1.3 Thorax– structure and appendages

Thorax

The thorax is the locomotory centre of insects. It is the middle region of the insect body, bearing three pairs of legs and usually two pairs of wings. Anteriorly it is connected with the head by a membranous neck called cervix while as posteriorly it is connected with the abdomen.

The thorax of modern insects consists of three segments termed the prothorax, mesothorax, and metathorax. The last two collectively are called the pterothorax (Greek, ptero = wing or feather) because extant insects bear wings on these segments only. The individual dorsal sclerites or terga of the thoracic segments are also known as nota (Greek, notos = back; sing, notum). The nota of Apterygota and many immature insects are similar to the terga of the abdomen with typical secondary segmentation. The nota of each thoracic segment are serially distinguished as the pronotum, mesonotum, and metanotum.

The size and shape of the prothorax are highly variable. The prothorax may be a large plate as in Orthoptera, Hemiptera, and Coleoptera, or reduced in size forming a narrow band between the head and mesothorax as in Hymenoptera. The prothorax is usually separated or free from the mesothorax. The sclerites are separated by a membrane that may be large and conspicuous in more primitive holometabolous insects such as Neuroptera and Coleoptera, or reduced in size in more highly evolved holometabolous insects such as Diptera and Hymenoptera.

The pterothorax includes the thoracic segments immediately posterior to prothorax. In winged insects the relationship between thoracic segments involved in flight can be complicated. In contrast, the thorax of larval insects and most wingless insects is relatively simple. The mesothorax and metathorax of these insects are separated by membrane. Adult winged insects show a mesothorax and metathorax that are consolidated (i.e., more or less united) to form a functional unit modified for flight.

The development of the pterothoracic segments varies among winged insects. When both pairs of wings participate equally in flight, the two thoracic segments are about the same size. This condition is seen in Odonata, some Lepidoptera, and some Neuroptera. When one pair of wings is dominant in flight, the corresponding thoracic segment is commensurately larger and modified for flight, whereas the other thoracic segment is reduced in size. This condition is seen in Diptera and Hymenoptera, where the forewing is large and dominant in flight. The reverse condition is seen in the Coleoptera, where the hind wing is large and dominant in flight.

In more closely related insect groups, such as families within an order, that are primitively wingless or in which wings have been secondarily lost in modern or extant species, many modifications to the thorax occur. Many wingless forms can be attributed to environmental factors that promote or maintain flightlessness. For instance, island-dwelling insects are commonly short winged (brachypterous), or wingless, whereas their continental relatives are winged, presumably because for island species, flight increases the likelihood of being carried aloft, moved out to sea, and subsequently lost to the reproductive effort of the population. The anatomical consequences of flightlessness can be predictable; in the Hymenoptera, short wings bring a disproportionate enlargement of the pronotum and reduction in size of the mesonotum and metanotum.

Sutures and Sclerites of Wing-Bearing Segments

The wing-bearing segments of the thorax are subdivided into a myriad of sclerites that are bounded by sutures and membranous areas. These sutures and sclerites are the product of repeated modification of the thorax in response to various demands placed on the insect body by the environment. Similar modifications have occurred independently in many groups of insects; some modifications are unique. Generalizations are difficult to make, given the large number of sutures and sclerites, coupled with the number of insects that there are to consider.

Dorsal Aspect

The nota of the pterothorax are further subdivided into the prescutum, scutum, and scutellum; again, serially distinguished as mesoscutum and mesoscutellum, and metascutum and metascutellum. Additionally, there are sclerites anterior and posterior to the notum.

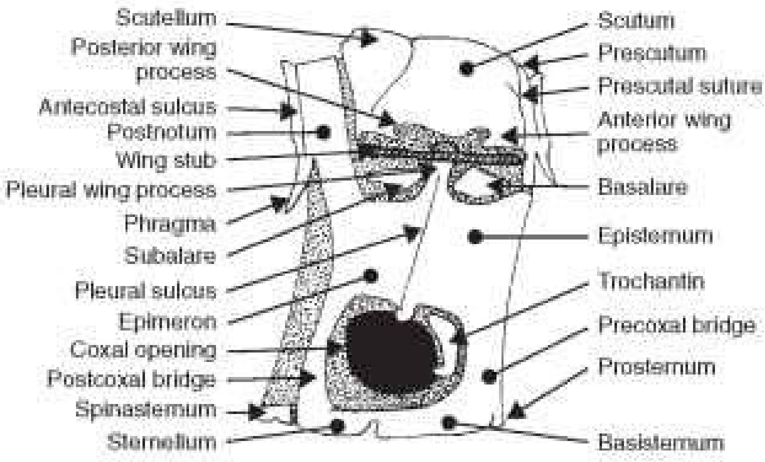


Fig. Diagram of the pterygote pterothorax.

The prescutum is the anterior portion of the scutum, laterally bearing prealar bridges separated by the prescutal suture from the mesoscutum. The scutum is the largest dorsal sclerite of the notum and is bounded posteriorly by the scutoscutellar suture, which divides the notum into the scutum and scutellum. The scutellum is generally smaller than the scutum. In Heteroptera it is a small triangular sclerite between the bases of the hemelytra. In Coleoptera the scutellum is the small triangular sclerite between the bases of the elytra. In Diptera and Hymenoptera the scutellum is relatively large, forming a subhemispherical sclerite, sometimes projecting posteriad. The posteriormost sclerite of the notum is the postnotum, separated from the notum by secondary segmentation. In some insects there is a postscutellum (metanotal acrotergite) that forms the posteriormost thoracic sclerite of the metanotum, or the posteriormost sclerite of the thorax. In Diptera the postscutellum appears as a transverse bulge below the scutellum.

The acrotergite and postnotum deserve further explanation. Again, the anteriormost sclerite is an acrotergite, the anterior pre-costal part of the notal plate. The postnotum is an intersegmental sclerite associated with the notum of the preceding segment. The postnotum bears the antecosta, a marginal ridge on the inner surface of the notal sclerite corresponding to the primary intersegmental fold. The antecostal suture divides the acrotergite from the antecosta, the internal ridge marking the original intersegmental boundary. Thus, when the antecosta and acrotergite are developed into larger plates and are associated with the notum anterior to them, they are referred to as a postnotum.

Lateral Aspect

The pleuron (Greek = side; pl., pleura) is a general term associated with the lateral aspect of the thorax. Adults, nymphs, and active larvae all display extensive sclerotization of the pleural area. Sclerites forming this part of the body wall are derived from the precoxa, sub-coxa, or supracoxal arch of the subcoxa.

Pleural regions of the thorax

Apterygota and Immature Plecoptera:

The anapleurite is the sclerotized area above the coxa (supracoxal area). The coxopleurite is a sclerotized plate situated between the coxa and the anapleurite, It bears the dorsal coxal articulation, the anterior part of which becomes the definitive trochantin. The sternop-leurite, or coxosternite, is the definitive sternal sclerite that includes the areas of the limb bases and is situated beneath the coxa.

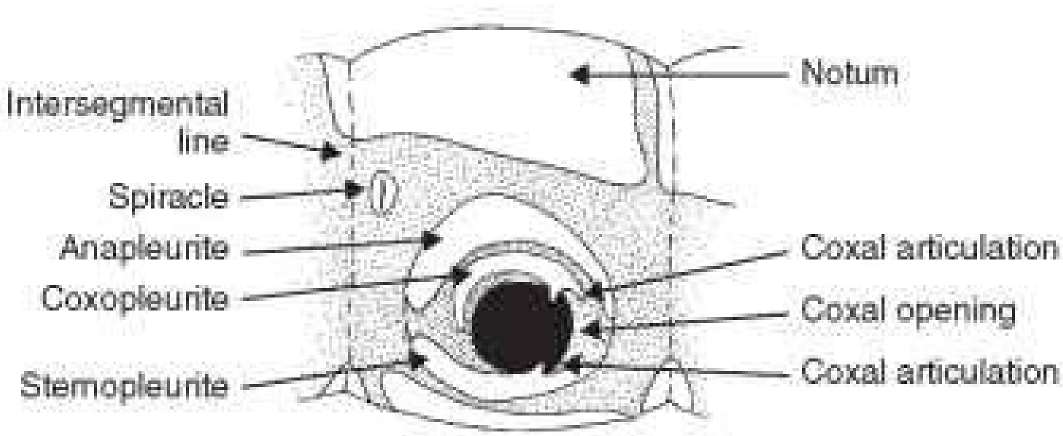


FIG. Pleural aspect of apterygote thorax.

Pterygota:

The basalare is a sclerite near the base of the wing and anterior to the pleural wing process. The basalare serves as a place of insertion for the anterior pleural muscle of the wing. The subalare is posterior to the basalare and the pleural wing process. It too serves as a place for insertion of the wing’s posterior pleural muscle. The tegula is the anteriormost independent scle-rite associated with the wing base. The tegula is typically scalelike, articulates with the humeral sclerite, and protects the wing base from physical damage. The tegula is absent from Coleoptera and from the metathorax of most orders. The pleural wing process is located at the dorsal end of the pleural ridge and serves as a fulcrum for the movement of the wing. The parapteron is a small sclerite, articulated on the dorsal extremity of the episternum just below the wings.

The pleural suture is an easily visible landmark on the pterothoracic pleura. It extends from the base of the wing to the base of the coxa. The pleural ridge is formed internally by the pleural suture and braces the pleuron above the leg. The episternum is a pleural sclerite anterior to the pleural suture and sometimes adjacent to the coxa; the episternum is typically the largest lateral thoracic sclerite between the sternum and the notum. The epimeron is the posterior division of a thoracic pleuron adjacent to the coxa and posterior to the pleural suture; it is typically smaller than the episternum and narrow or triangular. The episternum and the epimeron of many insects have become subdivided into several secondary sclerites bounded by sutures. The simplest condition shows the episternum divided into a dorsal anepisternum and a ventral katepisternum. Similarly, the epimeron is divided into an anepimeron and katepimeron. The trochantin is a small sclerite at the base of the insect leg of some insects.Some workers theorize that the trochantin may have developed into the pleural wall. The trochantin is often fused to the episternum or absent.

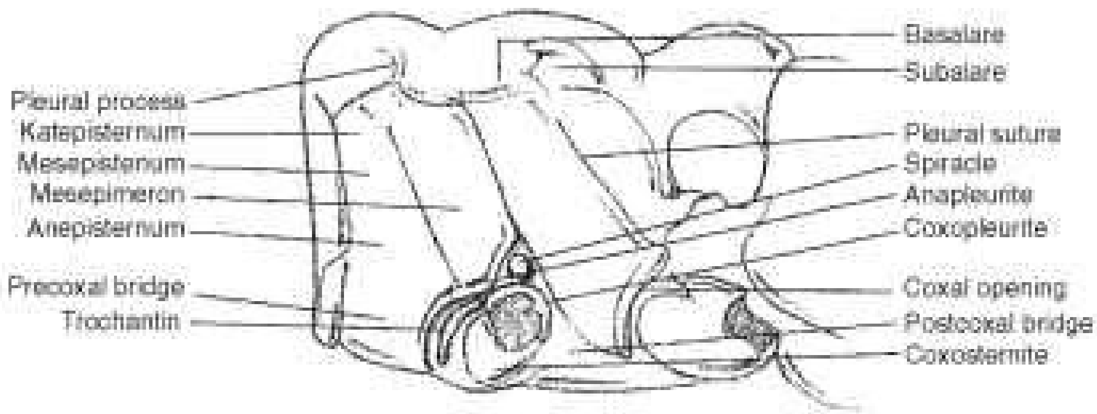


Fig. Lateral aspect of the pterygote thorax (Orthoptera: Acrididae).

The precoxal bridge is anterior to the trochantin, usually continuous with the episternum, frequently united with the basisternum, but also occurs as a distinct sclerite. The postcoxal bridge is the postcoxal part of the pleuron, often united with the sternum behind the coxa. The sclerite extends behind the coxa and connects the epimeron with the furcasternum. The meron is a lateral, postarticular basal area of the coxa and is sometimes found disassociated from the coxa and incorporated into the pleuron. The meron is typically large and conspicuous in panorpid and neurop-teran insects. In Diptera the meron forms a separate sclerite in the thoracic pleuron.

Ventral Aspect

The ground plan of the sternum (Greek, sternon = chest; pl., sterna) consists of four sclerites, including an intersternite (spinaster-nite), two laterosternites (coxosternites), and a mediosternite. The mediosternite and the laterosternite meet and join, and the line of union is called the laterosternal sulcus (pleurosternal suture).

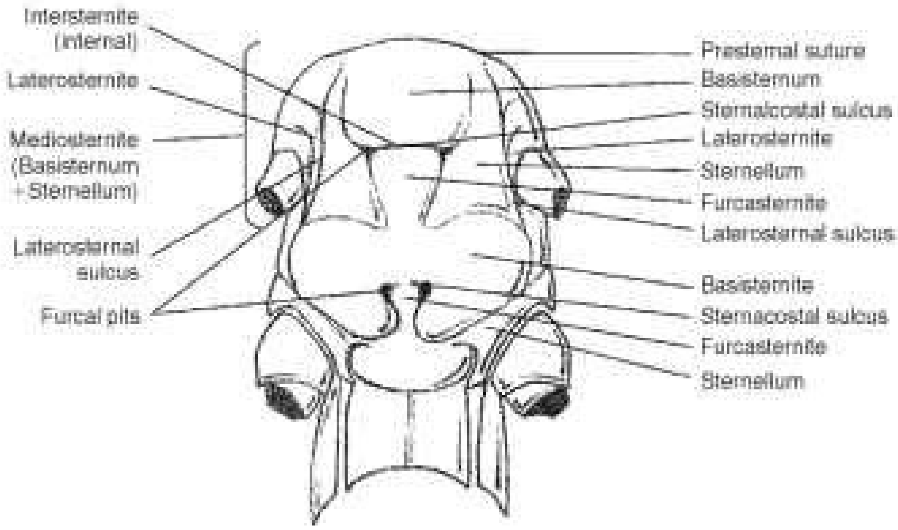


FIG. Ventral aspect of the thorax (Orthoptera: Acrididae).

Paired furcal pits are found in the laterosternal sulcus. A transverse sternacostal sulcus bisects the ventral plate and thereby forms an anterior basisternite and posterior furcasternite. The basisternite (basisternum) is the primary sclerite of the sternum. It is positioned anterior to the sternal apophyses or sterna-costal suture and laterally connected with the pleural region of the precoxal bridge. The furcasternite (furcasternum) is a distinct part of the sternum in some insects bearing the furca. The spin-asternum is a "spine-bearing" intersegmental sclerite of the thoracic venter, associated or united with the preceding sternum. The spin-asternum may become part of the definitive prosternum or mesos-ternum, but not of the metasternum. The sternellum is the second sclerite of the ventral part of each thoracic segment, frequently divided into longitudinal parts that may be widely separated.

Thoracic appendages:

a. **Legs**

Insect leg consists of six segements

1) The Coxa, this is the most basal aspect of the insect leg and articulates with the 'sternites'.

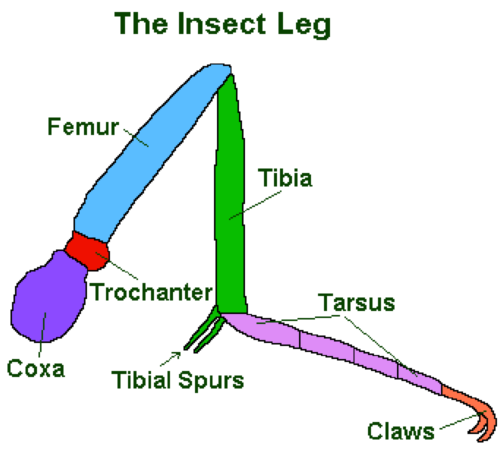
2) The Trochanter is usually small and serves as a joint between the 'coxa' and the 'femur'.

3) The Femur is usually long and stouter than the other segments and contains the main muscles used in running, jumping and digging.

4) The tibia is also generally long serving to increase the length of the leg, as well as adding an extra joint and thus extra flexibility the underside of the tarsal segments may possess pads.

5) The Tarsus is the foot of the insect leg and can consist of between one and five segments.

6) The Claws are situated at the end of the 'tarsus' and serve to assist the insect in holding onto the substrate or to its prey. Between the claws may be found a special pad known as an 'arolium' and which acts using suction developed by large numbers of minute tubular hairs to help hold the insect to smooth substrates.



b. Wings:

Unlike legs, wings occur only in the adult forms of those insects which possess them, in those insects with 'incomplete metamorphosis' small wing buds are visible in the place the wings will occupy in the adult.

Generally speaking wings are thin flat structures consisting of two fine membranes supported by a series of sclerotized veins. In many small insects the veins may be absent and in some very small insects, such as the Thrips, which are only one or two millimetres long, the wings consist of a central midrib supporting a series of fine hairs, these look more like feathers.

Wings are not totally stiff but bend and flex in an amazing manner during flight greatly improving their aerodynamics.

Most species of winged insect have two pairs of wings and in many of the more advanced orders these two wings are held together by a variety of mechanisms to form a single, larger, functionally wing.

Insect wings are soft and shapeless when the adults first emerge, but are immediately inflated with blood pressure through the veins before they harden and darken as a result of coming into contact with the air.

Though most insect wings appear bare to the naked eye many are dotted with minute hairs and in some cases such as the 'Trichoptera' (Caddis Flies) completely clothed in fine hairs, or as in the 'Lepidoptera' (Moths and Butterflies) completely covered in tiny scales.

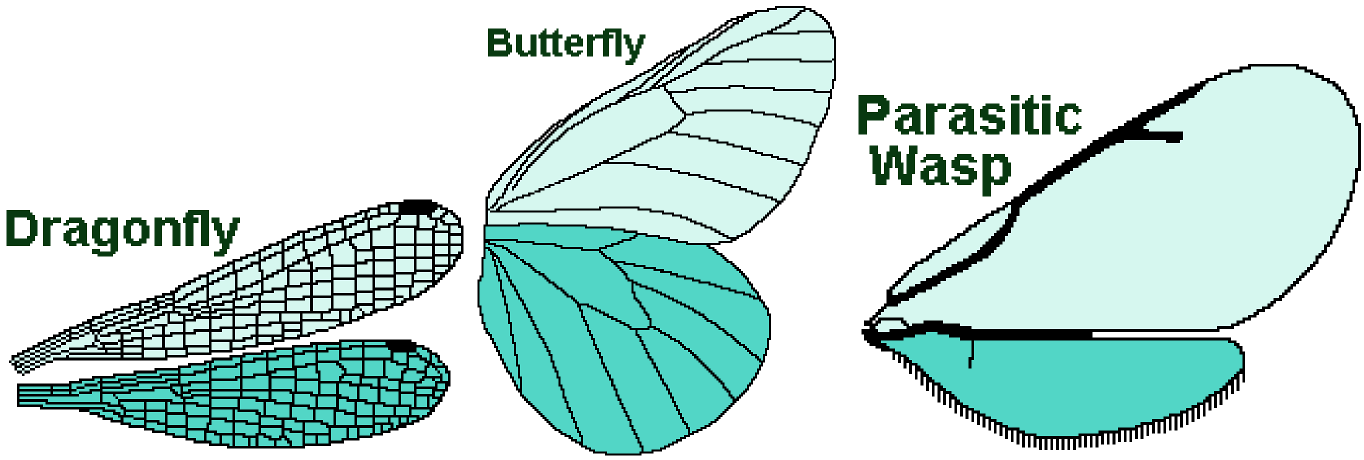
Though insect wings are primarily concerned with flight they serve a number of purposes, in the 'Coleoptera' (Beetles), and some 'Hemiptera' (True Bugs) the fore wings have become highly sclerotized and act as armour protecting the insect concerned. While some very small parasitic 'Hymenoptera' use their wings to swim through the water to their hosts.

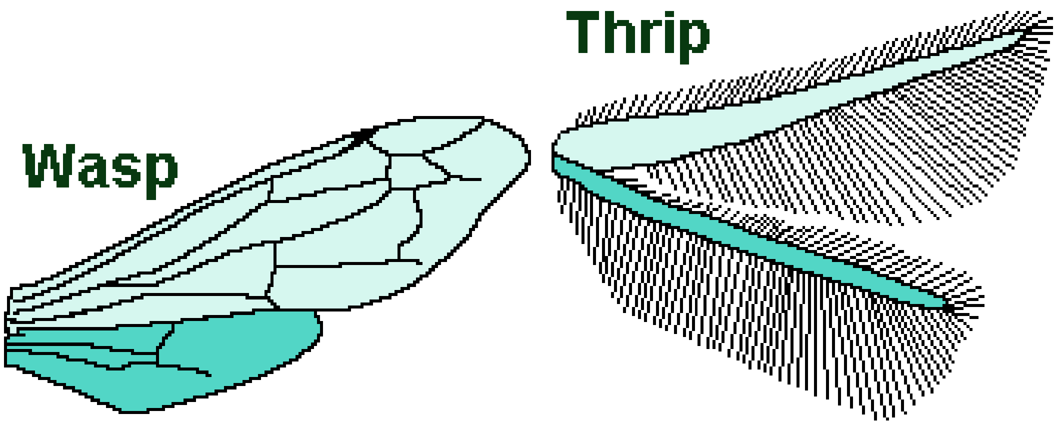
In Beetles the sclerotised forewings are called elytra, while the somewhat less stiffened forewings of Grasshoppers and Crickets are called tegmen.

The bright colours of many insect wings are there for mating purposes and allow males and females to recognise each other, in others the colours perform a role in camouflage hiding the insect from its predators, and in others they perform a thermodynamic role, the different colours reflecting and absorbing different wave lengths of light allowing the insect to control its internal temperature. In some insects the wings may perform two or more of these functions simultaneously.

In two orders of insects one pair of wings has become completely reduced to small balancing organs and they provide no power of lift during flight at all. The most common of these are the Flies (House Flies, Dung Flies etc.) which have the hind wing reduced. Much less commonly seen but just as interesting are the Stylopids which have the forewing reduced.

In many insects the hind wings are reduced to some extent and thus smaller than the forewings, in others, the the forewing has become stiffened to form a protective function the hind wing is often larger than the forewing, and therefore needs to be folded up when it is not in use. Grasshoppers and Crickets fold their wings longitudinally, while Beetles, and Earwigs the wings are folded both longitudinally and laterally. In Staphylinid betles and Earwigs the forewings are very short and the degree of folding of the hindwings is truly amazing.





Wings of different insect species