Chapter 11 Phylum Arthropoda

Arthropods are eucoelomate protostomes with well-developed organ systems. Their unique characteristic is a chitinous **exoskeleton** that is moulted (shed) at intervals to increase the body size. Arthropods colonise all types of habitat, even the house and garden. The group includes spiders, scorpions, ticks, mites, insects, crustaceans, millipedes and centipedes.

General structure and function

Arthropods have achieved a great diversity and abundance due to their various adaptations. They have metameric segmentation, segments grouped into tagmata (head and trunk; head, thorax and abdomen, or cephalothorax and abdomen), and **jointed appendages**, which are often modified for specialized functions.

The muscular system is complex and well-developed, with both striated and smooth muscles. The digestive system is complete. Many of the anterior appendages are modified to form mouth parts adapted for different feeding methods. Gas exchange occurs across the body surface, gills, trachea or book lungs. The coelom is reduced; most of the body cavity, composed of sinuses or spaces in the tissue (called the hemocoel), is filled with hemolymph. Thus they have an open circulatory system, with a dorsal contractile heart, arteries and hemocoel. The excretory system varies depending on the type of arthropod. Crustaceans have a pair of excretory glands, the antennal or maxillary glands. Insects, millipedes and centipedes have malpighian tubules, and many insects also posses nephrocytes which phagocytize waste particles. The nervous system has a dorsal brain connected by a ring around the esophagus to a double nerve chain of ventral ganglia. Sensory organs are well-developed.

Arthropods are dioecious, with paired reproductive organs and ducts. They usually have internal fertilization, and are oviparous, ovoviviparous or viviparous. A few arthropods have parthenogenesis. They usually have metamorphosis through their life cycle.

Arthropods are found in nearly all types of habitats. Their great diversity, abundance and wide distribution results from the following physiological and structural adaptations.

1. A hardened skeleton

The cuticle of arthropod is a hard external skeleton, or exoskeleton, which is light, flexible and highly protective without sacrificing mobility. It is made of protein and chitin components which are insoluble in water, alkaline solutions and weak acids. To grow, an arthropod must shed the exoskeleton at intervals and grow a larger new one. Before the new exoskeleton hardens, land arthropods enlarge it by swelling with air, while aquatic

arthropods swell it with water.

2. Tagmata and appendages

Each segment of arthropods usually has a pair of jointed appendages. But body segments can become reduced in number, grouped or fused in various way, to support more specialized functions. For example, in shrimps, different segments are combined to form the cephalothorax and abdomen. In insects, segments are combined to form a head, thorax and abdomen. The jointed appendages are equipped with sensory setae, and have been modified for sensing, feeding, walking, swimming, net spinning or transfering sex cells.

3. Respiratory structures

Most terrestrial arthropods have a highly efficient system of air tubes, or trachea, which can deliver oxygen directly to the tissues and cells. This makes high metabolic rates possible. Aquatic arthropods rely on gills or the body surface for gas exchange.

4. Highly developed sensory organs

In arthropods, sensory organs such as compound eyes and other sensory organs involved with touch, smell, hearing, balancing and chemical reception are well developed. These organs contribute greatly to the success of arthropods.

5. Reduced competition through metamorphosis

Many arthropods undergo metamorphosis, which involves various immature states and then, the adult. The structure of immatures differs from that of the adults. Thus the immatures can eat different kinds of food than the adult and occupy a different niche. This results in less competition within a species.

Ecological relationships and economic importance in the region

The arthropods are found in all types of habitats. Some species live on land, in freshwater, brackish and marine waters, and some are commensal or parasitic in living organisms. They are important components in aquatic food chains and play important roles in detrital processing and nutrient cycling in aquatic systems. Freshwater arthropods are used as food by many animals. Shrimps, crabs, and many aquatic insects are also sold as human food. Water fleas are important in aquaculture industries as food for rearing young fish and shrimp.

Classification

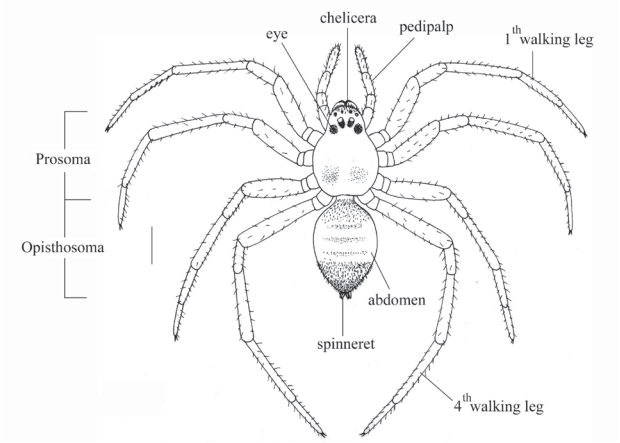
Members of the three subphyla Chelicerata, Crustacea and Uniramia are present in freshwater.

Chelicerate arthropods are an ancient group that includes horseshoe crabs, spiders, ticks and mites, scorpions and sea spiders. Among their common characteristics are six pairs of

appendages (that include a pair of **chelicerae**, a pair of **pedipalps** and four pairs of walking legs) and a lack of antennae and mandibles.Fish spiders (order Araneae) live on water plants near margin of streams, rivers and ponds (Fig.1). They feed mostly on aquatic and terrestrial insects. After it bites and injects venom to kill its prey, the digested contents of the prey are suck out. Hydracarina, or water mites (order Acarina), differ from all other arachnids in having their cephalothorax and abdomen completely fused, and no sign of external segmentation (Fig.2). Many species are ectoparasites of aquatic insects and feed on their host's fluids.

The majority of crustaceans are aquatic and of economic importance. Crustaceans bear two pairs of antennae, a pair of mandibles, and two pairs of maxillae on the head, followed by a pair of appendages on most body segments. Except the first antennae, all appendages are biramous, which means having two branches. Crustaceans are diverse and abundant. They include crabs, shrimps, prawns, water fleas, isopods and amphipods. More details of crustaceans are available in Chapter 12.

Uniramia consists of class Chilopoda (millipedes), Diplopoda (centipedes) and Insecta (insects). Only some insects occur in freshwater. In general, the insect body is divided into three tagmata: head, thorax and abdomen. The thorax has three pairs of walking legs and one or two pairs of wings in the adult. Immature stages have no wings, or only wing pads are present in insects with incomplete metamorphosis. Gas exchange occurs across the body surface or through gills. Insects are the largest group of macroinvertebrates found in streams. Most have aquatic immature stages and they leave the water when they grow up into adults. But some spend their whole life cycle in the water. Details of aquatic and semiaquatic insect orders are available in chapters 13-25.



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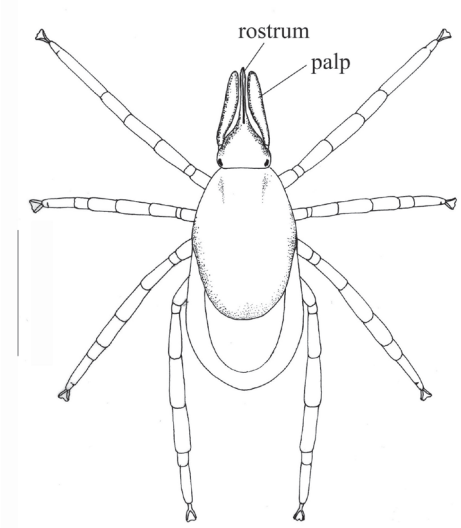

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Fig. 1-2 1. Dorsal view of a spider (Araneae); 2. Dorsal view of a water mite (Acarina) Scale = 1 mm.