General Entomology **College of Education**
Lecture: 7 Insect wings

Wings are developed fully only in the adult, or exceptionally in the subimago of Ephemeroptera. Typically, functional wings are broad leaf like, cuticular projections supported by tubular, sclerotized veins. The major veins are longitudinal, runningfrom the wing base towards the tip, and are moreconcentrated at the anterior margin. Additional supporting cross-veins are transverse struts, which jointhe longitudinal veins to give a more complex structure. The major veins usually contain tracheae, bloodvessels, and nerve fibers, with the intervening membranous areas comprising the closely appressed dorsal and ventral cuticular surfaces (Fig.1).

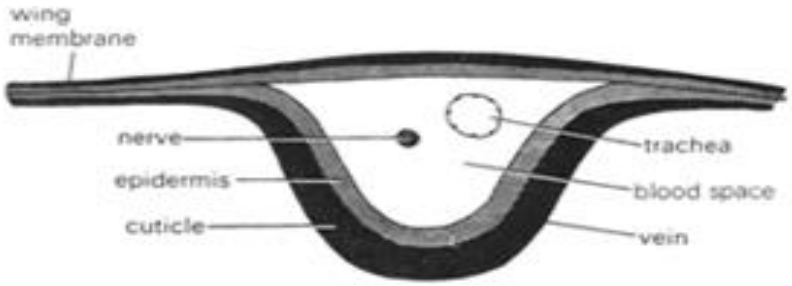

Fig.1 Diagrammatic section through part of awing including transverse section of vein.

A typical insect wing is triangular with three margins and three angles. **Three margins are: costal or anterior, Apical or outer and Anal or inner.**
Three angles are: Humeral angle: between body wall and costal margin, Apical or outer angle: between costal and apical margin, Anal angle: between apical and anal margin. The surface area of typical insect wing is divided into two portions ie. Remegium and Vannal Area. The anterior (upper) part of the wing towards coastal margin where more no of longitudinal veins are present is called remigium. The posterior part of the wing where veins are sparsely distributed is known as vannal area, which is called as clavus in forewings and vanus in hindwings. Jugum is the inner most portion of the wing that is cutoff from the main wing by jugal fold (Fig.2).

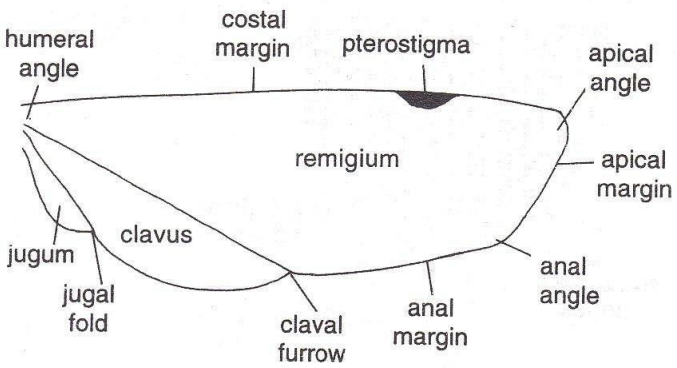

Fig. 2 Insect wing areas

Hair of two types occurs on the wings, larger hairs known as **macrotrichia**: are Socketed and may be restricted to veins, the scales of Lepidoptera and Trichoptera are highly modified macrotrichia, and **microtrichia**: Small and irregularly scattered fixed hairs that lack the basal articulation characteristic of setae. These are found onthe wings of some Mecoptera and Diptera.

Arrangement of veins on wing surface isknown as **Wing venation,** which consists of two types of veins, Longitudinal veins and Cross veins.

Longitudinal veins:

1. **Costa (C) :** It forms the thickened anterior margin of the wing (costal) and is un-branched. and is convex
2. **Sub costa (Sc) :** It runs immediately below the costa always in the bottom of a trough between **C** and **R** . It is forked distally .The two branches of **SC** are **Sc1** and **Sc2** and is concave
3. **Radial vein (R):** It is the next main vein , stout and connects at the base with second auxillary sclerite , it divided in to two branches **R1** and **Rs** (Radial sector). **R1** goes directly towards apical margin and is convex; **Rs** is concave and divided in to 4 branches, **R2, R3,R4, R5.**
4. **Media (M)** It is one of the two veins articulating with some of the small median seclerites. It is divided in two branches 1. **Media anterior** (MA) which is convex and 2.**Media posterior**(MP) and is concave.

Media anterior is again divided into **MA1** and **MA2**. Median posterior is again divided in to **MP1, MP2, MP3, MP4**.

5. **Cubitus (Cu):** It articulates with median auxillary sclerite. Cubitus is divided into convex **CU1** and concave **CU2**. CU1 is again divided into **CU1a** and **CU1b.**
6. **Anal veins (A) :** These veins are convex. They are individual un-branched, 1-3 in number. 1 or 2 jugal veins (unbranched) are present in the jugal lobe of the forewing

Cross veins

Humeral cross vein (h) : between costa and subcosta

Radial cross vein (r) : between radius and radial sector

Sectorial cross veins (s): between sub branches of radial sector

Radio medial cross vein (r-m): between radius and media

Medical cross veins : between branches of media

Medio-cubital veins : between media and cubitus

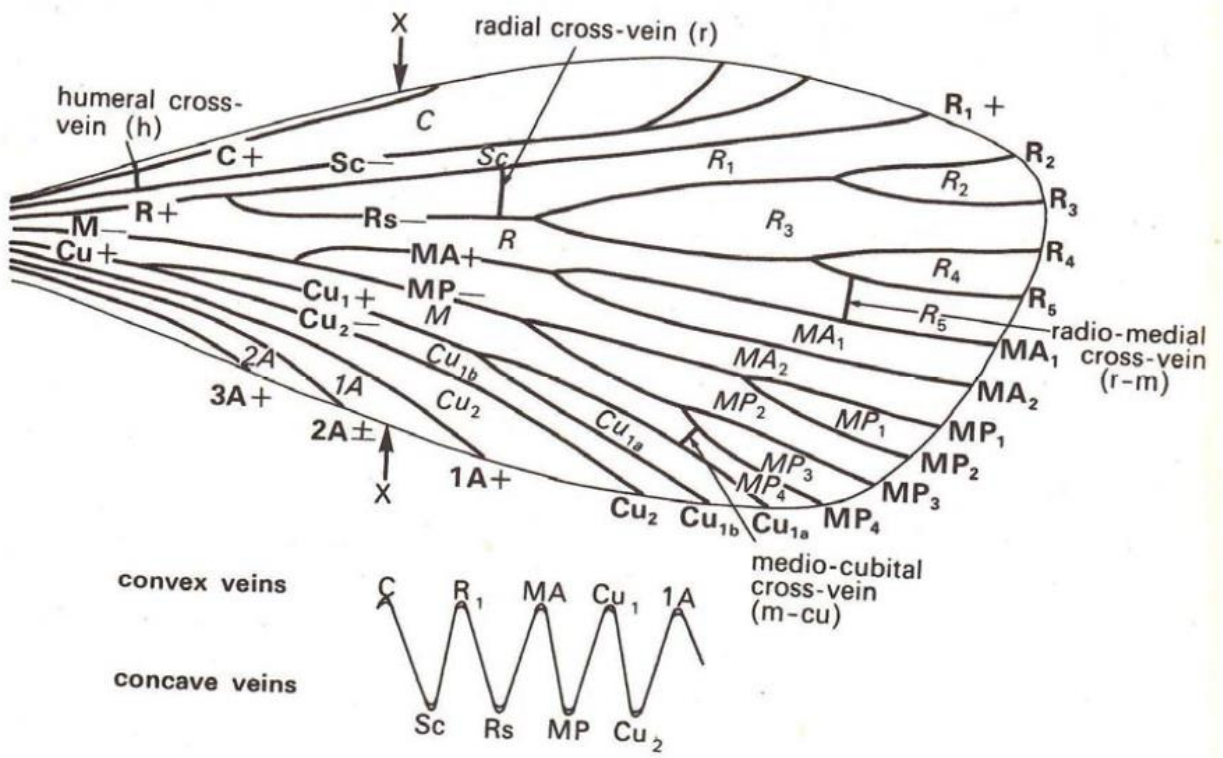

Fig.3 Basic scheme of wing venation.

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Insects are the only invertebrates possessing wings and capable of true flight. Based on the presence or absence of wings, class insecta is divided into two subclasses.

1. **Apterygota:** The primitive apterygotes are wingless eg. Silver fish and Spring tails.
2. **Pterygota**: among the pterygotes, wings arise from meso and meta thoracic segments, front pair of wings is known as forewings and back pair of wings is known as hindwings.

In the heterometabola their wing- buds develop as external outgrowths which are visible from outside throughout most of the nymphal instars till they expand to their full size after the last molt (hence also called **Exopterygota**).

In the holometabola their wing- buds develop inside invaginated sacs of the body wall, so they are not invisible from outside throughout the whole larval period (hence also called **Endopterygota**)

Sometimes wings may be reduced among pterygotes e.g. Mallophaga and Siphunculata . In coccids, only males are winged; and aphids may or may not havethe wings.Based on the degree of development of wings the insects may be classified into three forms

Macropterous (large-winged), **Brachypterous** (with short wings that donot cover the abdomen), and **Apterous** (wingless).

Cells are areas of the wing delimited by veins, and may be **open** (extending to the wing margin) or **closed** (surrounded by veins). They are named usually according to the longitudinal veins or vein branches that they lie behind, except that certain cells are known by special names, such as the discal cell in Lepidoptera (Fig. 4a) and the triangle in Odonata (Fig. 4b).

Pterostigma. is an opaque or pigmented spot anteriorly near the apex of the wing, on forewing in Hymenoptera, Pscoptera, Megaloptera and Mecoptera and on both wings in **Odonata**. Functions as **inertial mass in flight**. Reduces wing flutter during gliding in odonates, thereby increasing flight efficiency. Provides passive control of angle of attack in small insects, which enhances efficiency during flapping flight.

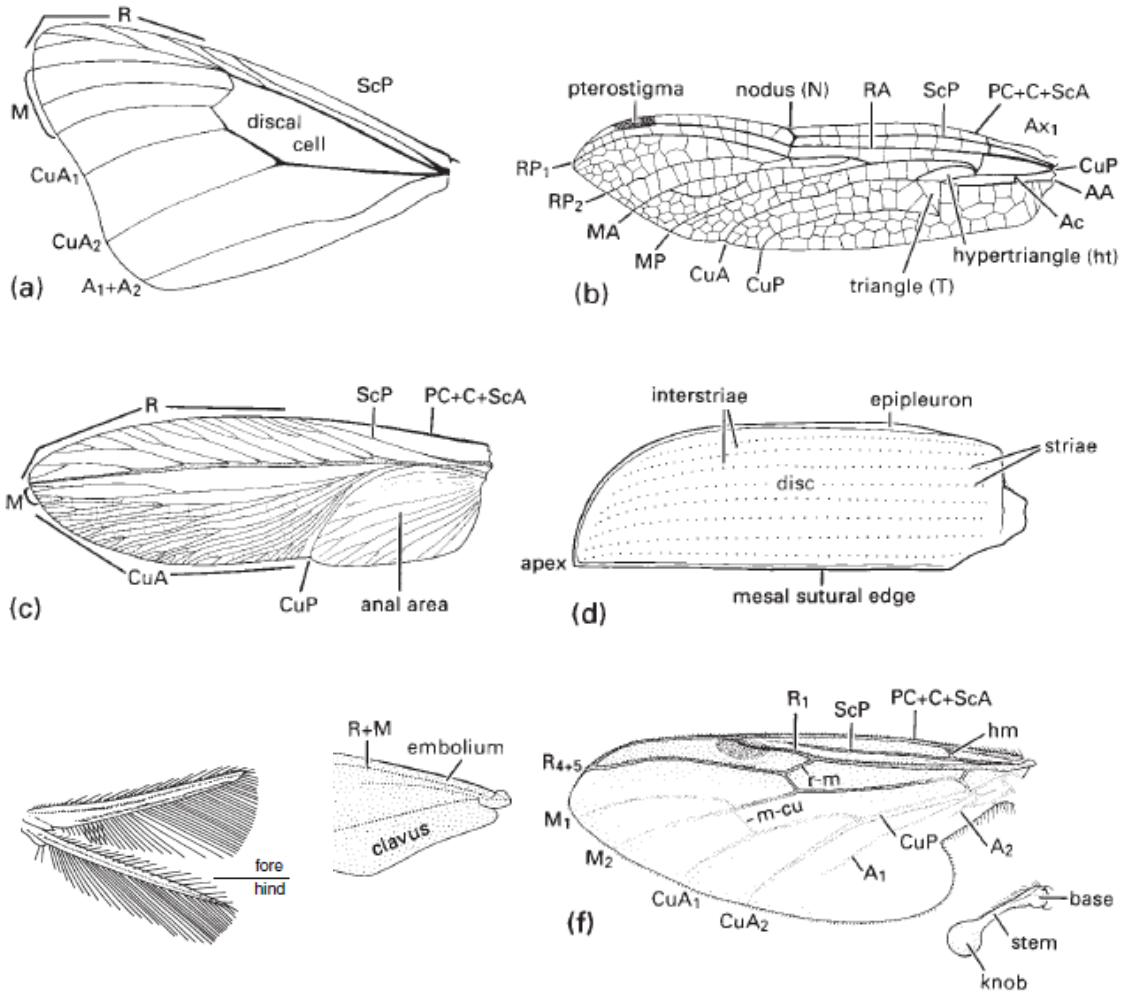
Different types of wings (Fig.4).

Usually, two pairs of functional wings lie dorsolaterally as fore wings on the mesothorax and as hind wings on the metathorax; typically the wings are membranous and transparent. However, fromthis basic pattern are derived many other conditions, often involving variation in the relative size, shape and degree of sclerotization of the fore and hind wings.

Examples of fore-wing modification include: the thickened, leathery fore wings of Blattodea, Dermaptera and Orthoptera, which are called tegmin (Fig. 4c); the hardened fore wings of Coleoptera that form protective wing cases or elytra (Fig. 4d); and the hemelytra of heteropteran Hemiptera, with the basal part thickened and the apical part membranous (Fig. 4e). Typically, the heteropteran hemelytron is divided into three wing areas: the membrane, corium and clavus. Sometimes the corium is divided further, with the embolium anterior to R+M, and the cuneus distal to a costal fracture.

Both the wings of moths and butterflies are thin, membranous but covered with unicellular scales allover the surface(Scaly wings), they are useful for flight. In Diptera the hind wings are modified as stabilizers (halteres) (Fig. 4f) and are divided in to three regions namely scabellum, pedicel and capitellum, they act as balancers and do not functionas wings, whereas in male Strepsiptera the fore wingsform halteres and the hind wings are used in flight.

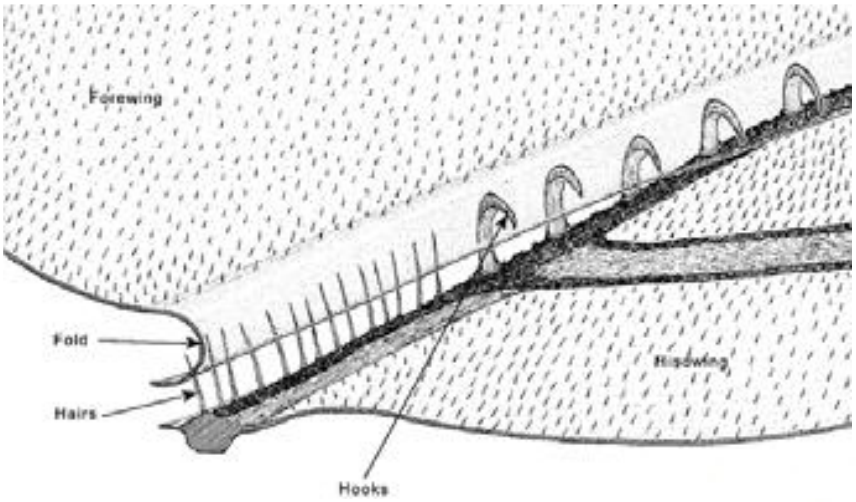
Small insects confront different aerodynamic challenges compared with larger insects and theirwing area often is expanded to aid wind dispersal. Thrips (Thysanoptera) for example, have very slender wings but have a fringe of long setae or ciliato extend the wing area (Fringed wings) (Fig. 4g).



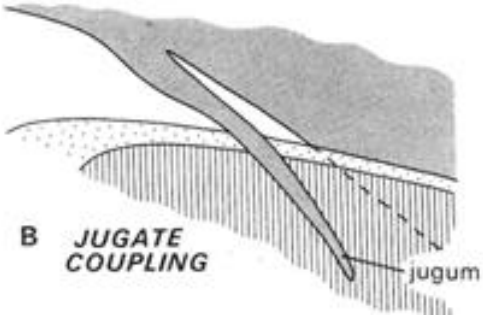
Wing coupling apparatus.

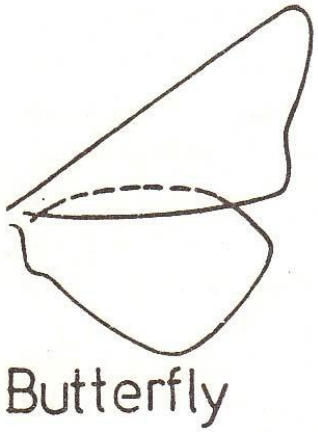
For taking flight, insect need to keep both the fore and hindwings together as a single unit. The structures in the form of lobes, bristles, hairs or spines that help thewings to be together are known as wing coupling organs. Orthoptera and Odonata wings are not anatomically coupled. Observe the following types of wing couplingin different insects.

The commonest coupling mechanism (seen clearly in Hymenoptera and some Trichoptera) is a row of small hooks, or **hamuli**, alongthe anterior margin of the hind wing that engages with a fold along the posterior margin of the fore wing (**hamulate coupling**) (fig.5 a). In some other insects (e.g. Mecoptera, Lepidoptera and some Trichoptera), a jugal lobe of the fore wing overlaps the anterior hind wing (**jugate coupling**) (fig.5b). , eg. Primitive lepidopterans of the family Hepialidae, or the margins of the fore and hind wing overlap broadly (**amplexiform coupling**) (fig.5c), eg. butterfly, or one or more hind-wing bristles (the **frenulum**) hook under a retaining structure (the **retinaculum**) on the fore wing (**frenate coupling**) (fig.5d) eg. Family Sphingidae of the order lepidoptera.



A Hamulate coupling type





C Amplexiform coupling type

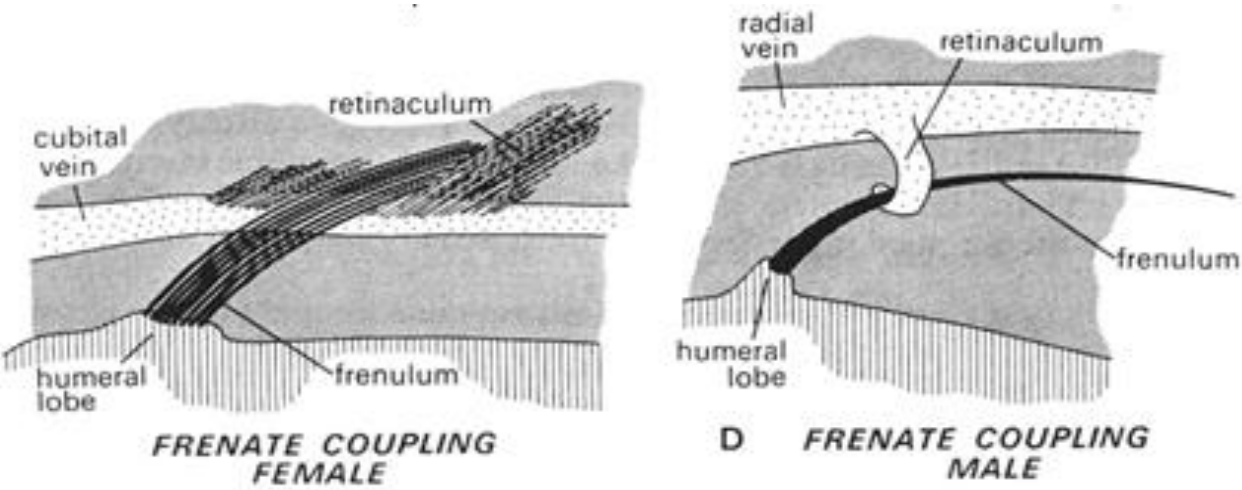


Fig.5 Wing coupling mechanism.