

ARTHROPODA PALAEMON
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Palaemon inhabits freshwater streams, rivers, lakes and ponds. It is a nocturnal creature and lies hidden at the bottom during the day and comes to the surface during night in search of food. It prefers slow moving clean water and feeds on algae, mosses and other weeds, small insects and the debris, i.e., omnivorous. It walks slowly at the bottom with the help of walking legs and swims actively at the surface with the help of swimmerets (pleopods). *P. malcolmsonii* breeds in May, June and July and the females carry eggs attached to their pleopods (abdominal appendages).

Features of Palaemon Malcolmsonii:

(i) Shape and Size:

The body of Palaemon is elongated, bilaterally symmetrical. The size of the adult Palaemon varies considerably in different species. *P. carcinus* from Travancore measures 90 cm, *P. malcolmsonii* from Central Provinces and Chennai is generally 25 to 38 cm and *P. lamarrei*, another common species in lakes and ponds, is only 2.5 to 5 cm in length.

(ii) Colouration:

The young specimens are transparent, pale yellow or perfectly white in appearance, but the older specimens are differently tinted according to the species. The colour is generally pale blue or greenish with brown or orange-red patches and bands of different patterns. The preserved specimens assume deep orange-red colour on a white or yellow background.

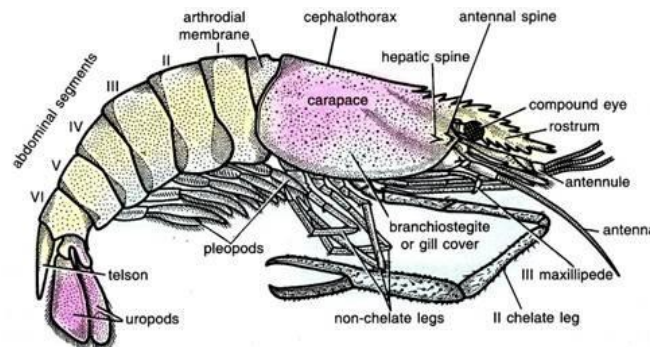


Fig. 71.1. *Palaemon malcolmsonii* (Lateral view).

(iii) Division of Body:

The body of adult *Palaemon Malcolmsonii* is consisting of nineteen appendage bearing segments having two distinct regions an anterior rigid cephalothorax and a posterior movable abdomen.

(i) Cephalothorax:

The cephalothorax is somewhat cylindrical in shape and is un-jointed; no external segmentation is marked. It is formed by the union of head comprising five appendage-bearing segments and the thorax comprising eight segments.

(ii) Abdomen:

The abdomen, rounded dorsally but compressed laterally, is jointed, i.e., external segmentation is clearly marked and composed of six movable segments having a terminal conical piece, telson. The abdomen is often turned downwards. Each segment of the abdomen carries a pair of jointed appendages called pleopods or swimmerets.

(iv) Exoskeleton:

The entire body and the appendages are covered by a hard and chitinous cuticle which forms exoskeleton.

The exoskeleton is hardened by deposit of salts of lime and is coloured with various pigments. The hard pieces of exoskeleton are called sclerites which are joined by softer cuticle forming arthro-dial membrane. The cephalothorax consists of a head and thorax, the head is covered with a dorsal plate and thorax with a carapace.

The dorsal plate and carapace are completely fused to form a continuous dorsal shield. The dorsal shield is produced in front into a rostrum which is laterally compressed and is serrated. At the base of rostrum, on either side is an orbital notch which accommodates the stalk of compound eye.

The dorsal plate has two short spines on each side, they are an antennal and a hepatic spine. The carapace hangs down on the sides of the thorax as a branchiostegite or lateral plate which encloses the gill chamber. On the ventral side of head and thorax are chitinous sclerites called sterna. The cephalothorax is joined to the abdomen by a calcified hardened arthro-dial membrane.

The dorsal shield covers the head and thorax dorsally and laterally. On the ventral side are sterna, they are an anterior most ophthalmic sternum, behind it an antennular sternum, followed by an antennal sternum or epistome to which a median labrum is attached.

The third and fourth segments have no sterna. The sterna of segments 5 to 13 have fused to form a floor. On the sides of segments 5 to 13 are 9 pairs of chitinous sclerites called epimera, one epimeron on each side of a segment.

In the abdomen each segment has a dorsal tergum or tergite which is broad and curved, a narrow ventral sternum or sternite, on each side is a pleuron formed from the tergum. On each side in the thorax and abdomen the pleuron is joined to an appendage by an epimeron which is a part of the pleuron.

Between the segments the two terga are joined by an inter-tergal arthro-dial membrane, and two sterna by an inter-sternal arthro-dial membrane. In the abdomen each segment articulates with the other laterally by pair of hinge-joints made of a ball and socket which permit movement of a segment on another in a vertical plane, but there is no movement from side to side.

External Apertures of Palaemon Malcolmsonii:

There are following external apertures in Palaemon Malcolmsonii:

(a) Mouth:

It is a mid-ventral slit-like aperture lying at the anterior end of the cephalothorax.

(b) Anus:

It is a longitudinal slit-like aperture lying at the ventral end of the base of telson.

(c) Renal Apertures:

These are paired; each situated on a raised papilla at the inner surface of the coxa of antennae.

(d) Openings of Statocysts:

These are paired; each situated in a depression at the dorsal surface on the basal podomere (precoxa) of antennules.

(e) Female Genital Apertures:

These are paired; each situated at the inner surface of the coxae of third pair of walking legs.

(f) Male Genital Apertures:

These are also paired; each situated at the inner surface of the coxae of fifth pair of walking legs.

Appendages of Palaemon Malcolmsonii:

From the ventrolateral margin of each segment arises a pair of appendages or limbs. All the appendages are biramous (L., bi = two + ramus = branch), except the first pair which are uniramous (L., uni = one + ramus = branch). Each appendage has a basal stalk or protopodite made of two joints or podomeres, a lower coxapodite or coxa and an upper basopodite or basis.

From the protopodite arise two rami, an inner endopodite and an outer exopodite, each of which may be composed of one to several podomeres. The first appendage is not comparable in detail with the others, it is uniramous.

Each appendage has a cuticular exoskeleton which is divided in most into tube-like segments or podomeres connected to one another by soft articular or arthrodial membrane, thus, a joint is created at each junction, these joints enable the podomeres of appendages to move. In each podomere are two protractor and two retractor muscles attached to the inner surface of cuticle.

Flexion and extension of appendages are brought about by the muscles, with the muscles and cuticle acting together as a lever system.

This co-ordination of muscular and skeletal systems for locomotion is essentially the same as in vertebrates, the only difference is that in arthropods muscles are attached to the inner surface of

an exoskeleton, whereas in vertebrates the muscles are attached to the outer surface of an endoskeleton.

Generally all the appendages are one of the following two types:

(a) Stenopodium is a slender limb, its endopodite and exopodite are set on a common stalk, the protopodite.

(b) Phyllopodium is broad and leaf-like with thinner cuticle, the endopodite and exopodite do not form a fork.

In Palaemon, however, as referred to, all the appendages are built on a biramous plan (except the first) but they are modified variously; it is because of their different functions.

A. Cephalic Appendages:

Of the five pairs of cephalic appendages, first two, i.e., antennules and antennae are pre-oral, while mandibles, maxillulae and maxillae are post-oral.

1. Antennules:

The antennules are situated, one on either side, immediately below the bases of eye-stalks.

Antennules are uniramous. Each antennule consists of a protopodite having three podomeres, precoxa, coxa and basis and a pair of slender many jointed feelers. The precoxa is very large and bears a depression, containing the opening of statocyst on its dorsal side and a spiny lobe called stylocerite on its outer margin. The coxa is short and cylindrical.

The basis is longer than coxa. From the basis arises a pair of long, jointed feelers which are probably not homologous with the exopodite and endopodite of a typical appendage. The outer feeler is divided into two unequal branches. Antennule is tactile and its statocyst is for equilibration. Antennules are homologous with the antennae of other mandibulate classes.

2. Antennae:

The antennae are situated, one on either side, just below and behind the antennules. The protopodite is considerably swollen due to the presence of the excretory organ within it, which opens by minute renal aperture on the inner margin of coxa.

The exopodite is broad leaf-like plate, the squama, while the endopodite is long many jointed feeler. The squama bears setae along its inner and distal margin and probably serves the function of a balancer during swimming. The antennae are tactile, excretory and balancing in function.

3. Mandibles:

The mandibles are short but stout appendages, lying one on each side of the mouth. The greater part of each mandible consists of the coxa which is differentiated into a proximal spoon-shaped apophysis and a solid distal head. The head consists of two parts a molar process with five or six dental plates and a flat plate-like incisor process with three teeth.

The outer margin of the head carries a small three jointed mandibular palp. The proximal segment of the mandibular palp represents the basis of the protopodite, while the two distal segments represent the endopodite. The exopodite is absent. The mandibles are masticatory in function.

4. Maxillulae:

The maxillulae are small, thin and leaf-like appendages. Coxa and basis are broad, and project inwards as jaws or gnathobases (Gr., gnathos = jaw) fringed with bristles. Endopodite is curved and bifurcated terminally, it has small hooks. Exopodite is absent. The maxillulae are used for passing food to the mouth.

5. Maxillae:

The maxillae are also thin and leaf-like appendages. The coxa is very small and incompletely divided into two, while the basis is larger forming a bifurcated gnathobase with stiff setae at its inner end.

The endopodite is small, while the exopodite forms a large fan-shaped scaphognathite or baler with plumose bristles along its border. The scaphognathite projects into a gill-chamber causing a current of water on the gills. Maxillae have both feeding and respiratory function.

B. Thoracic Appendages:

The thoracic appendages consist of the anterior three pairs of maxillipedes (Gr., maxilla = jaw + podos = foot) or foot jaws and posterior five pairs of walking legs or paraeopods.

1. First Maxillipedes:

The first maxillipedes or foot jaws are thin and tend to be phyllopodium. Coxa and basis form flat leaf-like gnathobases or endites by its inner borders. On its outer side coxa bears a bilobed leaf-like epipodite which acts as a gill. The endopodite is small and unsegmented.

The exopodite is longer and bears a thin plate-like expansion from its base. The margin of exopodite and endopodite are fringed with setae. First maxillipedes hold the food and also server the function of tactile and respiratory organs.

2. Second Maxillipedes:

The coxa is small with an epipodite and a gill on its outer border. The exopodite is long and slender. The endopodite arises from the basis and consists of five podomeres called ischium, merus, carpus, propodus and dactylus. Of these propodus and dactylus lie parallel and form a cutting plate with bristles. Second maxillipedes are tactile, hold food and are respiratory.

3. Third Maxillipedes:

The third maxillipedes are distinctly leg-like in appearance. The coxa bears a small epipodite on its outer side. The basis is small and supports a slender unjointed exopodite and an elongated endopodite consisting of three podomeres.

In the endopodite the first podomere represents fused ischium and merus, second is the carpus and third represents fused propodus and dactylus. The exopodite is thickly covered with setae all along its length. Third maxillipedes are tactile, hold food and are respiratory.

Walking legs:

The five pairs of walking legs of *Palaemon* differ from the maxillipedes in the absence of the exopodites and epipodites. A typical walking leg, like the fourth, consists of a two jointed protopodite and a five jointed endopodite. The protopodite consists of a short ring-shaped coxa and a triangular basis.

The endopodite consists of five podomeres, viz., ischium, merus, carpus, propodus, and dactylus.

All the seven podomeres are arranged in a linear series and are movably hinged together. In the first and second pairs of walking legs the propodus is prolonged distally beyond its articulation with the dactylus, so that the two podomeres work one against the other like the blades of a pair of forceps forming a chela or pincers with sharp terminal claws.

In fact, dactylus is movably articulated to propodus. Such legs are called chelate legs or chelipeds, and are used to catch the prey and transfer it to the mouth and also serve as organs of offense and defence. The second chelate legs in male are larger and more powerful than in the female.

The third, fourth and fifth pairs of walking legs are typical and non-chelate. In female, each of the third leg bears a crescentic female genital aperture on the inner side of its coxa, while in male, each of the fifth leg bears a slit-like male genital aperture on its side of the arthrodistal membrane connecting the leg and thorax.

C. Abdominal Appendages:

The six pairs of abdominal appendages are known as pleopods or swimmerets. Abdominal appendages are simple and typical biramous type. The third abdominal appendage may be taken as a typical type.

Third Abdominal Appendages:

Protopodite consists of only two podomeres, a short ring-like proximal coxa and a long cylindrical distal basis. The basis bears flattened leaf-like smaller endopodite and larger exopodite.

Closely applied against the inner margin of the endopodite, there is a short and slender, slightly curved rod called appendix interna with a knob-like head, bearing many hook-like processes. In the female, second, third, fourth and fifth abdominal appendages serve to carry eggs in the breeding season.

The appendix interna of each of these appendages becomes interlocked with its fellow of the opposite side, thus, leading to the formation of a series of bridges on the ventral side of the abdomen which serve to carry the eggs. The remaining five abdominal appendages resemble this typical appendage in all essential features but there are small differences which are given below.

First Abdominal Appendages:

In the first abdominal appendages, the endopodite is greatly reduced and the appendix interna is totally absent.

Second Abdominal Appendages of Male:

In the second abdominal appendages of male, the appendix interna gives off on its inner side an additional process called appendix masculina lying in between the appendix interna and endopodite.

Uropod:

The sixth or uncalcified the last pair of abdominal appendages are very large and form broad flat plates and lie one on either side of the telson. These appendages are called uropods or tail feet. In the uropod, the coxa and basis are fused together to form a sympod. The exopodite and endopodite are oval and oar-shaped.

The exopodite is broad and large and is divided into two unequal parts by a transverse suture. The endopodite is slightly smaller and is undivided. The margins of exopodite and endopodite, except the outer border of the exopodite, are fringed with long plumose setae. The two uropods with the telson form a fan-like tail fin which causes the strong and rapid backward spring of prawn in swimming.

4. Body Wall of Palaemon Malcolmsonii:

The body wall of *Palaemon Malcolmsonii* (Fig. 71.8) consists of an outer thick layer of cuticle, a middle single-layered epidermis and an inner dermis.

(i) Cuticle:

The body is covered with a thick two-layered cuticle, the outer layer is a thin non-chitinous epicuticle and an inner layer is a thick laminated endocuticle. The epicuticle is made of an outer lipid layer and an inner protein layer. It is produced into spines and setae of different forms and bears, at places, the fringes of setae.

The endocuticle contains layers of chitin and has three successive layers—the outermost layer is a thin pigmented layer, below it is a thick calcified layer and under it is an uncalcified layer. The pigmented layer is dark due to protein deposits and it becomes hardened by a process of tanning or sclerotisation. In the calcified layer are deposits of carbonates and phosphates of calcium which make the integument hard.

The chitin is an acetate of a polysaccharide containing glycosamine. The cuticle is relatively impermeable, except where it is thin and allows the passage of gases or absorption of water. The cuticle is cast off once a year in the adult, this is called moulting or ecdysis.

(ii) Epidermis:

Below the cuticle is a thick epidermis. It comprises a layer of glandular columnar epithelial cells resting on a thin basement membrane.

(iii) Dermis:

Below the epidermis is dermis. The dermis is made of loose connective tissue containing the blood lacunae. Situated within the connective tissue layer are a number of tegumental glands. Each gland consists of a cluster of secreting cells with nuclei placed at their bases.

Each gland-cell has a capillary canal and the canals of all the gland-cells join together in the centre of the gland to open into a long narrow cuticular duct leading to the exterior on the surface of the epicuticle. In the connective tissue are also found chromatophores. The epicuticle is non-chitinous and is secreted by the tegumental glands, while endocuticle is chitinous and is secreted by the epidermis.

5. Muscular System of Palaemon Malcolmsonii:

The muscles are almost all entirely striped, they are all longitudinal, except in the heart and arteries where they are circular.

The muscles are concerned with extension and flexion of abdomen and appendages. Seven pairs of extensor muscles arise from the six abdominal segments and telson, they run dorsally and are inserted on the lateral wall of the thorax, when these muscles contract they extend and straighten the abdomen.

There are five pairs of abdominal flexor muscles arising from the first five abdominal segments, they lie ventrally and are very strong, they are inserted on the sterna, epidermis and thoracic wall. When flexor muscles contract they bend the abdomen. The appendages have hollow, tubular podomeres, two adjacent podomeres being connected by a hinge joint having a soft arthrodial membrane which permits movement.

Each podomere has two extensor and two flexor muscles joined to preceding and succeeding podomeres, the flexor muscles bend the podomere and extensor muscles straighten it. In Crustacea each muscle has only two to five nerves, they are motor and sensory nerves, besides which there is an inhibitory nerve which inhibits or checks muscles contraction.

6. Endophragmal Skeleton of Palaemon Malcolmsonii:

An internal skeleton is formed by ingrowths of the cuticle called apodemes which serve for insertion of muscles. In prawn apodemes unite to form an endophragmal skeleton. It consists of rods lying between epimera and sterna of cephalothorax. It is best developed between segments 3/4 and segments 11/12 and 12/13.

Between third and fourth segments are two large apodemes joined by a transverse fibrous strand, together they form a cephalic apodeme for attachment of mandibular muscles.

In succeeding segments on each side there are two adjacent apodemes, an endopleurite arising from the epimeron, and an endosternite arising from the sternum. Between segments 11 and 12, and 12 and 13 there arises on each side from the endosternite a Y-shaped rod, its inner arm is mesophragm and outer arm is paraphragm, they are for attachment of flexor abdominal muscles.

7. Digestive System of Palaemon Malcolmsonii:

In *Palaemon Malcolmsonii*, the digestive system is composed of alimentary canal and hepatopancreas.

Alimentary Canal of Palaemon Malcolmsonii:

The alimentary canal consists of foregut, midgut and hindgut. The foregut comprises the mouth, buccal cavity, oesophagus and stomach. The foregut and hindgut have an internal lining of cuticle (intima) but the midgut has a soft lining of endoderm.

(i) Mouth:

The mouth is a large slit-like aperture situated mid-ventrally below the anterior end of head between the third and fourth segments. It is bounded in front by a shield-shaped labrum, on the sides by the incisor processes of the mandibles, and behind by the labium which is cleft to form two lobes or paragnatha.

(ii) Buccal Cavity:

The mouth leads into a short buccal cavity. It is anteroposteriorly compressed and has a thick chitinous lining which is thrown into irregular folds. The molar processes of the mandibles project into the buccal cavity from two sides to crush the food between them.

(iii) Oesophagus:

The buccal cavity leads into short but broad oesophagus running almost vertically upwards from the buccal cavity to the stomach.

Internally the thick muscular wall of the oesophagus is thrown into four prominent longitudinal folds projecting into the lumen. Of these folds, the anterior is short but the posterior and lateral folds are longer and more prominent. Each of the lateral folds being subdivided into two smaller unequal folds.

(iv) Stomach:

The oesophagus leads into a spacious chamber, the stomach, which occupies most of the cephalothoracic cavity. It is surrounded laterally, ventrally and posteriorly by the hepatopancreas.

The stomach is divided into two parts:

(a) A large anterior bag-like cardiac stomach, and

(b) A very small posterior pyloric stomach. Cardiac and pyloric stomach are separated by a number of valves.

(a) Cardiac Stomach:

The cardiac stomach is lined internally with delicate cuticle or intima. The inner lining of intima is produced into a very large number of inconspicuous longitudinal folds covered by minute bristles. The wall of the stomach is supported by some cuticular plates embedded in its internal lining.

The anterior wall of the oesophageal opening is covered by a thin circular cuticular plate and there is a similar lanceolate plate on the anterior part of the roof of the cardiac stomach the cardiac stomach.

(b) Pyloric Stomach:

The pyloric stomach is a very small and narrow chamber lying below the posterior end of the cardiac stomach.

Its walls are thick and muscular, they divide the lumen of the pyloric stomach into a small dorsal chamber and a large ventral chamber, the two communicating with each other by a narrow vertical slit-like aperture. The floor of the chamber is raised into a median longitudinal ridge so as to divide its cavity into two lateral compartments.

Midgut:

The midgut is a long, narrow, straight and slender tube running back along the median line above the mass of the ventral abdominal muscles up to the sixth abdominal segment. The internal lining of midgut is formed by epithelium which in the posterior part is thrown into many longitudinal folds, thus, greatly reducing its lumen.

Hindgut:

The hindgut extends from the posterior end of the midgut to the anus and forms the shortest portion of the alimentary canal. Anteriorly it is swollen into a thick muscular sac called the rectum, while its posterior part is narrow and tubular which opens to the exterior through the anus.

Hepatopancreas:

The hepatopancreas or the so called liver is a large bilobed, compact, orange-coloured glandular mass occupying a considerable area of cephalothoracic cavity. It lies immediately behind the cardiac stomach but a part of it lies around the floor and sides of the stomach. Dorsally it is covered over by the reproductive organs and the heart, while ventrally it overlies the nerve cord.

Respiratory System of Palaemon Malcolmsonii:

In Palaemon Malcolmsonii, the respiratory organs are well developed and consist of:

1. Branchiostegites or gill covers
2. Three pairs of epipodites
3. Eight pairs of gills or branchiae

1. Branchiostegites:

Each gill chamber is enclosed between the branchiostegite or carapace on the outer side and the thoracic wall on the inner side.

The gill chambers open on all sides except dorsally. The inner linings of branchiostegites are thin, membranous and highly vascular containing blood lacunae. These are constantly bathed in freshwater, thus, forming the respiratory surfaces which absorb oxygen dissolved in water and give out carbon dioxide.

2. Epipodites:

There are three pairs of simple, leaf-like and highly vascular epipodites which are the outgrowths of the coxal podomeres of three maxillipedes. The epipodites lie in the anterior part of the gill-chamber below the scaphognathite. The epipodites serve as respiratory organs like the primitive gills.

3. Gills:

There are eight gills or branchiae lying inside each gill-chamber but only seven of them are exposed at once on the removal of gill-cover as the eighth lies hidden beneath the dorsal part of the second gill.

Blood Vascular System of Palaemon Malcolmsonii:

In *Palaemon Malcolmsonii*, the blood vascular system is of the open type.

It comprises:

1. Pericardium
2. Heart
3. Arteries
4. Sinuses or blood-lacunae
5. blood channels

There are no veins and capillaries in *Palaemon*.