Chapter IV

TAXONOMIC TERMINOLOGY & KEY CHARACTERS

4.1 GENERAL MORPHOLOGY OF MOTH

The morphology of the adult moth resembles in many respects that of butterfly. The Lepidoptera, in common with all other insects, have the soft parts of body held inside a hard exoskeleton composed of a substance known as chitin. Integument is soft, delicate, fragile or hard and parchment like. Depending on the body size moths divisible in two groups Micro-moths and Macro-moths; size of moths differs from species to species from small to large with wing expands from 5-190 mm, and considering wing area certain moths are largest insects in existence (Richards, 1977). Body somewhat elongated, cylindrical, wings flat and narrow or wide giving a flattened aspect to the whole body. As moths belongs to class Insecta body divisible into three major segments Head, Thorax and Abdomen.

![Figure 4.1: General Morphology of Moth (Lateral view).](image)

1. Coxa, 2. Trochanter, 3. Femur, 4. Tibia, 5. Tarsus, 
Figure 4.2: © General Morphology of Moth (Dorsal view)

Figure 4.3: © The Head (side view).
4.1.1 Head: (Figure 4.3) Head is relatively small, hypognathous, globular or hemispherical, free with small neck, largely covered eyes. The head carries a pair of many segmented and often scaled antennae.

Antennae (Figure 4.4) may be simple filiform, unisegmented, bipectinate, doubly bipectinate, ciliate, setose-ciliate, lamellate, fasciculate or combination of these. In certain families, such as Cossidae and Notodontidae the base of the antennae is pectinate and end apparently simple with few minute hairs or bristles. In some species the structure of antennae is substantially different between males and females and shows some sexual dimorphism (Barlow, 1982). In general, the antennae of male have a more complicated structure than those of female to receive signals to find newly emerged females.
At the base of antennae a pair of prominent black globular compound eyes presents. Compound eyes may be smooth, hairy or lashed. In many families these distinctions are of considerable importance, although it is often difficult to observe the hairs or lashes in old or worn set specimens. Certain groups have ocelli, one above each eye, but these are frequently difficult to detect, as are the chaetosemata, which are paired organs, consisting of sensory hair of unknown function (Barlow, 1982).

The mouthparts comprise of proboscis, consisting of two highly modified maxillae, held together by a series of hooks and spikes to form a tube through which liquid food may be sucked. Normally proboscis is coiled like a watch-spring beneath the head. In certain species it is totally absent, and the adult insect is then incapable to taking any nourishment. In other it is atrophied, short, and probably useless. In certain hawkmoths (Sphingidae), it may be longer than body size. The maxillary palps are generally small and difficult to observe, or absent. The labial palps normally three segmented, hairy or scaled at base, projecting forwards and upwards. Labial palps are of considerable importance in classification at or below the family level, and are particularly strongly developed in certain Hypeninae.

4.1.2 Thorax: The thorax is well developed, and divided into three parts prothorax, mesothorax and metathorax. Thorax is segmented, closely fused, and not readily identifiable from each other; the Venter being called the pectus. Prothorax normal in lower forms and reduced to a narrow collar in high groups, with patagia or dorsolateral sclerites, which are directed backwards well developed in some genera.
Mesothorax is largest and bears a pair of articulated dorsal plate, the tegulae, on occasions scaled or hairy and strikingly different in color from the reminder of thorax. Metathorax is of same size or smaller than mesothorax, with scaly posteriorly directed sclerites over the bases of primeries. On either side of metathorax a complex organ is present i.e. Tympanum. Mesothorasic and metathorasic segments on either side bear a pair of wings; mesothorax bears the front pair of wings, and smaller metathorax the hind pair of wings as well as the thorax contains the muscles required for locomotion. In additions to that moth from families Notodontidae, Noctuidae, Pyralidae, Crambidae and Geometridae possess a pair of tympanal organs. On examination under a magnifying glass, and after removal of surface scales tympanal organs are visible as cavities situated either one each side of metathorax or on abdomen which detect the ultrasonic cries of predatory bats (Barlow, 1982).

The wings are well developed, rarely vestigial, fore pairs or primeries usually larger than hind pair; wings are membranous and usually covered with scales on both dorsal and ventral side, but in some species such as the sphingid *Cephonodes hylas*, the scales are shed during his first flight (Barlow, 1982). Wings usually held horizontally out from the body when at rest, sometimes with hindwings concealed (Castner, 2000). Specialized scales microtrichia (minute hairs), androconia and gland scales are found in males of certain species. They differs in shape and structure from the normal scales and are sometimes associated with pouches on the wings containing erectile hair-tufts, producing scents known as pheromones, which assist in courtship and mating.

A wing consists of an upper and lower membrane which are connected by minute fibres and strengthened by a system of thickened hollow ribs, popularly but incorrectly referred to as veins, as they may also contain tracheae, nerve fibres and blood vessels (Evans, 1932; Chapman, 1998). Tubular veins run through the two-layered membranous wing. Veins are connected to the haemocoel and in theory allow haemolymph to flow through them.
1. Basal sport,
2. Sub-basal fascia,
3. Antemedial fascia,
4. Orbicular stigma,
5. Basal streak,
6. Claviform stigma,
7. Median fascia,
8. Reniform stigma,
9. Sub-reniform stigma,
10. Post-medial fascia,
11. Sub-terminal fascia,
12. Terminal fascia,
13. Apical streak,
14. Tornal streak,
15. Fringe.

Figure 4.6: © Wing pattern in moth (A) Forewing, (B) Hindwing.

1. Frenulum,
2. Post-medial fascia,
3. Fringe,
4. Discal spot,
5. Terminal fascia

(B)
In addition, a nerve and trachea may pass through the veins (Capman, 1998). The venation of the wings is a subject of considerable importance in classifying the Lepidoptera. In the primitive Lepidoptera, the monotrysia, the venation of the forewing and hindwing is similar, i.e homoneurous rather than more highly developed ditrysia, the venation of the fore- and hindwings is markedly different, i.e heteroneurous.

![Diagram of wing venation]

C : Costal,  
Sc : Subcostal,  
R : Radius,  
Rs : Redial sector,  
M : Median,  
CuA : Cubitus anterior,  
CuP : Cubitus posterior,  
A : anal,  
D : Discal cell.

Figure 4.7: General heteroneurous wing venation.

The terminology is based on the Comstock-Needham system which gives the morphological description of insect wing venation (Scoble, 1995). Figure 4.7 shows the typical forewing and hindwing venation of a heteroneurous moth, while figure 4.6 represents the main elements of the wing pattern referred to in the text. Forewings usually dark with a mottled pattern of lines (fascia) or dots (stigma); hindwings may match forewings in colour or have bright colours that are concealed when at rest. The main features are the discal cell, and a series of veins radiating...
outwards from the base of the wing. Veins are strong many longitudinal and few cross veins, branching venations usually held erect horizontally or roof like at rest. In many species the number of veins is substantially reduced, especially amongst those groups which are more highly developed. Moths from family Pterophoridae wings are divided into lobe usually forewing with 2-4 and hindwings with 2-3 lobes (Castner, 2000) and looks T-shaped appearance when viewed dorsally. The functions of the veins are strengthen the wings for flight and has role in circulation of the blood.

Wing coupling is of considerable importance in the higher classification of the lepidoptera. A number of different forms are found; in primitive monotrysian, a jugum or finger-like process is present on the hind margin of the forewing base. It projects beneath the costa of the hindwing, which is thus firmly held between the jugum and the hind margin of the forewing. While in ditrysia the usual structure is a frenulum arising from the humeral angle of the hindwing. This is held in place on the underside of the forewing by a retinaculum. In the male the frenulum is usually represented by a single bristle, while in the female it is usually multiple. The retinaculum also shows sexual differences; in female it is no more than a group of stout hairs, while in male it generally takes the form of a curved hook, developed from one of the veins. An examination of the frenulum is often the simplest method of determining the sex of a moth. However, in the Saturniidae and Lasiocampidae no such frenular arrangement exists, and the wings are held together merely by a substantial degree of overlap between them as a result of the enlargement and strengthening of the humeral lobe of a hindwing, a system known as amplexiform coupling. Wings does different functions besides providing the primary function of flight, wings also have secondary functions of self-defence, camouflage and thermoregulation (Scoble, 1995).

The legs are usually well developed and are three pairs; each pair originated from ventral side of the three thorasic segments respectively. Legs (figure 4.8) are divided into five segments are coxa, trochanter, femur, tibia and tarsus.
The main articulating joint is that between the coxa and the trochanter. The tibia frequently bears spurs, the number on different legs being an important feature in classification. Forelegs are frequently shorter than the other two pairs; the foreleg tibia in certain families carries a special spur or epiphysis like the antenna cleaner. In the male of some species the mid- and more frequently hindleg tibiae are provided with a tuft of hair whose function is scent production. When at rest it lies in a groove on the tibia. The tarsi are generally five-segment and normally clawed, first longest and swollen. In many species the leg bears highly specialised sensory or taste organs.

4.1.3 Abdomen: Abdomen divided into ten movable segments. The abdomen carries the organs of digestion, respiration, excretion, and in females the gonads which produce the eggs. A tympanum may be present on the sides of segment near the first pair of abdominal spiracle. In geometroidea the tympanum is closely associated with the first abdominal spiracle. Spiracles are found on the sides of segments 1-7 of the abdomen. Spiracles are small respiratory openings, lead to a series of tracheae through which air diffuse to all parts of body of adult moth. The
female produces the heromones and plays an important communication role in social behaviour of insects.

The seventh and eighth segments are modified in some species to accommodate the genitalia, and the ninth & tenth are fused and greatly modified to form the genitalia. In the males there is pair of central claspers, which grip the females during mating and surround the central ejaculatory organ. The presence of pair of clasper at the hind end of the abdomen is simple and reliable way to distinguish the sexes.

Figure 4.9: General structure of male genitalia in Lateral view.

In male (Figure 4.9) the ninth abdominal segment consist of the tegument, he base of which rests on the plane of the ventral surface of the abdomen, the upper part curving anally, until it lies longitudinally in the plane of dorsal

Figure 4.10: General structure of female genitalia in Lateral view.
surface. It is flattened sac of thin chitin, enclosed in a stronger ring, the dorsal point of which is called the uncus, and the basal portion the vinculum (Pierce, 1909). This ring is sometimes articulated, in the middle laterally, enabling the uncus half to be thrown backward towards the head. In the females (Figure 4.10) some fusion of the terminal segments occurs to give rise to an egg laying tube or ovipositor. Ovipositor is segmented tube of varying length bearing a lateral pair of lobes, which is usually withdrawn within the body cavity (Pierce, 1909). The female also produces the scent that attracts male.

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