoidea

Family: Glyphipterigidae

62. *Phycodes minor* Moore (Plate E, Fig. 7)

Moore, Life histories of Indian Insects, Microlepidoptera. *Mem. Dep. Agric., India.* Vol. VI, No. 1: 123.

Collection data: Achenkovil; Aug., 2002 (2 ex.)

Distribution: N.W. India, Sri Lanka, Java.

Host: Larva reared from *Ficus carica, F. heterophylla*.

Remarks: New record for Southern India.

Family: Plutellidae

Subfamily: Plutellinae

63. *Plutella xylostella* Linnaeus (Plate E, Fig. 8)

Linnaeus, 1758, *Syst. Nat* (Edn. 10) 1: 538.

Collection data: Peechi; Aug., 2002 (3 ex.)

Distribution: India, Myanmar and Sri Lanka.

Host: Pest of cabbage, cauliflower, radish, mustard and other cruciferous plants.

Remarks: It is characterized by the series of pale diamond-shaped marking on its back when the moth is at rest.

Family: Yponomeutidae

Subfamily: Argyesthiinae

64. *Argyresthia* sp. (Plate E, Fig. 9)

Collection data: Vazhani and Sholayar, July 2003.

Distribution: Northern India

Host: Unknown

Remarks: New record to Southern India. Adult collected from moist deciduous forest habitat.

Family: Attevidae

65. *Atteva fabriciella* Swederus (Plate F, Fig. 1)

Swederus, *A field guide to smaller moths of South East Asia.* Malaysian Nature Society, Malaysia. 1994: 48.

Collection data: Peechi; April- Jun., 2002 (3ex.); Rosemala; July, 2003 (5 ex.).

Distribution: Kerala, Tamilnadu, Karnataka

Host: *Ailanthus exclesa*

Remarks: This species is monogeneric to the family Attevidae.

Family: Lyonetiidae

Subfamily: Cemiostominae

66. *Leucoptera sphenograpta* Meyrick (Plate F, Fig. 2)

Meyrick, 1911, *Journ. Bombay. Nat. Hist. Soc.* 21: 108.

Collection data: Sultan Bathery, Dec. 2000 (2 ex.)

Distribution: Eastern Himalayas

Host: Larva mining blotches in the leaves of *Dalbergia sisso.*

Remarks: New report for South India

Family: Heliodinidae

67. *Eretmocera* sp. (Plate F, Fig. 3)

Collection data: Rajamalai and Thekkady, Feb., 2003 (1 ex.).

Distribution: North India, Sri Lanka, Thailand, W. Malaysia.

Host: Unknown.

Remarks: New record for South India. *Eretmocera* currently contain 40 species, most from the afrotropical region, the reminder from the Indo-Australian region.

4.3. Genetalial Morphology of Microheterocera

The morphological details of external genitalia of moths recorded in this study were carried out with a view to generate charctaers that might be helpful in species identification. Descriptions of external genitalia of species belonging to various families are given below.

Superfamily: Tineoidea

Family: Psychidae

Subfamily: Psychinae

1. ***Brachycyttarus subteralbata* Hampson** (Plate XIII, Fig. 1)

Alar expanse: 13-15 mm.

Male genitalia: Saccus basally broad and distally produced into a handle-shaped process; valvae elongate, narrow, more or less of uniform breadth throughout with the apical part slightly narrow and fringed with short hairs; uncus broad, tongue-shaped, slightly cleft in the middle; aedeagus long rod-shaped, with the apex cleft forming two lobes.

2. *Metisa plana* Walker (Plate XIII, Fig. 2)

Alar expanse: 13 mm.

Male genitalia: Uncus roughly arch-shaped; socii absent; saccus basally broad, expanded into two arms that are distally prolonged into a handle-shaped process; vinculum long and Y-shaped; transtilla small with a median connective; sacculus arched, harpe curved and narrow at the apex, valvae short, narrow basally and elongated along the inner margin into a flap-like lobe, apical portion fringed with short stiff spines; a sub apical,

Fig. 1

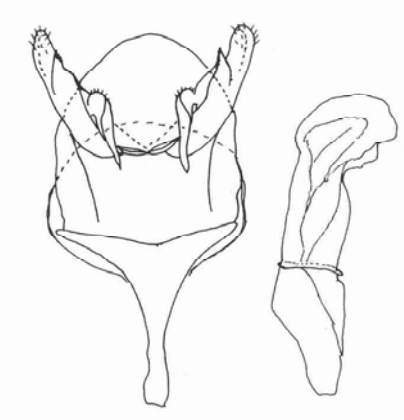


Fig. 2

Plate XIII. Male genitalia of Microheterocera

Fig. 1. *Brachycyttarus subteralbata* Hampson (Psychidae)

Fig. 2. *Metisa plana* Walker (Psychidae)

conical, pointed lobe near the apex; aedeagus long, hook-like at the apex, which bends and tapers towards the end; vesica with a distinct cornutus.

3. *Pteroma plagiophleps* Hampson (Plate XIV, Fig. 1)

Alar expanse: 10-11 mm.

Male genitalia: Uncus indent, bilobed, with a few short spines; socii absent; valvae short, narrow, of more or less uniform breadth, apically narrowed and ending in a blunt apex; a distinct harpe arising from 1/3rd distance from the apex on the outer margin; vinculum narrow and elongated; saccus massive, U-shaped; phallus short, tubular with the apex expanded into an irregular lobe.

Family: Tineidae

Subfamily Perissomastictinae

1. *Edosa glossoptera* Rose and Pathania (Plate XIV: Fig. 2; Plate XV: Fig. 1)

Alar expanse: 20-21 mm.

Male genitalia: Uncus long, broader apically, bifid in shape, sparsely spinose at the apex, dilated in the middle; socii absent; gnathos absent; tegumen small and broad; vinculum forms a sclerotized, moderately large cylinder, more or less emarginated ventrally; saccus is low; juxta small, cap-like, fused with tegumen, weakly sclerotized; valvae long, narrow and apically curved; costal margin almost straight having moderately long hairs, saccular margin slightly convex with small hook-shaped processes directed towards juxta at the base, cucullus convex dorsally, apex pointed, concave ventrally and hairy; aedeagus longer than valvae, stout, broad at the base, dilated near middle, slightly bent at about 2/3rd distance from base, apex rounded; vesica lacking.

Female genitalia**:** Ovipositor long, thin, with hairs all around; anterior apophyses about 2/3 length of posterior apophyses; ostium bursae broad, centrally placed; ductus bursae long and thin, almost straight, broader near corpus bursae; corpus bursae ovate in shape, simple; signum long and coiled.

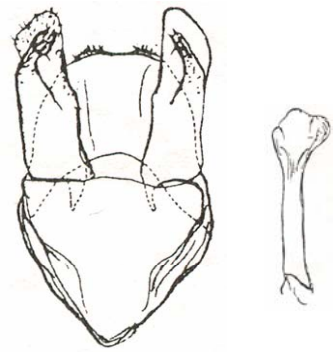


Fig. 1

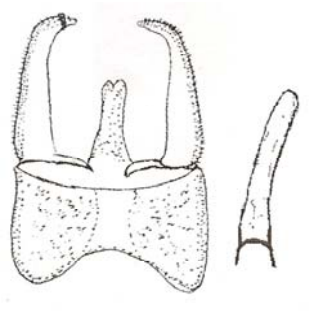


Fig. 2

Plate XIV. Male genitalia of Microheterocera

Fig. 1. *Pteroma plagiophleps* Hampson (Psychidae)

Fig. 2. *Edosa glossoptera* Rose and Pathania (Tineidae)

2. *Edosa opsigona* Meyrick (Plate XVI: Fig. 1)

Alar expanse: 22-23 mm.

Male genitalia: Uncus long, bifid apically, broader at middle, apex pointed; socii and gnathos lacking; tegumen small and broad; vinculum forms a moderately sclerotized, large cylinder, more or less emarginated ventrally; saccus low; juxta small, somewhat cap-like, fused with the tegumen, strongly sclerotized; valvae, elongated and broad, densely setose on the inner surface, costal margin slightly concave, saccular margin almost straight, with a moderately long, hook-like process at the base directed inwards; cucullus with long hairs ventrally, concave dorsally, apex pointed; aedeagus long, almost equal to the length of valvae, broader at middle and dilated, basally broad, apically narrowed with a rounded apex; cornuti absent in vesica

.

Subfamily Tineinae

3. *Monopis monachella* Hubner (Plate XV: Fig. 2; Plate XVI: Fig. 2)

Alar expanse: 18-19 mm.

Male genitalia: Uncus pointed, narrow with striation of hairs; valvae of rather variable shape, flap-like with patches of sparse hairs; saccus long, of the same length of aedeagus; aedeagus having long tube-like processes and with many spined cornuti.

Female genitalia: Ovipositor extremely short with small spines; anterior apophyses about 1/3rd length of posterior apophyses; ostium indent above and dilated towards corpus bursae; corpus bursae membranous, oval; signum large, having spines and shows serration

4. *Tinea pellionella* Linnaeus (PlateXVI I: Fig. 1; Plate XVIII: Fig. 1)

Alar expanse: 10 mm.

Male genitalia: Uncus tongue-shaped, bearing rows of short, stiff hairs, gnathos upturned toward the uncus; saccus elongate, narrow, pointed at the posterior end; valvae leaf-shaped, broad at the apex bearing a tuft of median hairs; costa gently curved; aedeagus rod-shaped, longer than saccus.

Female genitalia: Ovipositor short and conical; apophyses relatively long, the anterior ones being about 2/3rd the length of posterior apophyses; ostium bursa short and extend

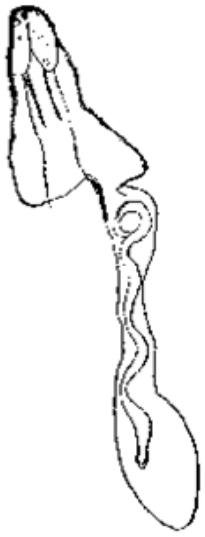


Fig. 1

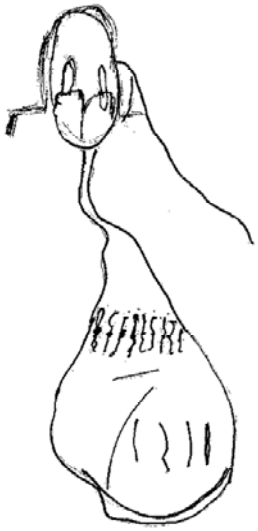


Fig. 2

Plate XV. Female Genitlia of Microheterocera

Fig. 1. *Edosa glossoptera* Rose & Pathania (Tineidae)

Fig. 2. *Monopis monachella* Hubner (Tineidae)

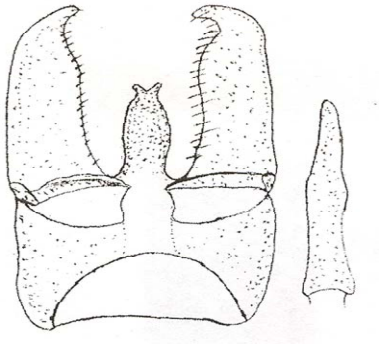


Fig. 1

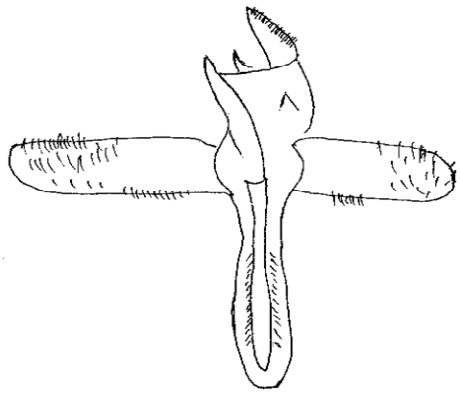


Fig. 2

Plate XVI. Male Genitalia Microheterocera

Fig. 1. *Edosa opsigona* Meyrick (Tineidae)

Fig. 2. *Monopis monachella* Hubner (Tineidae)

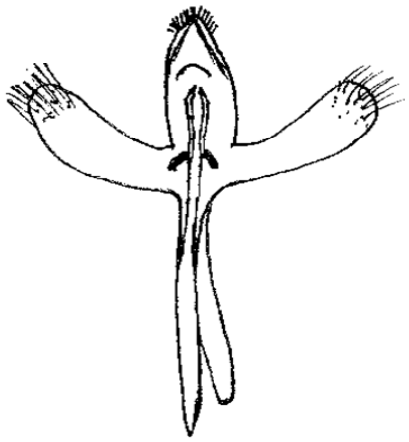


Fig. 1

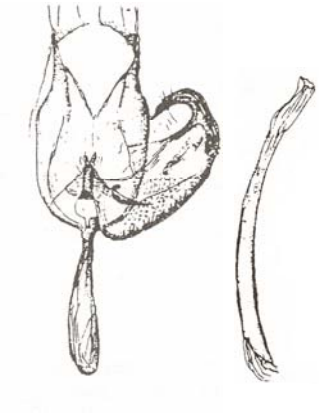


Fig. 2

Plate XVII. Male Genitalia of Microheterocera

Fig. 1. *Tinea pellionella* Linnaeus (Tineidae)

Fig. 2. *Setomorpha rutella* Zeller (Tineidae)

towards the short ductus bursae; corpus bursae small, conical in shape, bearing one to six needle-like signum.

Subfamily Setomorphinae

5. *Setomorpha rutella* Zeller (Plate XVII: Fig. 2; Plate XVIII: Fig. 2)

Alar expanse: 12 mm.

Male genitalia: Uncus broad; saccus elongate, spatulate or handle-shaped, narrowed proximally; valvae short, roughly oval, expanded apically having a sclerotization and with narrow sclerotized patches at the apex, which appears as narrow band proximally; vinculum swollen in the middle; aedeagus elongate, narrow and slender, slightly curved.

Female genitalia: Ovipositor small and cone-like, anterior apophyses short; posterior apophyses slender, long and double the length of anterior apophyses; ostium bursae large and tube-like, extending towards a tube-shaped ductus bursae that is slender and long, corpus bursae is a sac-like structure which is slightly curved at the end; signum absent.

Subfamily Erechthiinae

6. *Erechthias platydelta* Meyrick (Plate XX: Fig. 1)

Alar expanse: 17 mm.

Female genitalia: Ovipositor lobes broad; ductus long, slender and tubular; posterior apophyses longer than anterior apophyses; ostium bursae hemispherical, bell-shaped, slightly broader; ductus bursae relatively long and weakly sclerotized, broader in the middle towards the ostium and then narrowed; corpus bursae subovate, signum having a circular and an elongated, blunt tail-like distal part.

Subfamily Hieroxestinae

7. *Opogona lamprocrossa* Meyrick (Plate XX: Fig. 2)

Alar expanse: 8-9 mm.

Female genitalia: Ovipositor short triangular in shape with short spines on it; apophyses short, anterior and posterior apophyses of the length; ostium bursae tube- like apically and extend broadly at the base to ductus; ductus bursae short and tubular; corpus bursae roughly round in shape; a small streak-like signum present.

Fig. 1

Fig. 2

Plate XVIII. Female Genitalia of Microheterocera

Fig. 1. *Tinea pellionella* Linnaeus (Tineidae)

Fig. 2. *Setomorpha rutella* Zeller (Tineidae)

Fig. 1

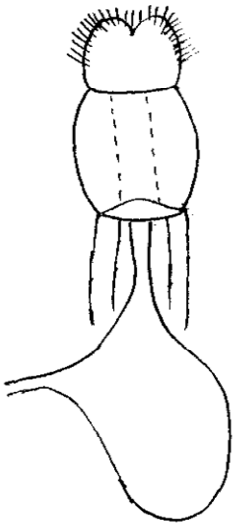


Fig. 2

Plate XIX. Female Genitalia of Microheterocera

Fig. 1. *Pyloetis mimosa Meyrick* (Tineidae)

Fig. 2. *Stathmopoda balanarcha* Meyrick (Oecophoridae)

Fig. 1

Fig. 2

Plate XX. Female Genitalia of Microheterocera

Fig. 1. *Erechthias platydelta* Meyrick (Tineidae)

Fig. 2. *Opogona lamprocrossa* Meyrick (Tineidae)

8. *Pyloetis mimosae* Meyrick (PlateXIX: Fig. 1)

Alar expanse: 18-19 mm.

Female genitalia: Ovipositor short and small, cone-shaped without hairs; apophyses long, anterior apophyses 2/3rd the length of posterior apophyses; ostium bursae straight, tube-like apically and extend to ductus; ductus bursae short, shorter than ostium; corpus bursae large, oval in shape; small spine-like signum present.

Superfamily: Gelechioidea

Family: Oecophoridae

Subfamily Xyloryctinae

1. *Nephantis serinopa* Meyrick (PlateXXI: Fig. 1)

Alar expanse: 22-24 mm.

Male genitalia: Uncus conical and blunt; valvae broadened and elongated bearing hairs; tegumen short, laterally enlarged and extending to vinculum; gnathos small; sacculus with pointed apex exceeding beyond each valva; saccus well developed, with very long conical processes; juxta long, Y- shaped and thickened; aedeagus small and pointed at the apex.

Subfamily Statmopodinae

2. *Stathmopoda balanarcha* Meyrick (Plate XIX: Fig. 2)

Alar expanse: 11 mm.

Female genitalia: Ovipositor lobes broad, flap-like, bearing a fringe of short hairs; antrum broad; ductus short, narrow and tubular; bursae elongate, broadly oval; signum long, thin, plate-like, moderately sclerotized.

Subfamily Oecophorinae

3. *Eucleodora coronis* Meyrick (Plate XXI: Fig. 2)

Alar expanse: 14-15 mm.

Male genitalia: Uncus well developed, rectangular in shape; socii absent; juxta absent; gnathos relatively strong and V-shaped; the outer margin of valvae characteristically

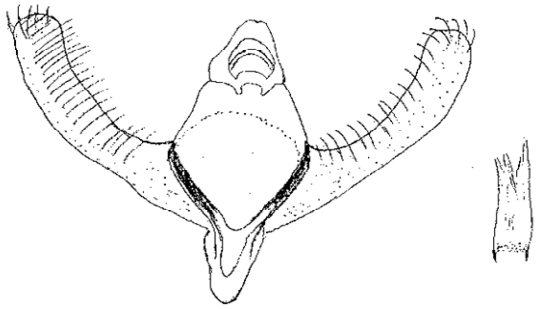


Fig. 1

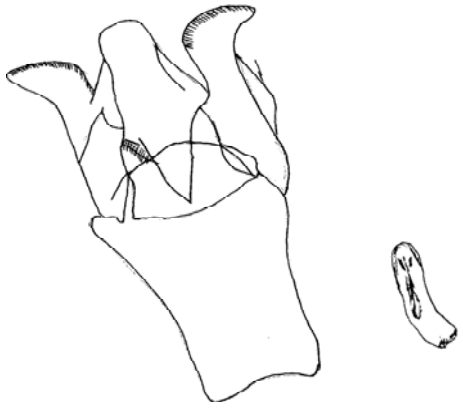


Fig. 2

Plate XXI. Male Genitalia of Microheterocera

Fig. 1. *Nephantis serinopa* Meyrick (Oecophoridae)

Fig. 2. *Eucleodora coronis* Meyrick (Oecophoridae)

incurved with short hairs; ventrally strongly angled, acute; saccus long, rectangular in shape; aedeagus long, foot-shaped, curved, vesica with cornuti.

4. *Periacma plumbea* Meyrick (Plate XXII: Fig. 1; Plate XXIII: Fig.1)

Alar expanse: 12-14 mm.

Male genitalia: Uncus blunt, slightly indented without hairs; valvae curved and elongated; juxta beak-like; saccus long and tubular; aedeagus long, rod-like; vesica with distinct cornuti.

Female genitalia: Ovipositor short, cone-like with a short tuft of hairs; apophyses very short; posterior apophyses of the same length as that of anterior apophyses; ostium bursae small, which enlarges into a small tube-like ductus; ductus bursae short and tube-like; corpus bursae rounded and ball-shaped bearing a spine-shaped signum.

5. *Promalactis semantris* Meyrick (Plate XXII: Fig. 2)

Alar expanse: 13 mm.

Male genitalia: Uncus indented, sharp and bilobed; valvae curved and sac-like, extending upto the whole length of uncus; juxta absent; saccus short and tubular; aedeagus slender, tube-like, vesica with cornuti.

6. *Promalactis thiasitis* Meyrick (Plate XIII: Fig.2)

Alar expanse: 7-8 mm.

Female genitalia: Ovipositor very narrow, lengthy and conical; apophyses long; anterior apophyses long and double the length of posterior apophyses; ostium small; ductus tubular and extend to a pouch-shaped corpus bursae having crescent-like sclerites; signum thorn-shaped.

7. *Tonica niveferana* Walker (Plate XXXV: Fig.1)

Alar expanse: 31- 32 mm.

Male genitalia: Uncus moderately long; broader at the base, narrowed distally, apex rounded, moderately sclerotized; gnathos small, not well developed in respect to the

Fig. 1

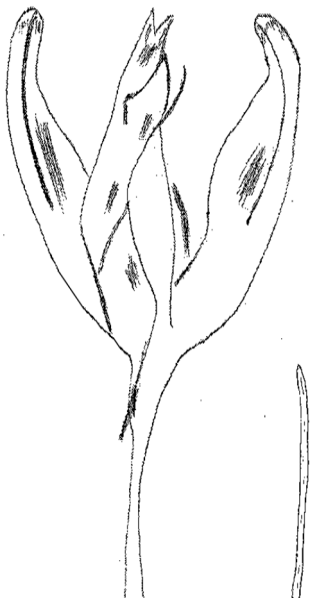


Plate XXII. Male Genitalia of microheterocera

Fig.1. *Periacma plumbea* Meyrick (Oecophoridae)

Fig. 2. *Promolactis semantris* Meyrick (Oecophoridae)

ventral plate; sacculus with pointed apex exceeding beyond each valva; aedeagus flap-shaped.

Subfamily Hypertrophinae

8. *Eupselia isacta* Meyrick (Plate XXV: Fig.1)

Alar expanse: 11-13 mm.

Female genitalia: Ovipositor short and conical; apophyses long and slender, anterior apophyses more or less of the same length as that of posterior apophyses; antrum broad; ductus short, wider and continued into an elongated and expanded bursa, basal half of bursa with sclerotizations and bearing tubular distal lobes; signum composed of a patch of short spiracle.

Family: Ethmidae

Subfamily Ethmiinae

1. *Ethmia acontias* Meyrick (Plate XXXV: Fig.2)

Alar expanse: 19-21 mm.

Male genitalia: Body without spines; uncus bilobed, deeply indent, hinged to the tegumen, below this is a scaphium; gnathos terminating in numerous blunt spines; costa separate from valva; aedeagus short, having an angular base.

Family: Lecithoceridae

Subfamily Lecithocerinae

1. *Timyra pastas* Meyrick (Plate XXIV: Fig.1; Plate XXV: Fig.2)

Alar expanse: 14-16 mm.

Male genitalia: Uncus curved and beak-shaped; gnathos small, rounded and scobinate; valvae long, flap-like, longer than the vinculum, a patch of short spine-like processes at the distal end of the valvae; vinculum U-shaped; saccus small, curved; sacculus broad at the base.

Female genitalia: Ovipositor small, conical and pointed, with short hairs; posterior apophyses slightly longer than the anterior apophyses; ostium funnel-shaped; ductus

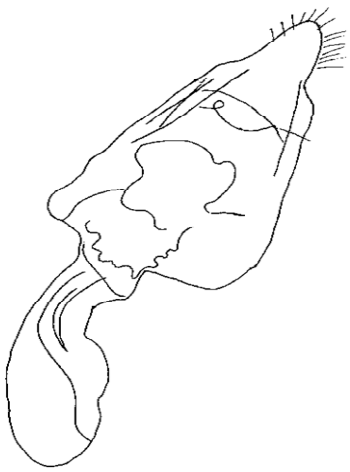


Fig. 1

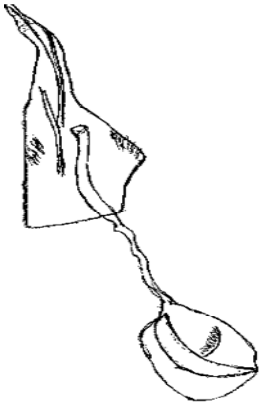


Fig. 2

Plate XXIII. Female Genitalia of Microheterocera

Fig. 1. *Periacma plumbea* Meyrick (Oecophoridae)

Fig.2. *Promalactis thiasitis* Meyrick (Oecophoridae)

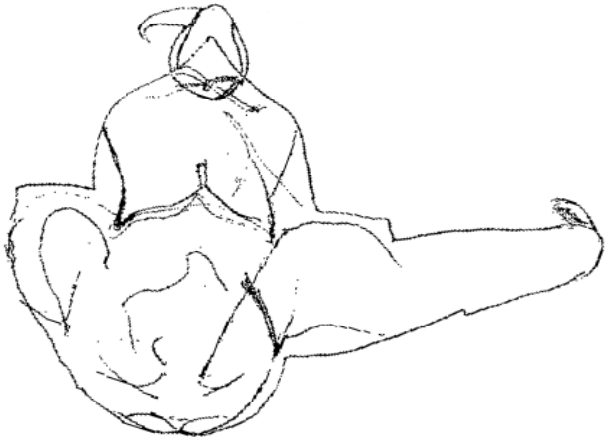


Fig. 1

Fig. 2

Plate XXIV. Male Genitalia of Microhetercera

Fig. 1. *Timyra pastas* Meyrick (Lecithoceridae)

Fig. 2. *Timyra xanthaula* Meyrick (Lecithoceridae)

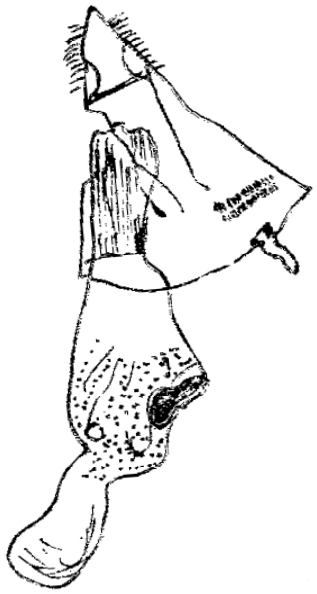


Fig. 1

Fig. 2

Plate XXV. Male Genitalia of Microheterocera

Fig. 1. *Eupselia isacta* Meyrick (Oecophoridae)

Fig. 2. *Timyra pastas* Meyrick (Lecithoceridae)

bursae elongate and slightly enlarged towards the end; corpus bursae short; a pocket-shaped signum present.

2. *Timyra xanthaula* Meyrick (Plate XXIV: Fig. 2; Plate XXVII: Fig. 1)

Alar expanse: 12-14 mm.

Male genitalia: Uncus short, lobe-shaped; saccus large, curved and pouch-shaped; valvae short and thin, with a tuft of hairs at distal end; aedeagus rod-like, broad apically and tapering toward the distal end.

Female genitalia: Ovipositor small and pointed at the tip, small hair-like processes present; posterior apophyses slightly longer than the anterior apophyses; ductus bursae long, broadened towards corpus bursae, which is a foot-shaped, saccular structure; a flap-like signum present.

Subfamily Torodorinae

3. *Hygroplasta lygaea* Meyrick (Plate XXVI:, Fig. 1; Plate XXVII: Fig. 2)

Alar expanse: 24 mm.

Male genitalia: Uncus moderately long; broad at the base, narrowed distally, apex rounded, moderately sclerotized; gnathos large; tegumen small, hood-like; vinculum V-shaped; juxta slightly broader; saccus small; valvae symmetrical, moderately sclerotized, sparsely setosed, costal margin broad at the base, strongly concave medially; aedeagus small.

Female genitalia: Ovipositor small and rounded; posterior apophyses longer than the anterior apophyses; ostium bursae large, ductus bursae long, slightly curved and narrowed at the middle; signum large and spindle-shaped.

4. *Hygroplasta spoliatella* Walker (Plate XXVI: Fig. 2)

Alar expanse: 23 mm.

Male genitalia: Uncus broader basally, pointed at the apex, sparsely setose dorsally; socii absent; gnathos small, somewhat hook-like, weakly sclerotized; tegumen short, weakly

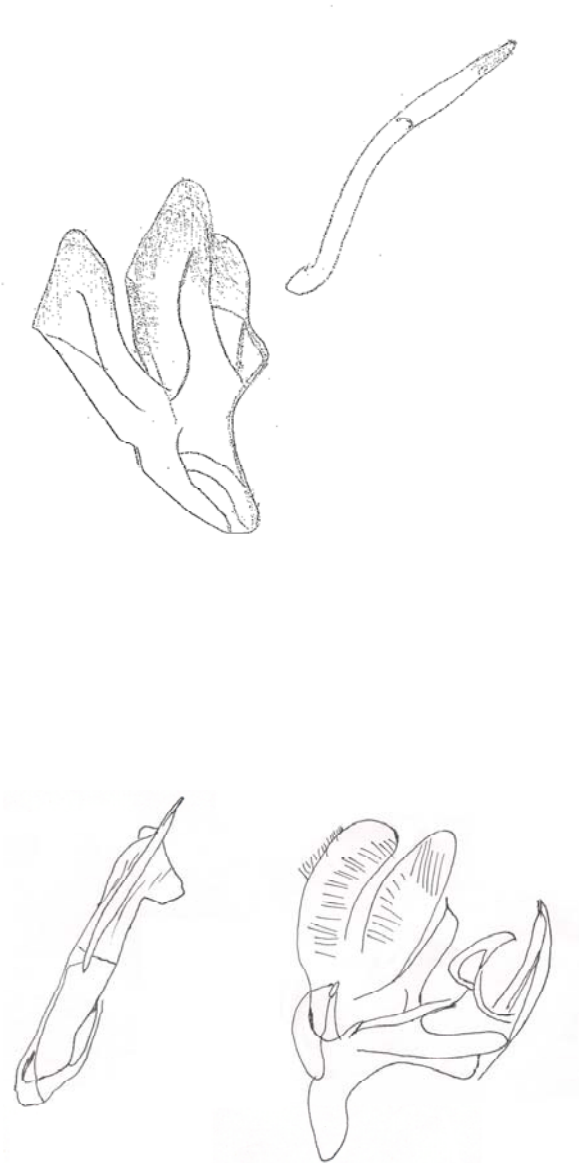


Plate XXVI. Male Genitalia of Microheterocera

Fig. 1. *Hygroplasta lygaea* Meyrick (Lecithoceridae)

Fig. 2. *Hygroplasta spoliatella* Walker (Lecithoceridae)

sclerotized; vinculum V-shaped, poorly sclerotized; saccus moderately long and broad, apex rounded; juxta large and broad, moderately sclerotized; valvae symmetrical, small, broad in the middle, costal margin narrowed at the base, strongly convex medially; sacculus convex at the base, narrowed, almost straight medially and apically, cucullus concave dorso-distally, pointed apically, weakly sclerotized and densely setose; aedeagus long, broad at the base, apex slightly curved and pointed, relatively less sclerotized; vesica without cornutus

Family: Gelechiidae

Subfamily: Gelechiinae

1. *Anarsia patulella* Walker (Plate XXIX: Fig. 1)

Alar expanse: 10–11 mm.

Female genitalia: Ovipositor small, cylindrical with short hairs; posterior apophyses double the length of anterior apophyses; ostium funnel-shaped; ductus bursae small, thin and slightly banded in the middle; ductus seminalis arising from the junction of the corpus bursae; corpus bursae large, sub ovate in shape with a crescent-shaped signum.

2. *Anarsia isogona* Meyrick (Plate XXVIII: Fig. 1)

Alar expanse: 12–13 mm.

Male genitalia: Uncus short; tegumen as long as valva, broad at the base, left Valva broad with a slender, tapered process at the base, right valva is narrower than the left; aedeagus slender and tapering.

3. *Hypatima haligramma* Meyrick (Plate XXVIII: Fig. 2; Plate XXIX: Fig. 2)

Alar expanse: 10-11 mm.

Male genitalia: Uncus about one third length of valvae, apically wider than at the base, medially narrowest; distal half of ventral and most of the dorsal surface with long scales; tegumen broad; gnathos long, slender and evenly curved; valvae nearly as long as tegumen; sacculus very short; aedeagus with inflated base, strongly bent medially, apex rounded; ductus ejaculatorius with a long band-like lamina.

Fig. 1

Fig. 1

Plate XXIX. Female Genitalia of Microheterocera

Fig. 1. *Anarsia patulella* Walker (Gelechiidae)

Fig. 2. *Hypatima haligramma* Meyrick (Gelechiidae)

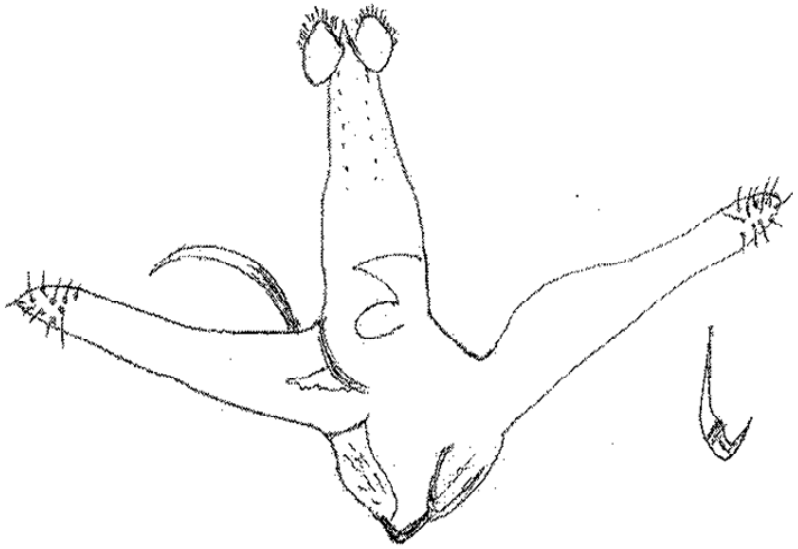


Fig. 1

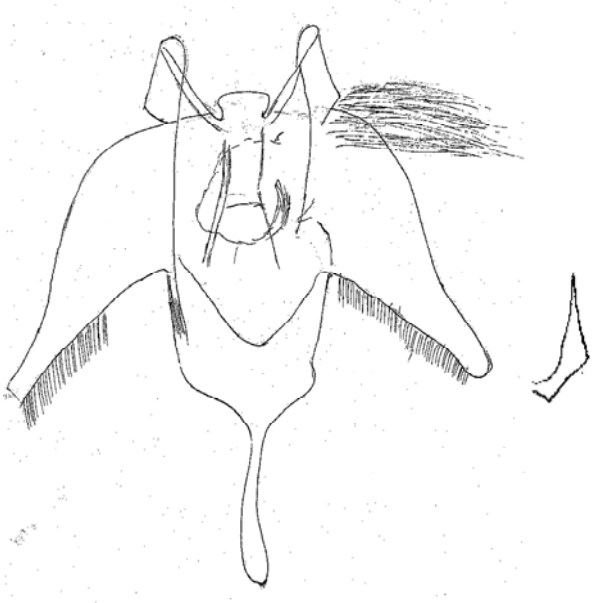


Fig. 2

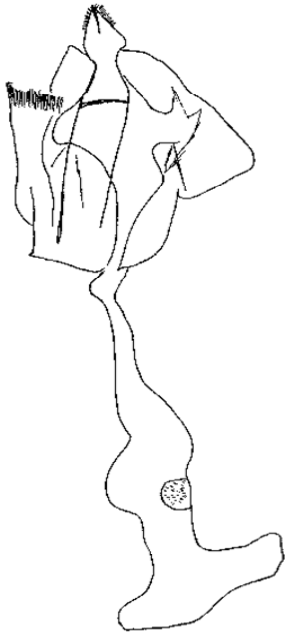


Fig. 1

Fig. 2

Plate XXVII. Female Genitalia of Microheterocera

Fig.1. *Timyra xanthaula* Meyrick (Lecithoceridae)

Fig. 2. *Hygroplasta lygaea* Meyrick (Lecithoceridae)

Female genitalia: Ovipositor lobes elongate and lobate bearing short hairs; apophyses short; anterior apophyses about 1/3rd length of posterior apophyses; ductus long, slender and tubular; bursa elongated and bean-shaped; signum composed of a roughly hemispherical body bearing short spines.

4. *Sitotroga cerealella* Oliver (Plate XXX: Fig. 1)

Alar expanse: 14 mm.

Male genitalia: Uncus small, apically pointed and triangular in shape; socii cylindrical, fringed with short hairs; gnathos long and tubular; tegumen short and broad; vinculum long and slender, of the same length of tegumen; saccus distinct and V-shaped; valvae broad, fringed with tufts of hairs which appears as a birds' beak at the distal end; aedeagus long and slender, narrow at the proximal end and bears a small cornuti.

Subfamily Dichomeridinae

5. *Dichomeris evidantis* Meyrick (Plate XXX: Fig. 2)

Alar expanse: 19 –20 mm.

Male genitalia: Uncus small, lobe-shaped, slightly indent with a short spine-like structure at the base; socii absent; valvae wide, with thick hairs on it; saccus bilobed and pointed apically; juxta well developed; aedeagus round spine-like, pointed at the tip.

6. *Dichomeris ianthes* Meyrick (Plate XXXVII: Fig. 1)

Alar expanse: 12–13 mm.

Female genitalia: Ovipositor small, lobe-shaped, with small spine-like processes; apophyses short and slender, posterior apophyses slightly longer than the anterior apophyses; ostium bursae triangular which narrow down to ductus bursae; ductus is short; ductus seminalis well developed, long; corpus bursae long, pouch-like, curved towards left; signum absent

.

Subfamily Anacampsinae

7. *Idiophantis acanthopa* Meyrick (Plate XXXI: Fig. 1)

Alar expanse: 11-12 mm.

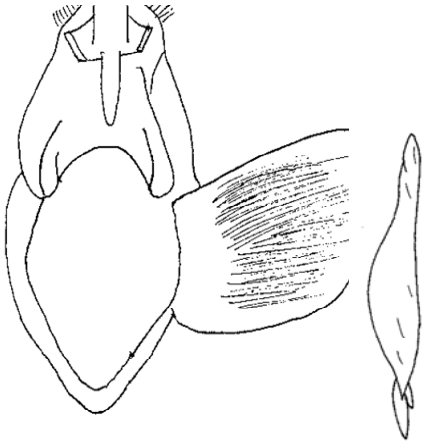


Fig. 1

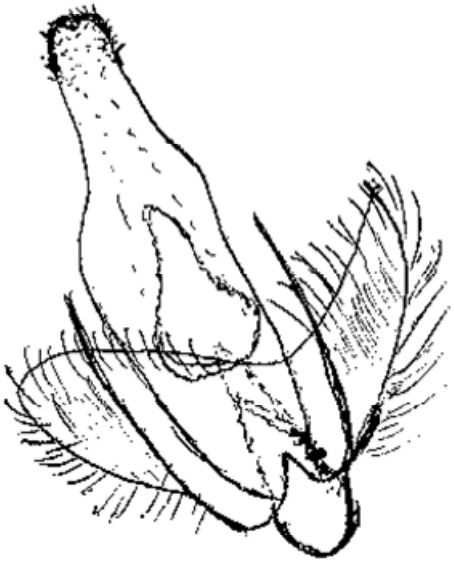


Fig. 2

Plate-XXX Male Genitalia of Microheterocera. Fig-1. *Sitotroga cerealella* Oliver (Gelechiidae); Fig-2. *Dichomeris evidantis* Meyrick (Gelechiidae)

Fig. 1

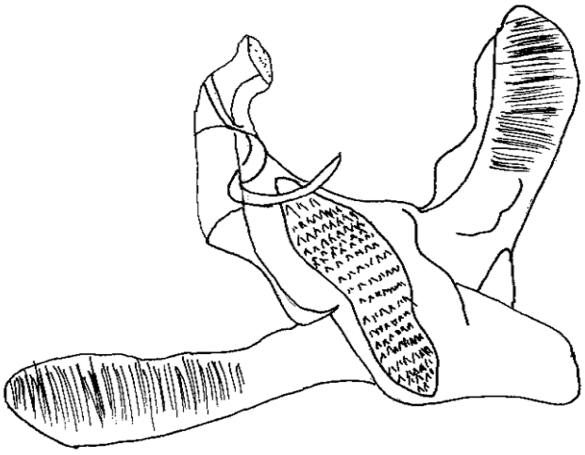


Fig. 2

Plate XXXI. Male Genitalia of Microheterocera

Fig. 1. *Idiophantis acanthopa* Meyrick (Gelechiidae)

Fig. 2. *Symmoca signetella* Meyrick (Blastobasidae)

Plate XXVIII. Male Genitaliaof Microheterocera

Fig. 1. *Anarsia isogona* Meyrick (Gelechiidae)

Fig. 2. *Hypatima haligramma* Meyrick (Gelechiidae)

Male genitalia: Uncus lobe-like without hairs; valvae large, well developed, with long hairs around it; saccus pointed and narrow, V-shaped structure; gnathos well developed, curved and hook-like, and bend toward the upper portion; juxta well developed; sacculus base is inflate.

Family: Blastobasidae

Subfamily Symmocinae

1. *Symmoca signetella* Meyrick (Plate XXXI: Fig. 2; Plate XXXVII: Fig. 2)

Alar expanse: 11- 13 mm.

Male genitalia: Uncus small, indent, forming two pads; gnathos hook-shaped; valvae long, curved, beak-like; sacculus angulate, clavate at the apex; juxta consisting of an elongated bar-shaped process compressed in the middle; saccus small, slightly curved at the end; harpe represented by an elongated, narrow process arising from about the middle of the costa and extending as far as the apex; aedeagus small rod-shaped, cornuti composed of a row of regularly arranged spines.

Female genitalia: Ovipositor lobes short, blunt, bearing short hairs; apophyses short, posterior apophyses of the same length as that of anterior apophyses; ductus short, narrow, tubular; bursa globular bearing a narrow spine-like signum.

2. *Symmoca indagata* Meyrick (Plate XXXVI: Fig. 1)

Alar expanse: 15 mm.

Male genitalia: Uncus small, U-shaped; vinculum elongated, about double the length of tegumen; valvae apically broadened, flat, apical 2/3rd portion bearing long patches of hairs; saccus conical, borne on narrow stalks; socii small; gnathos long Y-shaped; tegumen long; harpe long, tubular and slightly curved; saccus small, conical with an inner arc-like process; valvae long and broad, flap-like and uniformly hairy.

Subfamily Blastobasinae

3. *Blastobasis pulverea* Meyrick (Plate XXXVI: Fig. 2)

Alar expanse: 15 mm.

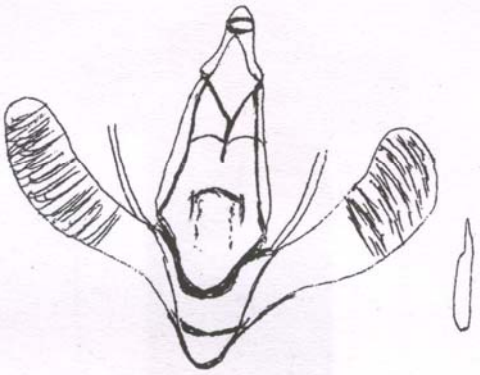


Fig. 1

Fig. 2

Plate XXXVI. Male genitalia of Microheterocera

Fig. 1. *Symmoca indigata* Meyrick (Blastobasidae)

Fig. 2. *Blastobasis pulverea* Meyrick (Blastobasidae)

Fig. 1

Fig. 2

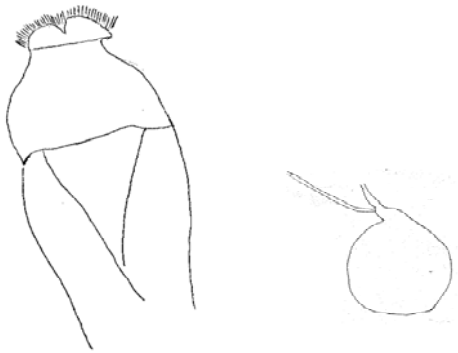


Fig. 3

Plate XXXIV. Female Genitalia of Microheterocera

Fig.1. *Eumenodora tetrachorda* Meyrick (Cosmopterigidae)

Fig. 2. *Plutella xylostella* Linnaeus (Plutellidae)

Fig. 3. *Atteva fabriciella* Swederus (Attevidae)

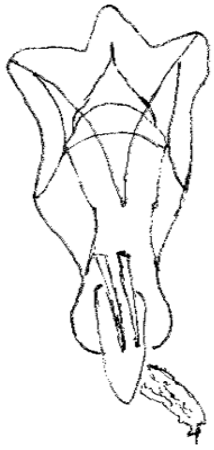


Fig. 1

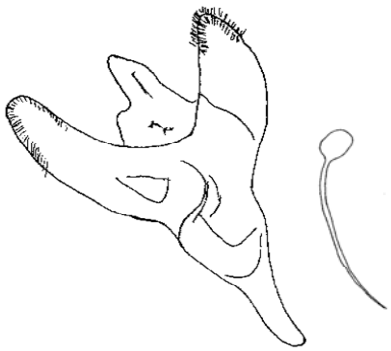


Fig. 2

Plate XXXV. Male Genitalia of Microheterocera

Fig-1. *Tonica niveferana* Walker (Oecophoridae)

Fig-2. *Ethmia acontias* Meyrick (Ethmidae)

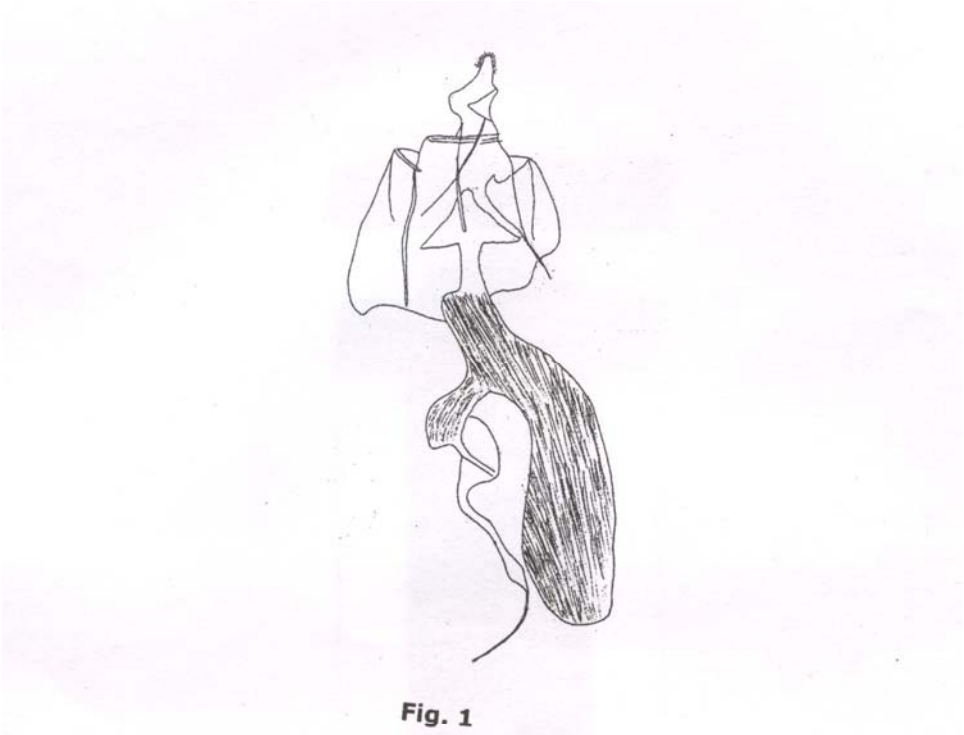


Fig. 1

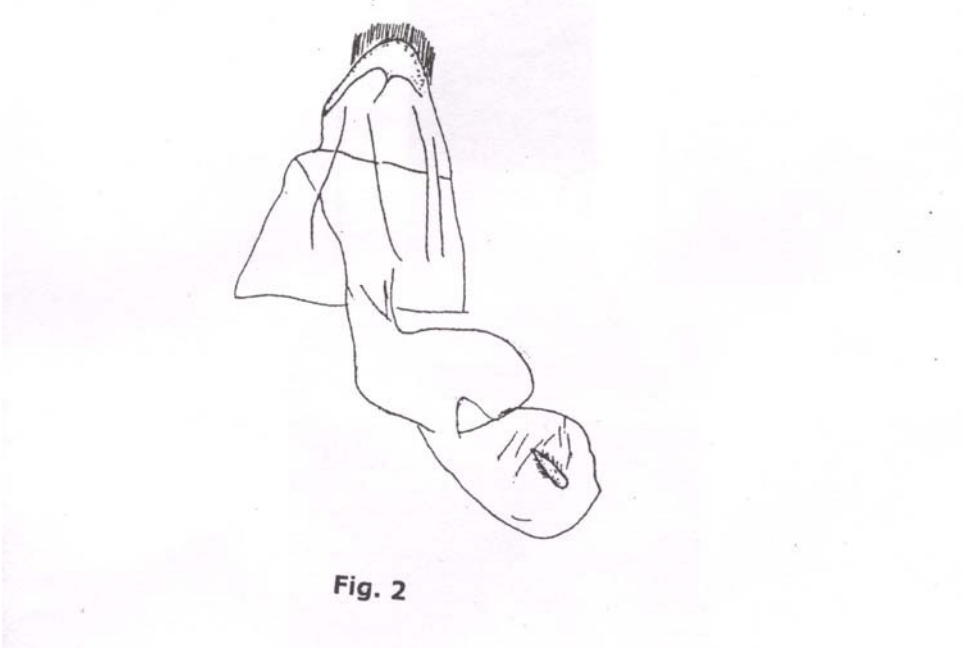


Fig. 2

Plate XXXVII. Female Genitalia of Microheterocera

Fig.1. *Dichomeris ianthes* Meyrick (Gelechiidae)

Fig.2. *Symmoca signetella* Meyrick (Blastobasidae)

Male genitalia: Uncus short slightly curved; dorsally thickened tegumen below the uncus is present; gnathos short and extended laterally; vinculum is wide; juxta lightly sclerotized; aedeagus sclerotized internally.

Family: Cosmopterigidae

Subfamily: Cosmopteriginae

1. *Labdia semicoccinea* Stainton (Plate XXXII: Fig. 1)

Alar expanse: 12-14 mm.

Male genitalia: Uncus triangular, less sclerotized, pointed apically with short hairs; saccus short, tubular and pointed; valvae slender, compressed, reaching beyond the uncus with some hairs on the apical region; aedeagus long tubular curved and widened towards the base.

Subfamily: Chrysopeleiinae

2. *Eumenodora tetrachorda* Meyrick (Plate XXXII: Fig. 1 Plate XXXIV: Fig-1)

Alar expanse: 7-9 mm.

Female genitalia: Ovipositor well developed, long, lobe-like with short tufts of hairs; antrum long; apophyses long, anterior apophyses double the length of posterior apophyses; ductus small and tubular; corpus bursae oval, longer than the ductus with the distal end slightly bend.

Superfamily: Yponomeutoidea

Family: Glyphipterigidae

Subfamily: Glyphipteriginae

1. *Phycodes minor* Moore (Plate XXXIII: Fig.1)

Alar expanse: 15-16 mm.

Male genitalia: Uncus small and lobe-like; valvae rounded, deeply curved bearing short hairs; saccus long tubular structure; aedeagus long, thin and pointed, small round structures seen apically.

Family: Plutellidae

Fig. 1

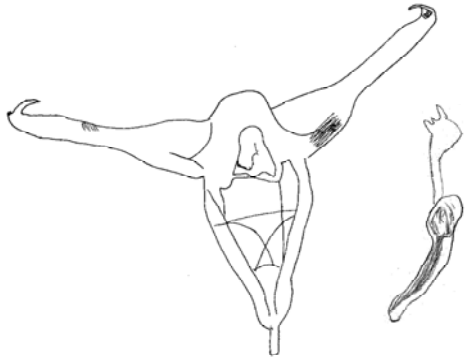


Fig. 2

Plate XXXII. Male Genitalia of Microheterocera

Fig. 1. *Labida semicoccinea* Stainton (Cosmopterigidae)

Fig. 2. *Eumenodora tetrachorda* Meyrick (Cosmopterigidae)

Fig. 1

Fig. 2

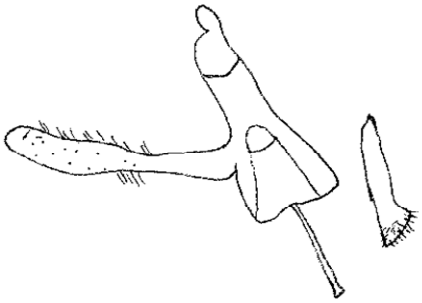


Fig. 3

Plate XXXIII. Male Genitalia of Microheterocera

Fig. *Phycodes minor* Moore (Glyphipterigidae)

Fig. 2. *Atteva fabriciella* Swederus (Attevidae)

Fig. 3. *Leucoptera sphenograpta* Meyrick (Lyonetiidae)

Subfamily: Plutellinae

2. *Plutella xylostella* Linnaeus (Plate XXXIV: Fig. 2)

Alar expanse: 16 mm.

Female genitalia: Ovipositor broad and cone-shaped with short tufts of hairs; anterior apophyses slender and straight, posterior apophyses slightly curved and extend the length of anterior apophyses; ostium bursae tube-like, deeply indent, slender, extending towards the ductus bursae; ductus bursae very small, somewhat broad; corpus bursae long and broad, broader distally then gradually narrowed upto the base; signum small, diamond-shaped, moderately sclerotized

.

Family: Attevidae

1. *Atteva fabriciella* Swederus (Plate XXXIII: Fig. 2; Plate XXXIV: Fig.3)

Alar expanse: 30 mm.

Male genitalia: Uncus small and rounded; gnathos well developed and hook-like in appearance; valvae long, with short hairs and extend to the length of gnathos; saccus bilobed and curved reaching as far as the valvae; aedeagus cone-shaped.

Female genitalia: Ovipositor short and cylindrical in shape with long tufts of hairs; posterior apophyses longer than anterior apophyses; ductus bursae small, tubular, slightly curved at the end, giving rise to ductus seminalis; a big, balloon-shaped corpus bursae having an elongate rod-shaped structure with several teeth-like striations forming the signum.

Family: Lyonetiidae

Subfamily: Cemiostominae

1. *Leucoptera sphenograpta* Meyrick (Plate XXXIII: Fig. 3)

Alar expanse: 8 mm.

Male genitalia: Anal tube is weakly sclerotized, beset with sparse hairs ventrally; gnathos divided on either side, short slender, weakly sclerotized; valvae short, apex rounded; saccus exceptionally elongated with hair; aedeagus basally broad, short pointed apically; vesica with cornuti.

4.4. Taxonomic segregation of Microheterocera

Taxonomic segregation of species

In the past, general coloration, wing pattern, venation, structure of labial and maxillary palpi, tarsal characters etc., of moths have been used for species separation. However, recent studies have shown the extreme usefulness of external genitalial characters in species segregation. Since sexual isolation is the most important criterion for segregating species, genitalial structure of each species is expected to be unique. The genitalial characters useful in taxonomic segregation of various Microheterocera studied herein are described in detail with a key for segregation of taxa.

4.4.1. Super Family Tineoidea

Salient characteristics

Vertex and frons dressed with erect scales; labial palpi with stout, erect, piliform scales (bristles) from apical and lateral surface of second segments; forewing with vein R_4 usually terminating on costa or apex.

4.4.1.1. Family Psychidae

Psychidae Rambur, 1886, Cat. Syst. Lepid. Andalousie: 313.

Salient characteristics:

Type genus: Psyche Schrank, 1801.

Vertex and frons dressed with erect scales; antennae filiform, long; labial palpi small with numerous lateral and terminal bristles; maxillary palpi absent or reduced with 1-2 segments; forewing with basal fork of A_{1+2} extremely long and prominent.

The family Psychidae is classified into four subfamilies- Penestoglossinae, Taleporiinae, Psychinae, Oiketicinae. Out of these, species representing one subfamily viz., Psychinae has been collected in this study.

Key for separation of species

Subfamily: Psychinae

1. Alar expanse 13-15 mm; male genitalia with uncus indented;
aedeagus slender, pointed and tubular……. *Brachycyttarus subteralbata*
- Alar expanse 10-11 mm; forewing with vein six absent
…..…… 2
- Alar expanse 13mm; forewing with vein six present
…….. 3
2. Uncus bilobed with few short spines; saccus V-shaped and prominent;
aedeagus broad and arched at apex …… *Pteroma plagiophleps*
3. Uncus rounded and arch-shaped; saccus long and narrow;
aedeagus hook-like tapers at the end ……. *Metisa plana*

4.4.1.2. Family Tineidae

Tineidae Latreille, 1810, Considerations generales Animaux crustaces Arachmides Insectes: 347, 363 (as Tineites).

Type genus: Tinea Linnaeus, 1758, Syst. Nat. (Edn. 10), 1:534.

Vertex and frons covered with erect scales; antennae filiform, long; labial palpi, upturned, drooping, or porrect, slightly to markedly flattened, in most species with numerous lateral and terminal bristles; maxillary palpi usually five-segmented; forewing with vein R_5 terminating on costa or apex, with tuft of long hairs surrounding ovipositor, the latter generally protruding, may be conspicouous, metathoracic leg with long hair-like scales on hind tibia.

The family Tineidae is classified into fourteen subfamilies (Nemapogoninae, Scardiinae, Euplocaminae, Tinissinae, Meessiinae, Teichobiinae, Dryadaulinae, Setomorphinae, Phthoropoeinae, Myrmecozelinae, Siloscinae, Tineinae, Erechthiinae) out of which five subfamilies have been covered in this study.

Key for separation of species

Subfamily Perissomastictinae

1. Alar expanse 30 mm; male genitalia with
valvae sickle-shaped …… *Edosa glossoptrea*

-Alar expanse 16-28 mm; male genitalia with valvae not being,
sickle-shaped, long and broad at the base …….. *Edosa opsigona*

Subfamily Tineinae

1. Alar expanse 10 mm; male genitalia with saccus elongate;
cornuti blade-shaped …….. *Tinea pellionella*

- Alar expanse: 18-19 mm; male genitalia, with aedeagus longer than saccus;
cornuti many spined …… *Monopis monachella*

Subfamily Setomorphinae

Only one species was studied. The diagnostic characters are given below:
Alar expanse 12 mm; male genitalia with valvae ear-shaped;
saccus long; female genitalia with corpus bursae sac-shaped and curved;
signum absent ……..... *Setomorpha rutella*

Subfamily Erechthiinae

Only one species was studied. The diagnostic characters are given below:
Alar expanse 19 mm; head whitish, female genitalia, with,
ostium bursae bell-shaped; corpus bursae sub ovate …… *Erechthias platydelta*

Subfamily Hieroxestinae

1. Alar expanse 8-9 mm; forewing with a pale yellow dark streak
along the basal 1/4th of the costa; male genitalia with sacculus,
convex at the base, narrowed, almost straight medially and apically;
aedeagus tube-like …… *Opogona lamprocrossa*

- Alar expanse 18-19 mm; forewing with pale hind margin and
with fringes; male genitalia with sacculus angulated, and curved;
aedeagus rod-like …….. *Pyloetis mimosae*

4.4.2. Super Family Gelechioidea

Salient characteristics:

Vertex and frons decorated with smooth scales; labial palpi 3-segmented, upturned, 3rd segment long, acute; forewing with veins $R_4 + R_5$ stalked; hind tibia with dorsal surface furnished with long slender scales. This superfamily is divided into ten family out of which six family have been covered in this study. In Gelechiinae, uncus of male genitalia is bifid and corpus bursae of female genitalia is appears as bulb.

4.4.2.1. Family Oecophoridae

Oecophoridae, Bruand, 1850, mem. soc. Emul. Doubs, (1) 3 (5-6): 45 (as Oecophoridae).
Type genus: Oecophora Latreille (1796), précis Caracteres generiques insects: 146.
Vertex and frons covered with smooth scales; antennae filiform, longer than half the length of forewing; labial palpi long, upturned; male genitalia with gnathos broad basally, unarticulated, tapering to a slender or rounded apex.

The family Oecophoridae is classified into ten subfamilies (Depressariinae, Peleopodinae,Autostichinae,Xyloryctinae, Stenomatinae, Oecophorinae, Hypertrophinae, Physoptilinae, Chimabachinae, Deuterogoniinae) out of which four subfamilies have been covered in this study.

Key for separation of species

Subfamily Xyloryctinae

Only one species was studied. The diagnostic features are given below:
Alar expanse 22-24 mm; uncus conical and blunt;
tegumen short; juxta long Y- shaped and thickened…….. *Nephantis serinopa*

Subfamily Statmopodinae

Only one species was studied. The diagnostic features are given below:

Alar expanse 11 mm; forewing very narrow,
light ochreous yellow basal patch occupying more than
1/4th of wing; hind wing and cilia grey; female genitalia
with corpus bursae ovate in shape…….. *Stathmopoda balanarcha*

Subfamily Oecophorinae

Only one species was studied. The diagnostic features are given below:

Alar expanse 31- 32 mm; forewing with black spot near base;
male genitalia with gnathos small; sacculus having pointed apex
exceeding beyond each valva …….. *Tonica niviferana*

Subfamily Hypertrophinae

Only one species was studied. The diagnostic features are given below:

Alar expanse 11-13 mm; ovipositor triangular;
ostium bursae curved; signum cylindrical in shape ……. *Eupselia isacta*

4.4.2.2. Family Ethmiidae

Ethmiidae Burck, 1909, Proc.ent.soc. Wash., 11:91

Type genus: Ethmia Hubner (1819) 1816, verz. bekannter Schmett.: 163.Vertex and frons studded with smooth scales; antennae filiform, longer than half length of forewing, labial palpi long, recurved, 2-segmented without brush of elongated scales; forewing with R_5 extending to costa or apex, with distinctive pattern of black spots on cream yellow or silver grey background; hindwing yellow with black margin in some species; metathoracic leg with hair-like erect scales on the dorsal surface of hind tibia. Recent family Ethmiidae has been derived from the subfamily Ethmiinae that originally belonged to the group Oecophoridae. Now this group is monogeneric.

Only one species representing this family has been studied. The diagnostic features are given below:

Alar expanse 19-21 mm; male genitalia with small labial lobes,
broader distally; aedeagus short, having an angular base……..... *Ethmia acontias*

4.4.2.3 Family Lecithoceridae

Lecithoceridae Le Marchand, 1947, Revve fr. Lepidopt., II: 153 (as Lecithocerinae)
Type genus: Lecithocera Herrich-Schaffer, 1853, Syst. Bearb. Schmett. Eur., 5:11 (Key) 45.

Vertex and frons studded with smooth scaled; antenna longer than $3/4^{th}$ length of forewing; labial palpi long, upturned, second segment long, acute; forewing with C_up absent; hindwing with the outer margin slightly excavated at the postered apex; male genitalia with uncus thorn-shaped, tapering to a slender, acute apex or narrowed base and broad, bilobed apex; female genitalia with corpus bursae ovate or sub ovate in shape. The family Oecophoridae is classified into four subfamilies (Ceuthomadarinae, Oditinae, Lecithocerinae, Torodorinae) out of which species belonging to two subfamilies were described.

Key for separation of species

Subfamily Lecithocerinae

1. Alar expanse 12-14 mm; uncus short, lobe-shaped;
saccus large, curved and pouch shaped …….. *Timyra xanthaula*
2. Alar expanse 14-16 mm; uncus bend, beak-like;
saccus small, curved ……... *Timyra pastas*

Subfamily Torodorinae

1. Alar expanse 23 mm; forewing with round discocellular spot; male genitalia with moderately long saccus; valvae broad; aedeagus long ……..... *Hygroplasta spoliatella*

- Alar expanse 20-22 mm; forewing with a prominent discocellular spot; male genitalia with relatively smaller saccus, broader distally; valvae small; aedeagus short ……. *Hygroplasta lygaea*

4.4.2.4. Family Gelechiidae

Gelechiidae Stainton, 1854, Insecta Br. Lepid. Tineina

Type genus: Gelechia Hubner, (1825) 1816, vertz. Bekannter Schmett., 415.

Vertex and frons covered with smooth scales; antennae smaller than ¾th length of forewing; labial palpi upturned, second segment long, acute; hindwing with vein R_1 and Sc united from base of wing or R_1 running into Sc beyond base of wing, discocellular perpendicular by axis of wing or directed at 45^0 angle toward base of wing from M_2 termen excavated. The family Gelechiidae is classified into three subfamilies (Gelechiinae, Pexicopinae, Dichomeridinae) out of which two subfamilies have been dealt herewith.

Key for separation of species

Subfamily Gelechiinae

1. Corpus bursae large, sub ovate in shape; signum crescent –shaped…….. *Anarsia patulella*

- Corpus bursa elongated and bean-shaped; signum rough, hemispherical body bearing short spines…….. *Hypatima haligramma*

2. Uncus small and short---------- 3

Uncus large and long ---------- 4

3. Uncus short and small arising from the anterior margin; tegumen, long and broad …….. *Anarsia isogona*

- Uncus short, small and apically pointed; tegumen short and broad; gnathos long and tubular…… *Sitotroga cerealella*

4. Uncus large and long about 1/3rd length of valvae;
tegumen broad, ventral and most of the dorsal surface
with long scales; gnathos long, slender and evenly curved ……. *Hypatima haligramma*

Subfamily Dichomeridinae

Only one species was studied. The diagnostic features are given below:
Socii absent; valvae wide peak with full of hairs on it;
saccus pointed and bilobed; juxta well developed;
aedeagus round, spine-like …… *Dichomeris evidantis*

Subfamily Anacampsinae

Only one species was studied. The diagnostic features are given below:
Alar expanse 11-12 mm; uncus lobe like without hairs;
valvae large well developed with long hairs around it;
saccus pointed and narrow V-shaped structure;
gnathos well developed and hook-like…….. *Idiophantis acanthopa*

4.4.2.5 Family Blastobasidae

Blastobasidae Meyrick, 1894, Trans. Ent. Soc. Lond. 1894: 22.
Type genus: Blastobasis Zeller, 1855.

Vertex and frons studded with smooth scales; antennae filiform; labial palpi long, upturned, second segment long, acute; forewing with R_2 closer to R_3; hindwing with costal margin relatively straight.

The family Blastobasidae is classified into three subfamilies (Symmocinae, Holocerinae, Blastobasinae) out of which species belonging to two subfamilies were described.

Key for separation of species

Subfamily Symmocinae

1. Alar expanse 11- 13 mm; Uncus small indent;
valvae long, curved, beak like; gnathos hook- shaped…….. *Symmoca signetella*

- Alar expanse 15 mm; Uncus small U-shaped;
valvae long and broad, flap like with uniformly hairy;
gnathos long Y-shaped which extend gradually …….*Symmoca indagata*

Subfamily Blastobasinae

Only one species representing this family has been studied. The diagnostic features are given below:

Alar expanse 15 mm; gnathos short and extended laterally;
vinculum wide; juxta lightly sclerotized;
aedeagus sclerotized internally…….*Blastobasis pulverea*

4.4.2.6 Family Cosmopterigidae

Cosmopterigidae Heinemann and Wocke, (1876) 1877, Schmett. Dtl. Schweiz, 2(2): 520 (as Cosmopterigidae)
Type-genus: Cosmopterix Hubner, (1825) 1816, verz. Bekannter Schmett., 424.

Vertex and frons covered with smooth scales; antennae filiform; labial palpi upturned; second segment long, acute; forewing with vein R5 extending to costa or apex, with bright and conspicuous colour pattern in some species; abdomen without any medial band; metathoracic leg with hair-like erect scales on dorsal surface of hind tibia.
The family Cosmopterigidae is classified into three subfamilies (Antequerinae, Cosmopteriginae and Chrysopeleiinae) out of which two subfamilies have been dealt herewith.

Subfamily: Cosmopteriginae

Only one species was studied. The diagnostic features are given below:
Alar expanse: 12-14 mm; uncus triangular, less sclerotized;
valvae slender, compressed;
aedeagus tube-like, long and curved……. *Labdia semicoccinea*

Subfamily: Chrysopeleiinae

Only one species was studied. The diagnostic features are given below:

Alar expanse: 7-9 mm; ovipositor long, lobe like, well developed,

narrow and triangular with short tufts of hairs;

antrum long; corpus bursae longer; ductus is oval…… *Eumenodora tetrachorda*

4.4.3. Super Family Yponomeutoidea

Salient characteristics:

Vertex and frons mostly covered with erect scales, sometimes erect; labial palpus drooping, porrect or ascending; forewing with vein R_4 terminating on termen, pterostigma and chorda may be present or absent, M-stem cell usually vestigial or absent. This superfamily is divided into nine family out of which four family have been dealt herewith.

4.4.3.1. Family Glyphipterigidae

Type genus: Glyphipteryx Curtis, 1827, Br. Ent. 4: folio 152

Vertex and frons covered with somewhat erect scales; Labial palpi usually with the apical segment distinctly flattened dorso-ventrally; forewing with metallic mark or white crescent; Hindwing with CuA_2 closer to CuA_1 and usually all median veins present.

The family Glyphipterigidae is classified into two subfamilies (Orthoteliinae and Glyphipteriginae) out of which one subfamily is dealt herewith.

Subfamily: Glyphipteriginae

Only one species was studied. The diagnostic features are given below:

Alar expanse 15-16 mm; uncus small, lobe-like

without hairs covered in between two valvae;

saccus long, tube-like, deeply extended;

aedeagus long, thin and pointed……. *Phycodes minor*

4.4.3.2. Family Plutellidae

Plutellidae Guenee, 1845, Annls Soc.ent.Fr., (2) 3:339 (as Plutellidae)

Type genus: Plutella, Schrank 1802, Fauna Boica, 2(2): 169

Vertex and frons covered with some what erect scales; Labial palpi long upturned, occasionally dropping or recurved; in some species with a brush of long scales from under side of 2nd segment; wings broad, fringes small, forewing with vein R_5 reaching termen, hindwing with vein M_1 and M_2 stalked, metathoracic leg with hind tibia often thickened with scales. The family Plutellidae is classified into four subfamilies (Ypsolophinae, Pluellinae, Scythropinae and Praydinae) out of which one subfamily is dealt herewith.

Subfamily Plutellinae

Only one species was studied. The diagnostic features are given below:

Alar expanse 16 mm; female genitalia with a

diamond shaped signum…….. *Plutella xylostella*

4.4.3.3 Family Attevidae

Attevidae Mosher, 1916, Bull. Illinois State Lab. Nat. Hist. 12:71.

Type genus: Atteva Walker, 1984.

Vertex mostly covered with semi erect scales; frons smooth scaled antennae filiform, long; labial palpi usually curved upward, occasionally drooping or recurved; wings broad, forewing with R_5 extending to termen; hindwing with the apical hindwing area abruptly narrowing in front of veins $Sc+R_1$, veins M_1 and M_2 free; metathoracic legs often thickened with scales, in a few species with semi erect scales. The family Attevidae, has been derived from family Yponomeutidae which is monogeneric.

Subfamily Attevinae

Only one species was studied. The diagnostic features are given below:

Alar expanse 30 mm; saccus bilobed and curved;

aedeagus cone-like; corpus bursae big, balloon-shaped;
signum rod-shaped with numerous striations……..……. *Atteva fabriciella*

4.4.3.4. Family Lyonetiidae

Plutellidae Guenee, 1845, Annls. Soc.ent.Fr., (2) 3:339 (as Plutellidae)
Type genus: Plutella, Schrank 1802, Fauna Boica, 2(2): 169
Vertex and frons covered with somewhat erect scales; Labial palpi long, upturned, occasionally dropping or recurved, in some species with a brush of long scales from the under side of 2nd segment; wings broad, fringes small, forewing with vein R_5 extending to termen, hindwing with vein M_1 and M_2 stalked, metathoracic leg with hind tibia often thickened with scales.

The family Lyonetiidae is classified into three subfamilies (Cemiostominae, Lyonetiinae and Bedelliinae) out of which one subfamily is dealt herewith.

Subfamily Cemiostominae

Only one species was studied. The diagnostic features are given below:
Alar expanse 8 mm; saccus exceptionally elongated besets with hairs;
aedeagus small, slender, pointed apically…… *Leucoptera sphenograpta*

5. DISCUSSION

Morphological details of the external genitalia offer reliable clues for species segregation in Lepidoptera. The morphological details of the external genitalia of various Microheterocera have not been studied in detail. In this study, the external genitalial morphology of forty species of Microheterocera belonging to 13 families were covered. The morphological details of the external genitalial structure of various species are discussed herein in order to evaluate their usefulness in taxonomic segregation of the group.

5.1. Comparative morphology of male external genitalia

Uncus: In Psychidae, within the same subfamily uncus showed variations in shape. It may be bilobed bearing a few short, spines in *Pteroma plagiophleps* or arch-shaped in *Metisa plana* or as broad-tongue shaped in *Brachycyttarus subteralbata*.

In Tineidae, uncus is well developed in all the members of the family. It may be long and broader at middle as in *Edosa glossoptera*; broader apically as in *Edosa opsigona;* broader and conical in *Tinea pellionella* and *Setomorpha rutella*; tongue-shaped as in *Tinea pellionella* or pointed narrow with striation of hairs in *Monopis monachella*.

In Oecophoridae, the uncus is long and narrow at the apex in as *Tonica niveferana*; blunt and slightly indented without hairs as in *Periacma plumbea*; indented, sharp and bilobed as in *Promalactis semantris* or conical and blunt in as *Nephantis serinopa*.

In Lecithoceridae, Uncus is broader basally, pointed at the apex, sparsely setose dorsally as in *Hygroplasta spoliatella*. It is moderately long; broader at the base, narrowed distally, apex rounded and moderately sclerotized in *H. lygaea*. It is short and lobe-shaped in *Timyra xanthaula* and bend, beak-like and curved in *Timyra pastas*.

In Gelechiidae, Uncus is hook-shaped and basally enlarges as in *Anarsia patulella*; short arising from the anterior margin as in *Anarsia isogona*; small, apically pointed and

triangular in shape as in *Sitotroga cerealella* or about one-third length of valva as in *Hypatima haligramma*. In *Symmoca signetella*, uncus is small indent, forming two spinal pads and in *Symmoca indagata*, it is small and U-shaped. In Blastobasidae, uncus is short and slightly curved in *Blastobasis pulverea*. Uncus triangular and less sclerotized in *Labdia semicoccinea.*

In the family, Glyphipterigidae, uncus is a small lobe-like structure without hairs as in *Phycodes minor;* deeply indent as in *Plutella xylostella* or it is weakly sclerotized as in *Leucoptera sphenograpta*.

Tegumen: In Tineidae, it is well developed and relatively large in *Edosa glossoptera*; small and broad in *Edosa opsigona* or short and narrow in *Tinea pellionella*. In Oecophoridae, tegumen is long and flattened in *Tonica niveferana*; short in *Nephantis serinopa* and *Ethmia acontias*.

In Lecithoceridae, it is short and weakly sclerotized in *Hygroplasta spoliatella;* small and hood-like in *Hygroplasta lygaea*. In Gelechiidae, it is long in *Anarsia patulella*; it is short, broad in *Sitotroga cerealella,* and broad as in *Hypatima haligramma*. It is longer in *Symmoca indagata.* Tegumen small and somewhat arched in *Plutella xylostella*.

Valvae: In Psychidae valvae are short and narrow and of more or less uniform breadth as in *Pteroma plagiophleps*, *Metisa plana* and *Brachycyttarus subteralbata.*

In Tineidae, valvae are symmetrical, sickle-shaped, broad at the base, narrowed apically, curved near the apex as in *Edosa* glossoptera or valvae symmetrical, elongated and broad, densely setose, on the inner surface in *Edosa opsigona*; valvae of rather variable shape in *Tinea pellionella* and *Monopis monachella* or valvae short, broadly oval, expanded apically having a sclerotization as in *Setomorpha rutella*.

In Oecophoridae, valvae are symmetrical as in *Tonica niveferana*; curved and long as in *Periacma plumbea*; curved and sac-like as in *Promalactis semantris* or broadened and

elongated, bearing hairs as in *Nephantis serinopa*. In Gelechiidae, valvae are asymmetrical in *Anarsia patulella*. Valvae fringed with tufts of hairs, which looks like a birds' beak as in *Sitotroga cerealella*. Valvae are nearly as long as tegumen in *Hypatima haligramma*.

In Blastobasidae, valvae are long, curved, beak-like in *Symmoca signetella* or apically broadened, flat, apical 2/3rd portion bearing long patches of hairs in *Symmoca indagata*.
In Lecithoceridae, valvae are symmetrical, small, broader at middle in *Hygroplasta spoliatella*; it is symmetrical, moderately sclerotized, sparsely setosed in *H. lygaea;* short in *Timyra xanthaula* or long as in *T. pastas*.

In Cosmopterigidae, valvae are slender, compressed rising beyond the uncus with some hairs on the apical region as in *Labdia semicoccinea*; symmetrical, foot-shaped as in *Plutella xylostella* or short with rounded apex as in *Leucoptera sphenograpta*.
Saccus: In Psychidae, saccus is massive and U-shaped as in *Pteroma plagiophleps* or may have a handle-shaped process as in *Metisa plana* and *Brachycyttarus subteralbata*.
In Tineidae, saccus is elongated as in *Setomorpha rutella* or may be absent as in *Edosa glossoptera* and *E. opsigona.* It is elongated in *Tinea pellionella.* In the family Oecophoridae, it is absent from *Tonica niveferana*. Saccus moderately long and broad, with apex rounded in *Hygroplasta spoliatella*.

In Lecithoceridae, it is small in *H. lygaea*; large curved and pouch-like as in *Timyra xanthaula* and small, curved in shape in *T. pastas*.

In Gelechiidae, saccal region well developed in *Anarsia patulella*; distinct and V-shaped in *Sitotroga cerealella*; very short in *Hypatima haligramma*; saccus small, slightly curved at end in *Symmoca signetella* and in *Symmoca indagata* it is conical bearing stalks. In Cosmopterigidae, saccus is short, tube-like with a pointed end as in *Labdia semicoccinea.*

Gnathos: It is lacking in *Edosa glossoptera* and *E. opsigona*; it is straight, upturned as in *Tinea pellionella* (Tineidae); large and hook-like as in *Tonica niveferana* small as in

Nephantis serinopa (Oecophoridae). In Ethmidae, gnathos terminate in numerous blunt spines as in *Ethmia acontias*. It is small, somewhat hook-like and weakly sclerotized as in *Hygroplasta spoliatella*; large in *H. lygaea;* small in *Timyra pastas* (Lecithoceridae); absent as in *Anarsia patulella;* long and tube-like as in *Sitotroga cerealella*; long, slender and evenly curved as in *Hypatima haligramma;* hook-like in *Symmoca signetella* or Y-shaped as in *Symmoca indagata* (Gelechiidae). It is short and extended laterally in *Blastobasis pulverea* (Blastobasidae). Gnathos with two sparsely lobes setose curved, small as in *Plutella xylostella* (Plutellidae).

Costa: Costal margin is slightly concave in *Edosa glossoptera* and *Edosa opsigona*. It is gently curved in *Tinea pellionella.* Costa is separated from valvae in *Ethmia acontias*. Costal margin narrow and broader at base in *Hygroplasta spoliatella* and *Hygroplasta lygaea* respectively. It is tapered in *Symmoca signetella*.

Sacculus: Sacculus arched in *Metisa plana;* saccular margin almost straight in *Edosa opsigona*; with a pointed apex in *Nephantis serinopa*; convex at the base in *Hygroplasta spoliatella*; broad at the base in *Timyra pastas*; very short in *Hypatima haligramma*; angulate in *Symmoca signetella*; merged into the valvae as in *Symmoca indagata*. Sacculus not extended, with patch of upright spines in *Plutella xylostella*

Juxta: Juxta small, cap-like in *Edosa glossoptera* and *Edosa opsigona*. Long Y- shaped in *Nephantis serinopa*. Large and broad, moderately sclerotized in *Hygroplasta spoliatella* and slightly broader in *Hygroplasta lygaea*. Juxta consists of an elongated bar-shaped processes compressed in the middle in *Symmoca signetella*. Lightly sclerotized in *Blastobasis pulverea* or weak and thin as in *Plutella xylostella*.

Harpe: In Psychidae, harpe is distinct as in *Pteroma plagiophleps* or curved and narrow as in *Metisa plana.* Harpe is represented by an elongated narrow process arising from about the middle of the costa and extending upto the apex in *Symmoca signetella*; tube-like in *Symmoca indagata*.

Aedeagus: Well developed in all sub families. It is long in *Metisa plana* and *Brachycyttarus subteralbata*; short in *Pteroma plagiophleps*. Elongated long and rod-shaped in *Setomorpha rutella, Edosa glossoptera, Edosa opsigona* and *Tinea pellionella*. Long, tube-like process beset with many spines forming cornuti in *Monopis monachella*. Aedeagus longer than the length of valvae in *Hygroplasta spoliatella* and *Hygroplasta lygaea*; long and slender in *Sitotroga cerealella*; with inflated base in *Hypatima haligramma*; small rod-like in *Symmoca signetella*; sclerotized in *Blastobasis pulverea*; aedeagus tube like and curved in *Labdia semicoccinea*; small, slender, apex pointed and base is broadened as in *Leucoptera sphenograpta*.

5.2 Comparative morphology of female genitalia

Ovipositor: Ovipositor small and cone-like in *Setomorpha rutella;* it is small, rounded, sparsely setose in *Edosa opsigona*; extremely short with small spines in *Monopis monachella* (Tineidae). Ovipositor small, rounded, with short hairs in *Tonica niveferana*; small, rounded, sparsely setose in *Statmopoda balanarcha*; triangular shape with short hairs as in *Eupselia isacta*; or flat as in *Periacma plumbea* (Oecophoridae).

In Lecithoceridae, Papillae anales small and rounded in *Hygroplasta lygaea*. It is small and pointed at the tip in *Timyra xanthaula*; it is small, conical pointed beset with short hairs in *T. pastas*; small, ovipositor anales broad, curved with spines of hairs in *Symmoca signetella*.

In Gelechiidae, ovipositor is extremely short in *Hypatima haligramma*; cylindrical with short hairs as in *Anarsia patulella*; small and cone-like structure with short tuft of hairs in *Plutella xylostella* (Plutellidae). It is short and cylindrical in shape with long tufts of hairs in *Atteva fabriciella* (Attevidae). Papillae anales broad and blunt without hairs in *Decadarchis platydelta* (Lyonetiidae).

Apophyses: The posterior apophyses which is long and double the length of anterior apophyses as in *Setomorpha rutella*; anterior apophyses are long and thin with the apophyses posterior very long and thin in *Edosa opsigona*; apophyses anterior about 1/3rd

length of posterior apophyses in *Monopis monachella*. In Oecophoridae, posterior apophyses are longer than anterior apophyses in *Tonica niveferana*; apophyses posterior, longer than anterior apophyses in *Stathmopoda balanarcha*. Anterior apophyses of the same the length of apophyses posterior in *Eupselia isacta*; posterior apophyses 2/3rd longer than anterior apophyses in *Periacma plumbea* (Oecophoridae). Posterior apophyses long and thin, longer than anterior apophyses in *Hygroplasta lygaea* (Lecithoceridae). Posterior apophyses slightly longer than anterior apophyses as in *Timyra xanthaula* and *T. pastas*. In *Anarsia patulella*, posterior apophyses double the length of anterior apophyses; anterior apophyses about 1/3rd length of posterior apophyses in *Hypatima haligramma*; posterior apophyses of the same length of anterior apophyses in *Symmoca signetella* (Gelechiidae); anterior apophyses slender and straight, posterior apophyses is slightly curved and extend the length of anterior apophyses in *Plutella xylostella* (Plutellidae); posterior apophyses are longer than anterior apophyses in *Atteva fabriciella* (Attevidae); and in *Erechthias platydelta* (Lyonetiidae).

Ostium bursae: In Tineidae, it is large and tube-like in *Setomorpha rutella*; it is broad and centrally placed in *Edosa opsigona*; slender and tube-like in *Monopis monachella*; it is narrow in *Tonica niveferana*; it is small and centrally placed in *Stathmopoda balanarcha*; it is curved in *Eupselia isacta* (Oecophoridae); it is large in *Hygroplasta lygaea* (Lecithoceridae); funnel-shaped in *Timyra pastas* and *Anarsia patulella*; it is large and placed in the middle in *Hypatima haligramma*; it is bell-shaped in *Symmoca signetella* (Gelechiidae); or tube-like and slender in *Plutella xylostella* (Plutellidae). Ostium bursae is bell-shaped and slightly broader in Lyonetiidae.

Ductus bursae: In Tineidae, it is slender and tube-shaped as in *Setomorpha rutella*; long and thin, almost straight in *Edosa opsigona* or bulging and dilated towards corpus bursae in *Monopis monachella*. With regard to Oecophoridae, it is long and coiled in the middle as in *Tonica niveferana*; it is long and broader in *Stathmopoda balanarcha*; in *Eupselia isacta*, ductus bursae is broad in the middle and slightly curved at the distal end; short, coiled and widens towards corpus bursae as in *Periacma plumbea*; long and slightly curved and narrowed at the middle in *Hygroplasta lygaea*; long in *Timyra xanthaula*;

long, thin and slightly enlarged at the end in *T. pastas*; ductus bursae small, thin and slightly banded in the middle as in *Anarsia patulella*; Ductus bursae narrow and slightly dilated in *Hypatima haligramma*; relatively short and broader at middle in *Symmoca signetella* (Gelechiidae); ductus bursae long leading to a tube-like ductus ejaculatories in *Plutella xylostella* (Plutellidae); small, tube-like, slightly curved at the end in *Atteva fabriciella* (Attevidae) or relatively long and weakly sclerotized as in *Erechthias platydelta* (Lyonetiidae).

Corpus bursae: Corpus bursae is sac-like and slightly curved at the end in *Setomorpha rutella*; sub ovate and simple in *Edosa opsigona* or membranous and oval in *Monopis monachella* (Tineidae). In *Tonica niveferana,* corpus bursae is large and semi ovate; small and semi ovate in *Stathmopoda balanarcha*; it is small pouch-like in *Eupselia isacta*; rounded and coiled in *Periacma plumbea* (Oecophoridae). In Gelechiidae, corpus bursae is foot-shaped, sac -like structure in *Timyra xanthaula*; short and foot-shaped in *T. pastas*; large, sub ovate in shape as in *Anarsia patulella*; membranous and oval in *Hypatima haligramma*; sub ovate shape in *Symmoca signetella* round, ball-like as in *Plutella xylostella* (Plutellidae). In *Atteva fabriciella* (Attevidae) corpus bursae is big balloon-like structure occurring at the end, which covers most of the female genetalic region. It is sub ovate in *Erechthias platydelta* (Lyonetiidae).

Signum: Signum is long and coil like in *Edosa opsigona*; it is large, having spines and showing serration as in *Monopis monachella* (Tineidae); small and sclerotized in *Tonica niveferana*; long, thin, plate-like and moderately sclerotized in *Stathmopoda balanarcha*; cylindrical in shape as in *Eupselia isacta*; bean-shaped in *Periacma plumbea* (Oecophoridae); large and spindle-shaped in (*Hygroplasta lygaea*); flap- like signum is present slightly above the corpus bursae in *Timyra xanthaula*; pocket-shaped in *T. pastas*; a crescent -shaped signum present in *Anarsia patulella*; signum large, hat- shaped, covered with strong spines showing serration in *Hypatima haligramma* or signum slender and triangular as in *Symmoca signetella* (Gelechiidae).

5.3. Similarity and dissimilarity of Microheteroceran subfamilies (Based on genitalial morphology)

5.3.1. Tineoidea

In psychidae, three species belonging to the subfamily psychinae were examined in this study. These species showed wide variations in the structure of the male genitalia particularly with respect to uncus, saccus, and aedeagus, so that no generalization is possible. In *Brachycyttarus subteralbata* uncus is broad tongue-shaped and slightly cleft in the middle; it is rounded and arch-shaped in Metisa plana it is indent, bilobed with few short spines in *Pteroma plagiophleps*. The saccus is handle-shaped processes in *Brachycyttarus subteralbata* and *Metisa plana* whereas it is massive and U-shaped in *Pteroma plagiophleps*. Aedeagus is long rod-shaped in *Brachycyttarus subteralbata*, hook-like in *Metisa plana* and in *Pteroma plagiophleps* it is short and tubular.

In Tineidae, two species belonging to the Subfamily Perissomastictinae were examined in this study. In both the species uncus is long, socii and gnathos lacking; saccus absent; juxta was small. The saccular margin is slightly convex in *Edosa glossoptera* which is straight in *E. opsigona*. In Tineinae, uncus is tongue-shaped bearing a row of short stiff hairs in *Tinea pellionella*. It is pointed and narrow with a striation of hairs in *Monopis monachella*. The valvae are rather variable in shape in both the species. The saccus shows similarity, which is elongated in both the species. The female genitalia of these species showed variations. Corpus bursae is small, conical, bearing one to six needle-like signum in *Tinea pellionella* whereas it is oval, bearing a spine like signum.

5.3.2. Gelechioidea

In the subfamily Oecophorinae, uncus shows great modifications. Uncus is blunt slightly indented without hairs in *Periacma plumbea* while it is indented, sharp and bilobed in *Promalactis semantris*. The valvae are curved and sac-like in both the species. In the female genitalia, no differences were observed in the morphology of the ovipositor and apophyses although in ductus bursae and signum were dissimilar. It is a short tube bearing spine-like signum as in *Periacma plumbea* while it is long, slender slightly coiled with arc-shaped serration forming signum as in *Promalactis thiasitis*.

With regard to subfamily Lecithocerinae, uncus and saccus showed modifications being bent, beak-like and curved in *Timyra pastas* and lobe-shaped in *T. xanthaula*. Saccus is large curved pouch-like in *Timyra xanthaula* and it is curved in *T. pastas*. Similarity of ovipositor, apophyses and corpus bursae was noticed in both the species. However, ductus bursae is long in *Timyra xanthaula* where as in *Timyra pastas* it is not so. Bursa is small, lengthy, and thin slightly enlarges at the end. Signum is flap like in *Timyra xanthaula* and it is pocket-shaped in *Timyra pastas*. In the subfamily, Torodorinae the uncus, saccus, valva and vinculum showed no great difference. However, differences were observed in the structure of gnathos. It is small in *Hygroplasta spoliatella* and large in *Hygroplasta lygaea.*

In Gelechiidae, only the subfamily Gelechiinae was studied. In *Anarsia isogona*, uncus short arising from the anterior margin, which is about one third length of valva, apically wider than at base, medially narrowest in *Hypatima haligramma* and uncus is small, apically pointed and triangular in *Sitotroga cerealella*. Saccus is small and narrow in *Anarsia isogona* and *Hypatima haligramma* and in *Sitotroga cerealella* it is distinct and V-shaped. Valvae are broad in *Anarsia isogona*. Valvae are nearly as long as tegumen in *Hypatima haligramma* and in *Sitotroga cerealella* valvae are broad fringed with tufts of hairs, which look like a bird's beak at the distal end. In the female genitalia, ovipositor is small, cylindrical with short hairs in Anarsia patulella and in *Hypatima haligramma*, it is elongate and lobate bearing short hairs. Signum also shows wide variations. In *Anarsia patulella*, signum is crescent-shaped and in *Hypatima haligramma* it is composed of a roughly hemispherical body bearing short spines. In the subfamily Symmocinae uncus small indent, forming two spinal pads in *Symmoca signetella*. It is small U-shaped in *Symmoca indagata*. Valvae are long, curved, beak like in the former and it is broadened and flat in latter. Gnathos hook-like and Y-shaped in both the species. However there is no much difference seen in the other parts.

5.3.3. Yponomeutoidea

As far this superfamily is concerned, no family with more than one subfamily was examined. With regard to subfamily Plutellinae and Cemiostominae, uncus and valvae

offered major characters. Uncus is deeply indent in *Plutella xylostella*. It is small and weakly sclerotized in *Leucoptera sphenograpta*. Saccus small, with a rounded apex in *Plutella xylostella*. However, in Leucoptera it is exceptionally elongated with hair. Aedeagus small, anchor like, broader in the former species while in latter it is small, slender, apex pointed and base broadened. As far as the female genitalia is concerned, close associations were noticed in all the families with regard to ovipositor, apophyses and ductus bursae. However, with regard to in corpus bursae and signum, differences were noticed. In Attevinae, corpus bursae looks like a big balloon with signum having teeth-like striations in *Atteva fabriciella*. In *Plutella xylostella* corpus bursae is long and broad, broader distally then gradually narrowed upto the base; signum small, diamond-shaped, moderately sclerotized.

6. SUMMARY

Microheterocera comprises of a paraphyletic assemblage of all the primitive as well as higher taxa of the Ditrysian Lepidoptera. Many species of Microheterocera are economically important as pests of various cultivated crops and stored commodities. They also have great ecological significance as indicators of environmental health because of their close association with vegetation. So far, about 2,420 species of Microheterocera belonging to 458 genera grouped under 22 super families and 80 families have been described from all over the world. Except for the pioneering work on Microheterocera fauna of India in the Exotic Microheterocera series by Meyrick during 1912-1936, no comprehensive study on this group of moths has been made from the Indian region. Segregation of taxa belonging to this group is rather difficult since no satisfactory identification scheme is available for their separation.

The Kerala part of the Western Ghats is known to be rich in faunal diversity and no detailed survey of Microheterocera has been made in this region. It was in this context that the present study on this group of insects in the Kerala part of Western Ghats was undertaken to generate baseline data on the fauna of this region and to develop an easy identification scheme. Considering the large number of taxa involved, the scope of the present study has been limited to three super families *viz*., Tineoidea, Gelechioidea and Yponomeutoidea.

Intensive survey of Microheterocera has been made in different parts of Kerala viz., Silent Valley, Mukkali, Muthanga, Sultan Bathery, Amarambalam, Meenmutty, Vellimuttam, Nilambur, Peechi, Vazhani, Sholayar, Thekeddy, Rajamalai, Ranni, Thenmala, Arienkavu, Rosemala, Kattlapara, Achenkovil, Neyyar and Peppara.

Sampling of insects was done by light trapping using a lighted sheet. Altogether, 67 species of Microheterocera belonging to the families Psychidae, Tineidae (Tineoidae); Oecophoridae, Ethmiidae, Lecithoceridae, Gelechiidae, Blastobasidae, Cosmopterigidae

(Gelechioidea); Plutellidae, Yponomeutidae, Lyonetiidae, Glyphipterigidae and Heliodinidae (Yponomeutoidea) have been recorded in this study. A major share of moths collected in the study belonged to Gelechiidae, Tineidae, Oecophoridae and Cosmopterigidae. The faunal elements were interesting in that they contained several new records for the region- six species as new records for Kerala; 44 species as new records for Southern India and two species as new records for India.

Studies on the morphology of various species with special reference to head appendages, wings and external genitalia have shown that characteristics of the labial palpi, wing venation and parts of external genitalia such as uncus, saccus, gnathos, juxta, tegumen of the male as well as corpus bursae, ductus bursae and signum of the female have diagnostic value in species identification.

In the super family Tineoidea, the labial palpi are stout, erect, bearing piliform scales (bristles) from the apical and lateral surface of second segments. In the forewing, vein R4 usually terminates on costa. In the male external genitalia, the valvae and saccus showed several characters useful in the segregation of species. Valvae are sickle-shaped and broad at the base in *Edosa glossoptera*, while in *Edosa opsigona,* valvae are elongated, broad and densely setose on inner surface. Valvae are leaf- shaped in *Tinea pellionella*. Saccus is low in *Edosa glossoptera* and *E. opsigona* while in *Tinea pellionella* it is elongated. In the female external genitalia, corpus bursae is sac-like and slightly curved at the end in *Setomorpha rutella*; it is sub ovate and simple in *Edosa opsigona*. Ductus bursae is slender and tube-shaped in *Setomorpha rutella*; long and thin, almost straight in *Edosa opsigona*.

In the super family Gelechioidea, labial palpi are three-segmented, upturned with the third segment long and acute. Forewing with veins $R_4 + R_5$ stalked and the male external genitalial characters particularly of uncus and saccus presented several characters useful for segregating species. Uncus is hook-shaped and basally enlarged in *Anarsia patulella*; it is small, apically pointed and triangular in *Sitotroga cerealella* and it is about one third length of valvae in *Hypatima haligramma*. Saccal region is well developed in *Anarsia*

patulella; saccus distinct and V-shaped in *Sitotroga cerealella* and saccus very short in *Hypatima haligramma*. In the female external genitalia, corpus bursae are foot-shaped in *Timyra xanthaula* and in *T. pastas*; large and sub ovate in *Anarsia patulella*; membranous and oval in *Hypatima haligramma* and *Symmoca signetella*. The ductus bursae are small, thin and slightly banded in the middle in *Anarsia patulella*; narrow and slightly dilated in *Hypatima haligramma*; relatively short and broad in the middle in *Symmoca signetella*. In the super family Yponomeutoidea, labial palpi are drooping, porrect or ascending. In the forewing, R_4 terminates on termen and M-stem in the cell is usually absent. With regard to the genitalial characters of taxonomic significance, the corpus bursae and ductus bursae of female genitalia are useful. Corpus bursae are round and ball-like in *Plutella xylostella* and large balloon-like in *Atteva fabriciella*. Ductus bursa is a small tubular structure in *Plutella xylostella* which is slightly curved at the end in *Atteva fabriciella*. An identification key for the various species using wing venational and external genitalial characters was prepared for easy segregation of species studied here. In addition, an inventory of species recorded in this study along with details of collection localities, distribution and hosts is also given along with a microdem distribution map. Thus, the study has generated essential basic information on this group of moths and updated the taxonomy of Microheteroceran fauna using genitalic characters.

Acknowledgements:

I am grateful to my colleagues Dr. K.V. Bhat, Dr. M.S. Mukteshkumar and Dr. T.V. Sajeev for kindly going through the manuscript and for offering useful suggestions. I thank Dr. R.S.M. Shamsudeen, Research Fellow attached to this project for assistance in laboratory and field work. This project was funded by the Ministry of Environment and Forests, New Delhi.

7. LITERATURE CITED

Arita, Y. and Heppner, J.B. 1992. Sedge moth of Taiwan. Trop. Lepidoptera. Vol: 3, (2), 40p.

Bengtsson, A.B. 1995. Scythridids found by H. Hacker in Pakistan 1988 and India 1992. Buchreihe Zur Entomologie Bull., 4: 467-481.

Bradley, J.D. 1965. Microlepidoptera. In Ruwenzori Expedition (1952). London, Br. Mus. (Nat. Hist.) 2(12): 81-148.

Bradley, J.D. 1981 Anarsia achrasella sp. nov. (Lepidoptera: Gelechiidae) on Sapodilla (Achras zapota) in Northern India and Pakistan. Bull. Ent. Res., 71: 617-619.

Bradley, J.D., Carter, D.J. and Sankaran, T. 1973. A new species of *Mompha* Hubner (Lepidoptera: Momphidae) from Assam North East India a potential agent for Biological control of *Ludwigia adscendens*. Bull. Ent. Res., 63: 57-63.

Butler, A.G. 1883. On a collection of Lepidoptera received from Leiut. Colonel Charles Swinohoe with numerous notes by the collector. Proc. Zool. Lond., 144-175.

Chamber, V.T. 1874. Tineina from texas. Can.Ent., 6; 229-249.

Chamber, V.T. 1878. Descriptions of new Tineina from Texas and others from more northern localities. Bull. U.S. Geol. Surv. Terr., (Washington), 4: 79-106.

Clarke, J.F.G. 1941. Revision of the North American moths of the family Oecophoridae with descriptions of new genera and species. Proc. U.S. Natn. Mus., 90: 33-286.

Clarke, J.F.G. 1955. Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick. Trustees of the British Museum (Natural History) London, Vol. I: 332.

Clarke, J.F. G. 1963. Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick. Trustees of the British Museum (Natural History) London, Vol. IV: 517.

Clarke, J.F.G. 1965. Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick. Trustees of the British Museum (Natural History) London, Vol. V: 581.

Clarke, J.F.G. 1969a. Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick. Trustees of the British Museum (Natural History) London, Vol. VI: 537.

Clarke, J.F.G. 1969b. Catalogue of the type specimens of Microlepidoptera in the British Museum (Natural History) described by Edward Meyrick. Trustees of the British Museum (Natural History) London, Vol. VII: 528.

Common, I.F.B. 1958. A revision of the pink bollworms of cotton Pectinophora Busk (Lepidoptera: Gelechiidae) and related genera in Australia. Aust. J. Zool., 6(3): 268-306.

Common, I.F.B. 1970. Lepidoptera (moths and butterflies). In: The insects of Australia. Textbooks for Students and Research Workers, 765-866.

Diakonoff, A.N. 1952. Entomological results of Swedish expedition 1934 to Burma and British India. Lepidoptera collected by R. Malaise. Mirolepidoptera 1. Ark. Zool., 3: 73-79.

Diakonoff, A.N. 1968. Microlepidoptera of the Philippine Islands. Bull. U.S. Natl. Mus. (Washington), 484p.

Duponchel, 1838. Annls Soc. ent. Fr., 7:146.

Fletcher, T.B. 1909. Lepidoptera, exclusive of the Tortricidae and Tineidae, with some remarks on their distribution and means of dispersal amongst the islands of the Indian Ocean. Trans. Linn. Soc. London, 13: 265-323.

Fletcher, T.B. 1920. Life histories of Indian Insects, Microlepidoptera. Mem. Dep. Agric. India. Vol. VI, No. 1: 217.

Fletcher, T.B. 1933. Life histories of Indian Microlepidoptera (2nd ser.) Cosmopterigidae (auctorum) to Neopseustidae. Imp. Council Agric. Res. Sci. Monog. (Pusa), 4: 8.

Gaede, M. 1937. Catalogue of Gelechiidae. Lepidopterorum catlalogus. 79: 630.

Gozmany, L.A. 1971. Notes on Lecithoceridae taxa (Lepidoptera) I. Acta zool. Hung., 17 (3-4): 251-254.

Hampson, G.F. 1892. The Fauna of British India including Ceylon and Burma- Moths Vol. I, (eds.) Blanford, W.T., Published by Taylor and Francis, London, 577p.

Heppner, J.B. 1991. Faunal regions and the diversity of Lepidoptera. Trop. Lepidoptera Vol. 2(1): 85.

Heppner, J.B. 1998. Classification of Lepidoptera. Part 1. Introduction. Holarctic Lepidoptera Vol. 5(1): 148.

Herrich-Schaffer, 1853. Syst.Bearbeitung Schmett. Eur. 5: 12

Holloway, J.D.*et.al.*1987. Lepidoptera, C.A.B international Institute of Entomology, British Museum Natural History., 262p.

Hubner, 1816. Vertz. Bekannter Schmett., 407p.

Hubner, 1818. Zutrage Sammt.Exot. Schmett., 1:25.

Hubner, 1822. Syst. Alphab. Verz., 52: 66-80.

Keifer, H.H. 1927-37. California Microlepidoptera. Pan-Pac. Ent. (San Francisco). 3:136-138, 162 (1927); 4:129-132 (1928); 7:27-34 (1930); 8:61-73 (1931); Monthly Bull. Dept. Agric. (Sacramento). 22:351-365 (1933); 24:195-218 (1935); 25:235-259, 349-359 (1936): 26:177-204, 334-338 (1937): Bull. S. Calif. Acad. Sci. (Los Angeles), 35:9-29 (1936).

Krasil'nikova, G.A. 1981. Topographical distribution of Microlepidoptera in southern-western Turkmenia. Trudy Vsesoyuznogo Entomologicheskogo Obshchestva 63: 99-102.

Kulkarny, H.L. 1967. General Entomology for Agriculture Students. Asia Publishing House, Bombay,. i-xiv, 291p.

Linnaeus, C. 1758. Systema naturae per regna tria naturae. Secundum classes, order, genera, species cum characteribus, differentiis, synonymis, locis 106 (eds.) Stockholm. 2 v. (1956 facs. Reprint: Br. Mus. Nat. His. London).

Mani, M.S. 1971. Modern classification of Insects. Satish book enterprise, Agra, 331p.

Mathew G. 2004. Biodiversity Documentation for Kerala. KFRI Handbook No. 17, Part 7: Insects. 281p.

Mehta, D. 1978. A taxonomic account of Gelechiidae (Lepidoptera) of Chandigarh and surrounding areas along with the external morphology of Stegasta variana Meyrick M.Sc. Dissertation, Panjab University, Chandigarh, 290p.

Melline, E. and Verenini, M. 1986. Biological notes on insects of the semi-arid areas of Bolivian highlands during the spring. Bollettino Dell'stituto di Entomologia della Universita degli studi di Bologna. 40: 121-149.

Metcalfe, C.L. and Flint, W.B. 1962. Destructive and useful Insects, their habits and control (fourth edition), Mc Graw-Hill Book Co. Inc. 1087p.

Meyrick, E. 1905. Descriptions of Indian Microlepidoptera. J. Bombay nat. Hist. Soc., 16, 580-619.

Meyrick, E. 1907. Descriptions of Indian Microlepidoptera. J. Bombay nat. Hist. Soc., 17, 730-754, 976-994.

Meyrick, E. 1908a. Descriptions of Indian Microlepidoptera. J. Bombay nat. Hist. Soc., 18, 137-160, 437-460, 613-638, 806-832.

Meyrick, E. 1908b. New Microlepidoptera from India and Burma. Rec. Ind. Mus. 12, 3295-4000.

Meyrick, E. 1909. Descriptions of Indian Microlepidoptera. J. Bombay nat. Hist. Soc., 19, 410-437, 582-607.

Meyrick, E. 1910. Descriptions of Indian Microlepidoptera. J. Bombay nat. Hist. Soc., 20, 143-168, 435-462, 706-736.

Meyrick, E. 1911. Descriptions of Indian Microlepidoptera. J. Bombay nat. Hist. Soc., 21, 104-131, 852-877.

Meyrick, E. 1912-1916. Exot. Microlepid., I: 640p.

Meyrick, E. 1914. Descriptions of Indian Microlepidoptera. J. Bombay nat. Hist. Soc., 23, 118-130.

Meyrick, E. 1916-1923. Exot. Microlepid., II: 640.

Meyrick, E. 1923-1930. Exot. Microlepid., III: 640.

Meyrick, E. 1930-1936. Exot. Microlepid., IV: 642.

Minet, J. 1986. Ebauchedene Classification modern de l' orde des lepidopters. Alex., 14: 291-313.

Minet, J. 1991. Tentative reconstruction of the ditrysian phylogeny (Lepidoptera: Glossata). Ent. Scand. (Copenhagen). 22: 69-95.

Moore, F. 1867. On the Lepidopterous Insects of Bengal. Proc.Zool.Soc., 1865: 44-99.

Nayar, K.K., Ananthakrishnan, T.N. and David, B.V. 1976. General and Applied Entomology. Published by Tata Mc Graw-Hill publishing company Ltd. 589p.

Nel, P.J. 1999. New or poorly known species of Microlepidoptera from france (Lepidoptera) Bull. ent. Soc. Fr., 104 (4): 347-355.

Newman, 1856. Trans. ent. Soc. Lond., 2(3): 293p.

Pajni, H.R. and Mehta, D. 1986. A report on the Gelechiidae (Lepidoptera) of Chandigarh and adjoining areas. Research Bull. (Sc.) Panjab University., 37: 161-165.

Park, K.T. 2000a. Lecithoceridae (Lepidoptera) of Taiwan (II): Subfamily Lecithocerinae: Genera Lecithocera Herrich- Schaffer. Zoological Studies. 39(4): 360-374.

Park, K.T. 2002a. A revision of the genus Nosphistica Meyrick (Lepidoptera, Lecithoceridae). Zoological Studies 41 (3): 251-262.

Park, K.T. 2002b. Taxonomic review of the genus Torodora Meyrick in Thailand, with descriptions of fifteen new species (Lepidoptera: Lecithoceridae). Ins. Koreana, 18(4): 307-310. Ins. Koreana, 19(2): 147-166.

Park K.T. and Heppner, J.B. 2000. Lecithoceridae (Lepidoptera) of Taiwan (III) Subfamily Torodorinae: genus Torodora Meyrick. Trans. Lepid. Soc. Japan 51(4): 287-297.

Park, K.T. and Ponomarenko, G. 1999. Genus Hypatima Hubner and Allied Genera from Thailand (Lepidoptera: Gelechiidae). Species Diversity 4, 321-337.

Pathania, P.C. and Rose, H.S. 2004. Description of one new and redescription of two known species of Hygroplasta Meyrick (Lepidoptera: Lecithoceridae: Torodorinae) from India. Shashpa, 11 (2): 93-99.

Povolny, D. 1992. A critical review of the Palaearctic taxa of Gnorimoschema Busck (Lepidoptera, Gelechiidae). Acta Entomol. Bohemoslov. 89: 217-233.

Richard, O.W & Davies, R.G.1977. Imm's General Text Book of Entomology.Chapman & Hall, A Harvested Press Book, John widely & Sons, Newyork. 394

Robinson, G.S. 1976. A Taxonomic Revision of the Tinissinae of the world (Lepidoptera: Tineidae). Bull.Br.Mus.nat.Hist. (Ent.) 32(7): 253-300.

Robinson, G.S. 1979. Clothes moths of the Tinea pellionella complex: a revision of the World's species. Bull.Br.Mus.nat.Hist. (Ent.) 38(3): 57-128.

Robinson, G.S. 1988. A phylogeny for the Tineoidea. Ent. Scand., 19(2): 117-129.

Robinson, G.S. and Tuck. K.R. 1996. A revisionary checklist of the Tineidae (Lepidoptera) of the Oriental region. Occ. Pap. Syst. Ent., 9: 29.

Robinson, G.S., Tuck, K.R., and Shaffer, M. 1994. A field guide to smaller moths of South East Asia. Malaysian Nature Society, Malaysia, 309p.

Rose, H.S. and Pathania, P.C. 2003a. Taxonomic studies of Genus *Torodora* Meyrick (Lepidoptera: Lecithoceridae: Torodorinae) from Northwest India. Bioved, 14(1, 2): 141-157.

Sakamaki, Y. 2000. Japanese species of the genus Apatetris (Lepidoptera, Gelechiidae). Tijdschrift Voor Entomologie, Vol.143: 211-220.

Schaffner, J. V., Jr. 1959. Microlepidoptera and their parasites reared from field collections in the northeastern United States. U.S. Dept. Agric., For. Serv., Misc. Publ. (Washington), 767: 97.

Shamsudeen, R.S.M., Chandran, R., and Mathew, G. 2005. Collection of Microheterocera: A Newer Method. Bugs ' R' All. Vol. 8 No.1: 3P.

Sinev, S. Yu. 1986. A review of the Blastobasidae of the USSR (Lepidoptera), Proc. Zool. Inst. Acad. Sci. USSR 145: 53-71.

Srivastava, K.P. 1996. A textbook of allied entomology, Kalyani Publishers, Ludhiana,. 1-xiii, 507p.

Swinhoe, C. 1885. On the Lepidoptera of Bombay and the Deccan part IV: Heterocera (Count.). Proc.Zool.Soc. Lond., p. 881-885.

Turner, A.J. 1913. Studies on Australian Microlepidoptera. Proc. Linn. Soc. N.S.W. (Sydney). 28: 42-92.

Tuxen, S.C. 1970. Taxonomic glossary of genitalia of insect's 2nd (eds.) Copenhagen. 115-129.

Walker, 1863. Tineites. List of the specimens of lepidopterous insects in the collection of the British Museum. Trustees of the British Museum (Natural Museum) London.28: 521.

Walker, 1864. Tineites. List of the specimens of lepidopterous insects in the collection of the British Museum. Trustees of the British Museum (Natural Museum) London. 29: 563-835.

Walshingham, T. de G. 1881. On the Tortricidae, Tineidae and Pterophoridae of South Africa. Trans. Ent. Soc. London. 1881: 219-288.

Walshingham, T. de G. 1891. African Microlepidoptera. Trans. Ent. Soc. London. 1897: 33-67.

Walshingham, T. de G. 1892. On the Microlepidoptera of the West Indies. Proc. Zool. Soc. London, 1891: 491-549.

Walshingham, T. de G. 1897. Revision of the West-Indian Microlepidoptera with description of new species. Proc. Zool. Lond., 54-183.

Walshingham, T. de G. 1907. Microlepidoptera of Tenerife. Proc. Zool. Lond., 911-1028.

Warren, W. 1888. On the Lepidoptera collected by Major Yerbury in Western India in 1886 and 1887. Proc. Zool. Soc. Lond., 292-339.

Zimmerman, E.C. 1978. Insects of Hawaii. Vol. 9. Microlepidoptera. Honolulu: Univ. Hawaii, 1903p.

Appendix 1. List of Microlepidoptera recorded from India and Sri Lanka

Family	Distributions				Host	Remarks
	India	**W. Ghats**	**Kerala**	**Sri Lanka**		
Tortricidae						
Catamacta provocata	Assam, Khasis					Collection period: April
Capua cornigera	Madras	Nilgiris				Aug; 3500ft
Adoxophyes parastropha	Assam, Khasis					April and July
Homona socialis	Assam, Khasis					April, July and September
Totrix tricensa	Assam, Khasis					April, Oct and Nov.
T. humana	Sikkim, Dargiling					August; 7000ft
Epichorista ingenua	Sikkim, Kangra Valley					July; 4500ft
Arotrophora crustata	Assam, Khasis					June-August
Tymbarcha astuta	Assam, Khasis					
Spatalistis orbigera	Assam, Khasis					April
S. tyrophthora	Assam, Khasis					November
Eboda haruspex				Sri Lanka		April and October
E. facilis	Assam, Khasis					June, July, October
Peronea amethystas	Assam, Khasis					January
P. erioptila				Sri Lanka		June

P. enitescens	Assam, Khasis					September and October
P. dryadarcha	Assam, Khasis; Sikkim, Darjiling					July; 7000ft
P. semitexta	Sikkim					Nov., 4500ft
P. placata	Assam, Khasis					Assam, Khasis
P. hapalactis	Assam, Khasis					July
P. nectaritis		Nilgiris				May; 6000ft
P. petulana	Assam, Khasis					October
Graciilaridae						
Acrocercops hyphantica	Bengal, Pusa				Larva bred from *Caesalpinia bonducella*	August
Cyphosticha caerulea	Bengal, Pusa				*Crotalaria juncea*	April-July
Eucosmidae						
Ancylis tumida		N. Coorg		Kandy		September, August 3500ft
A. aromatias		N. Coorg				February and November; 3500ft
A. hylaea	Assam, Khasis					October and November
A. glycyphaga	Bengal, Pusa, Assam, Khasis				Feeds on sugary excretion of *Phromnia marginella*	January
Ecosma stereoma	Bengal, Pusa				*Acacia* sp.	August
Glyphipterygida*e*						
Mictopsichia picturata	Assam, Khasis					October
M. hexaphala				Sri Lanka		May
Lasiodictis melistoma	Assam, Khasis					May, June and September

Simaethis trogalia	Assam, Khasis					Jan and Dec.,
S. eumetra	Assam, Khasis					March
S. antichlora	Assam, Khasis					March
S. strepsidesma	Assam, Khasis					September and November
S. cothurnata	Assam, Khasis					November
S. achyrodes	Assam, Khasis, Bombay	Nilgiris, S. India				May-Dec; 3500ft
S. ialeura		Nilgiris, S. India		C Sri Lanka		Aug.; 3500 ft
S. psilachyra				Sri Lanka		May
S. holachyrma	Assam, Khasis					November
S. lethaea	Assam, Khasis					October and November
S. fulminea				Sri Lanka		December
S. diplogramma	Assam, Khasis					June, September and October
S. itriodes	Assam, Khasis					November
S. pilaria	Assam, Khasis					June
S. halimora	Assam, Khasis					July-September
Brenthia luminifera	Assam, Khasis					October and November
B. strophalora	Assam, Khasis					October
B. ardens	Assam, Khasis					October
B. cyanaula	Calcutta, Pusa	S. India, Coorg				Feb, July, Aug; 3500 ft
B. carola	Assam, Khasis					October, November
B. paranympha	Assam, Khasis					Dec-March
Choreutis hestiarcha	Assam, Khasis					July-October

C. philonyma				Sri Lanka		February
C. argyrota	Assam, Khasis					July-November
Glyphipteryx cultrata	Assam, Khasis					April
G. stilata				Sri Lanka		February
G. molybdora				Sri Lanka		November
G. tripedila	Assam, Khasis					April
Actinoscelis irina	Bombay, Kanara					December
Corsocasis coronias	Assam, Khasis	S. India, Coorg				May; 3500 ft
Trichothyrsa coridarcha	Assam, Khasis					September, October
T. flammivola		S. India, Coorg				Dec; 3500 ft
A. T. taedifera				Sri Lanka		November
T. pyrrhocoma				Sri Lanka		
T. grypodes		S. India, Palani hills				6000 ft
Gelechiidae						
Anarsia epotias			kerala			
Anthistarchia binocularis			kerala			
Aproaerema modicella			kerala			
Brachmia convolvuli			Amarambalam			
Hypatima haligramma			kerala			
Desmophylex barymochla			Amarambalam			
Dichomeris petalodes			Amarambalam			
Gaesa biignella			Amarambalam			
Gaesa decusella			Amarambalam			
Onebala lamprostoma			kerala			
Sitotroga cerealella			kerala			

Aristotelia leptocentra	Bengal, Pusa					June and July
Thiotricha janitrix	Bengal, Pusa					June
Epithectis palearis	Bengal, Pusa					June
Telphusa melanozona	Bengal, Pusa					August
Pachnistis arens	Bengal, Pusa					June
Brachmia parasema	Bengal, Pusa					May and June
Carposinidae						
Paramorpha aulata				Sri Lanka		Dec, Jan, September
Meridarchis concinna	Assam, Khasis					March and April
M. vitiata	Assam, Khasis					April
M. famulata				Sri Lanka		May
Carposina hercots	Assam, Khasis					September
Heliodinidae						
Idioglossa triacma	Assam, Khasis					October
I. argodora		Coorg				September; 3500 ft
Diadoxastis parathicta		Kanara				October
Isorrhoa antimetra	Assam, Khasis					April
Patanotis metallidias				Sri Lanka		April-June
P. harmosta				Sri Lanka		April-June
Hieromantis chrysoleuca	Assam, Khasis					July
H. ioxysta				Galle		June
Phalaritica vindex				Maskeliya		March
Stereosticha pilulata				Kiridi		November
Stathmopoda pentasema	Assam, Khasis					

S. stimulata				Colombo		
S. cissota						March
S. triloba				Sri Lanka		June and August
S. commoda	Assam, Khasis					April-September
S. tetrarma		S. India, Nilgiris				May; 6000ft
S. astricta		S. India, Nilgiris				July; 3500 ft
S. aprica				Sri Lanka		October
S. ignominiosa		Coorg				March, 3500ft
S. informis	Assam, Khasis					June
S. iners				Sri Lanka		March
S. sycophaga	Bengal, Pusa					May
S. neomeris				Sri Lanka		April
S. amphidyma		Coorg				October; 3500ft
S. brachygramma	Assam, Khasis					September
S. balanistis	Assam, Khasis					October
S. aristata	Assam, Khasis			Sri Lanka		
S. ochrodelta				Sri Lanka		October
S. porphyrantha				Sri Lanka		December
S. spilozona				Sri Lanka		
Yponomeutidae						
Aestherastis circulata			kerala			
Atteva fabriciella			kerala			
Comocritis pieria			kerala			
Ethima hilarella			Nilambur			
Plutellidae						
Plutella maculipennis			Palakkad			
Hilarographa caminodes			kerala			
Xyloryctidae						
Opsinia arenosella			kerala			
Oechophoridae						
Aelonthes dicraea			Peechi			

Psorosticha zizyphi			Amarambalam			
Tonica laganopis			Nilambur			
Tonica niviferana			Thrissur			
Tineidae						
Drimylastis telamonia			Nilambur			
Hapsifera rugosella			Palakkad			
Setomorpha rutella			kerala			
Tinea pellionella			kerala			
Cosmopterigidae						
Cosmopterix phaeogastra			kerala			
Labdia molybdaula			Nilambur			
Limnaecia peronodes			Silent valley			

List of plates

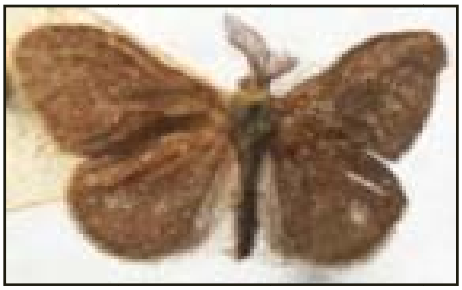
Plate- XVII	Male genitalia of Microheterocera Fig.1. *Tinea pellionella* Linnaeus (Tineidae) Fig.2. *Setomorpha rutella* Zeller (Tineidae)
Plate-XVIII	Female genitalia of Microheterocera Fig.1. *Tinea pellionella* Linnaeus (Tineidae) Fig.2. *Setomorpha rutella* Zeller (Tineidae)
Plate- XIX	Female genitalia of Microheterocera Fig.1. *Pyloetis mimosae* Meyrick (Tineidae) Fig.2. *Stathmopoda balanarcha* Meyrick (Oecophoridae)
Plate-XX	Female genitalia of Microheterocera Fig.1. *Erechthias platydelta* Meyrick (Tineidae) Fig.2. *Opogona lamprocrossa* Meyrick (Tineidae)
Plate- XXI	Male genitalia of Microheterocera Fig.1. *Nephantis serinopa* Meyrick (Oecophoridae) Fig.2. *Eucleodora coronis* Meyrick (Oecophoridae)
Plate-XXII	Male genitalia of Microheterocera Fig.1. *Periacma plumbea* Meyrick (Oecophoridae) Fig.2. *Promolactis semantris* Meyrick (Oecophoridae)
Plate- XXIII	Female genitalia of Microheterocera Fig.1. *Periacma plumbea* Meyrick (Oecophoridae) Fig.2. *Promalactis thiasitis* Meyrick (Oecophoridae)
Plate-XXIV	Male genitalia of Microheterocera Fig.1. *Timyra pastas* Meyrick (Lecithoceridae) Fig.2. *Timyra xanthaula* Meyrick (Lecithoceridae)
Plate- XXV	Female genitalia of Microheterocera

	Fig.1. *Eupselia isacta* Meyrick (Oecophoridae) Fig.2. *Timyra pastas* Meyrick (Lecithoceridae)
Plate- XXVI	Male genitalia of Microheterocera Fig.1. *Hygroplasta lygaea* (Meyrick) (Lecithoceridae) Fig.2. *Hygroplasta spoliatella* (Walker) (Lecithoceridae)
Plate-XXVII	Female genitalia of Microheterocera Fig.1. *Timyra xanthaula* Meyrick (Lecithoceridae) Fig.2. *Hygroplasta lygaea* (Meyrick) (Lecithoceridae)
Plate- XXVIII	Male genitalia of Microheterocera Fig.1. *Anarsia isogona* Meyrick (Gelechiidae) Fig.2. *Hypatima haligrama* Meyrick (Gelechiidae)
Plate- XXIX	Female genitalia of Microheterocera Fig.1. *Anarsia patulella* (Walker) (Gelechiidae) Fig.2. *Hypatima haligramma* (Meyrick) (Gelechiidae)
Plate-XXX	Male genitalia of Microheterocera Fig.1. *Sitotroga cerealella* Oliver (Gelechiidae) Fig.2. *Dichomeris evidantis* Meyrick (Gelechiidae)
Plate-XXXI	Male genitalia of Microheterocera Fig.1. *Idiophantis acanthopa* Meyrick (Gelechiidae) Fig.2. *Symmoca signetella* Meyrick (Blastobasidae)
Plate- XXXII	Male genitalia of Microheterocera

	Fig.1. *Labdia semicoccinea* Stainton (Cosmopterigidae) Fig.2. *Eumenodora tetrachorda* Meyrick (Cosmopterigidae)
Plate- XXXIII	Male genitalia of Microheterocera Fig.1. *Phycodes minor* Moore (Glyphipterigidae) Fig.2. *Atteva fabriciella* Swederus (Attevidae) Fig.3. *Leucoptera sphenograpta* Meyrick (Lyonetiidae)
Plate- XXXIV	Female genitalia of Microheterocera Fig.1. *Eumenodora tetrachorda* Meyrick (Cosmopterigidae) Fig.2. *Plutella xylostella* Linnaeus (Plutellidae) Fig.3. *Atteva fabriciella* Swederus (Attevidae)
Plate- XXXV	Male genitalia of Microheterocera Fig.1. *Tonica niveferana* Walker (Oecophoridae) Fig.2. *Ethmia acontias* Meyrick (Ethmidae)
Plate- XXXVI	Male genitalia of Microheterocera Fig.1. *Symmoca indagata* Meyrick (Blastobasidae) Fig.2. *Blastobasidae pulverea* Meyrick (Blastobasidae)
Plate-XXXVII	Female genitalia of Microheterocera Fig.1. *Dichomeris ianthes* Meyrick (Gelechidae) Fig.2. *Symmoca signetella* Meyrick (Blastobasidae)

PLATE- A

1

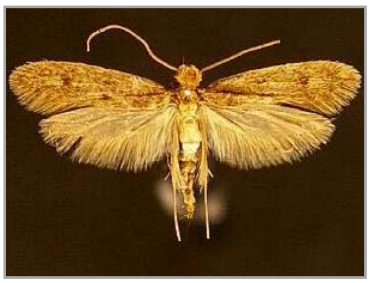


2

3

4

5



6

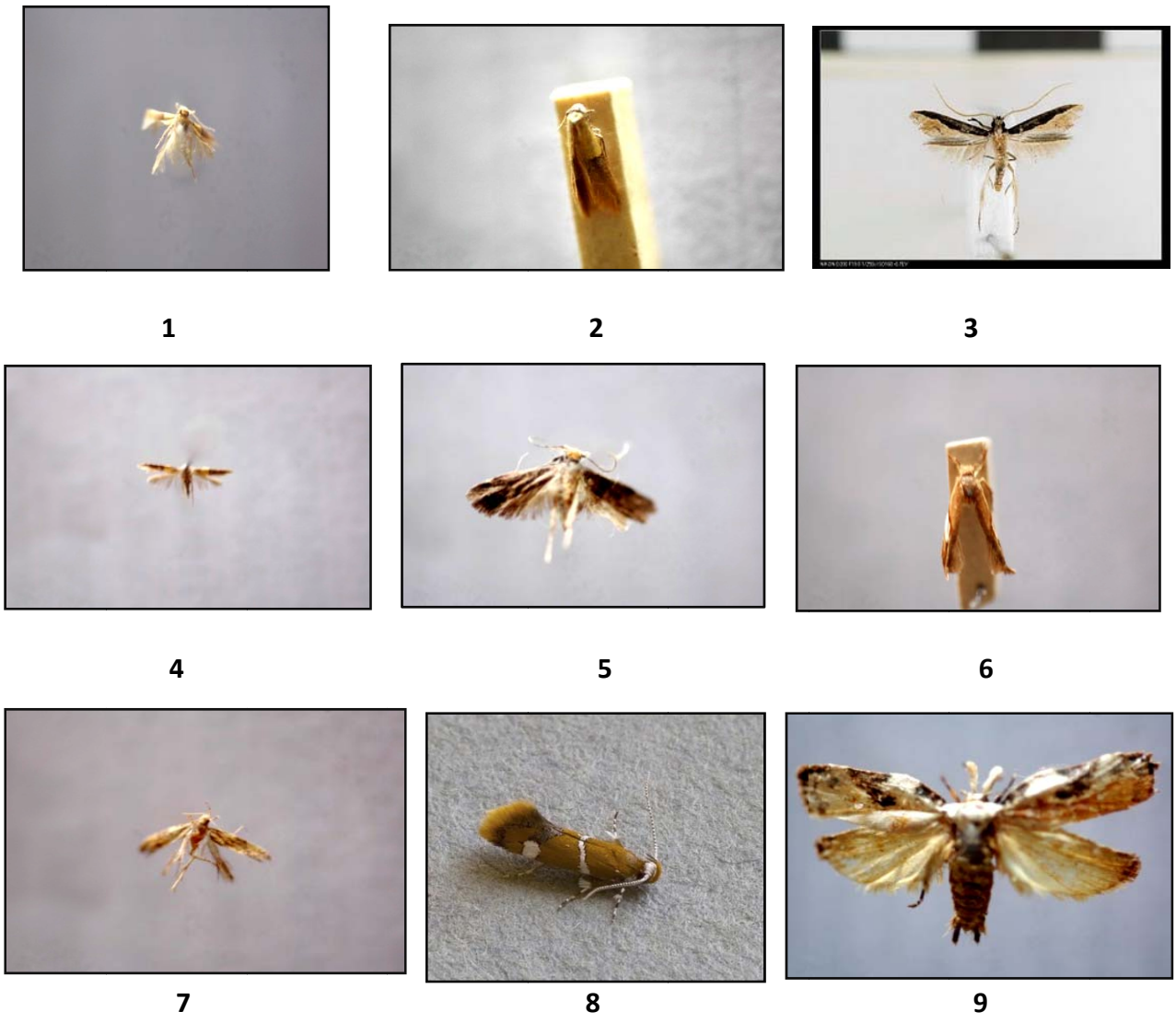
7

8

9

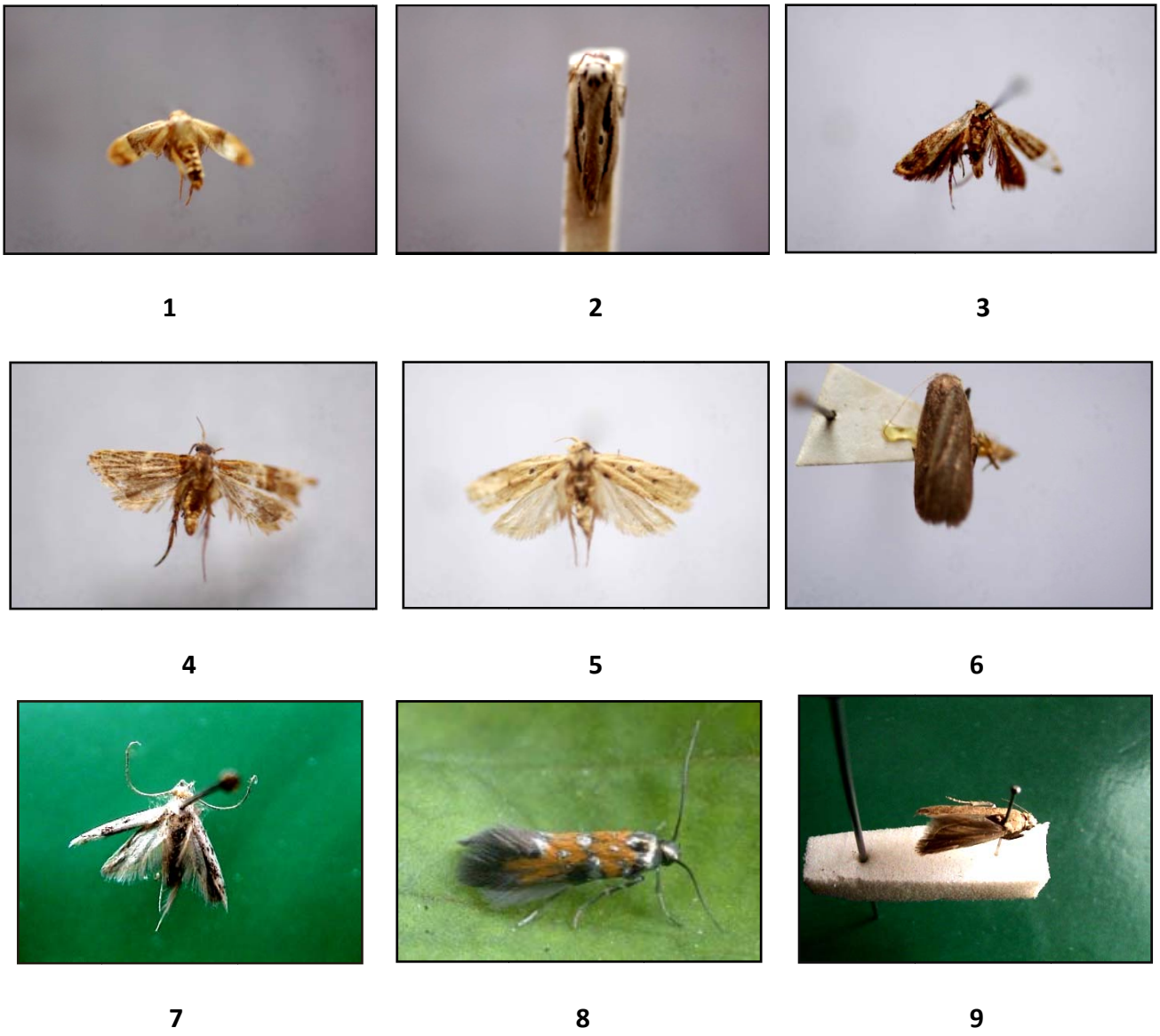
Figs. 1-9: 1. *Eumeta crameri* (Psychidae); 2. *Pteroma plagiohleps* (Psychidae); 3. *Edosa glossoptera* (Tineidae); 4. *Edosa opsigona*; 5. *Monopis monachella* (Tineidae); 6.*Tinea pellionella (*Tineidae); 7. *Tinea platyntis* (Tineidae); 8. *Tinea synaema* (Tineidae); 9. *Setomorpha rutella* (Tineidae)

PLATE- B



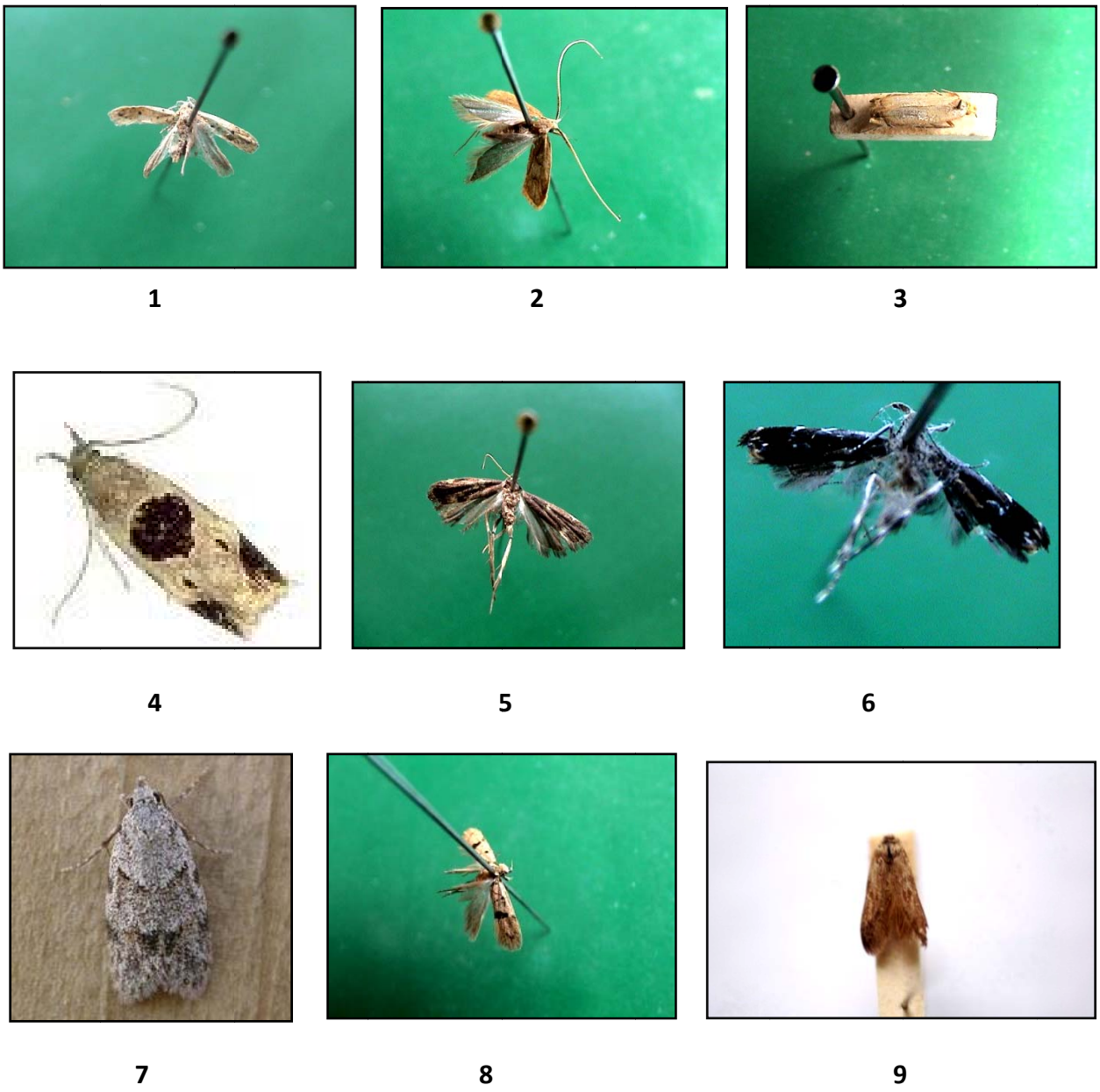
Figs. 1-9: 1. *Opogona lamprocrossa* (Tineidae); 2. *Opogon a xanthocrita* (Tineidae); 3. *Pyloetis mimosae* (Tineidae); 4. *Stathmopoda balanarcha* (Oecophoridae); 5. *Stathmopoda theoris* (Oecophoridae) 6. *Eucleodora coronis* (Oecophoridae); 7. *Periacma plumbea* (Oecophoridae); 8. *Promalactis semantris* (Oecophoridae); 9. *Tonica niveferana* (Oecophoridae).

PLATE- C



Figs. 1-9: 1.*Eupselia isacta* (Oecophoridae); 2. *Ethima acontias* (Ethmidae); 3.*Timyra pastas* (Lecithoceridae) 4. *Timyra xanthaula* (Lecithoceridae); 5. *Hygroplasta lygaea* (Lecithoceridae); 6. *Hygroplasta spoliatella* (Lecithoceridae); 7. *Anarsia* sp. (Gelechiidae); 8.*Sitotroga cerealella* (Gelechiida) 9.*Dichomeris evidantis* (Gelechiidae).

PLATE- D



Figs. 1-9: 1.*Dichomeris ianthes* (Gelichiidae); 2. *Fresilia* sp. (Gelechiidae); 3. *Idiophantis acanthopa* (Gelechiidae); 4. *Onebala hibisci* (Gelechiidae); 5. *Onebala hoplophora* (Gelechiidae); 6.*Stegasta* sp. (Gelechiidae); 7. *Symmoca signetella* (Blastobasidae); 8. *Symmoca* sp. 9. *Blastobasis pulverea* (Blastobasidae).

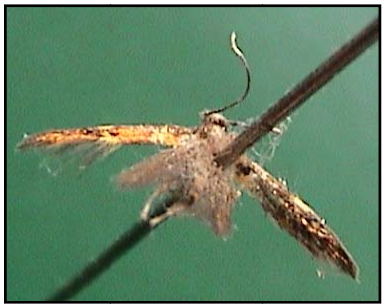
PLATE- E

1

2

3

4



5

6

7

8

9

Figs. 1-9: 1.*Blastobasis* sp. (Blastobasidae); 2. *Cosmopterix mimetis* (Cosmopterigidae); 3. *Labdia semicoccinea* (Cosmopterigidae); 4. *Labdia stibogramma* (Cosmopterigidae); 5. *Limnaecia chromaturga* (Cosmopterigidae); 6. *Limnaecia peronodes* (Cosmopterigidae); 7. *Phycodes minor (*Glyphipterigidae); 8. *Plutella xylostella* (Plutellidae); 9. *Argyresthia* sp. (Yponomeutidae).

PLATE- F

1

2

3

Figs. 1-3: 1. *Atteva fabriciella* (Attevidae); 2. *Leucoptera sphenograpta* (Lyonetiidae); 3. *Eretmocera* sp. (Heliodinidae).