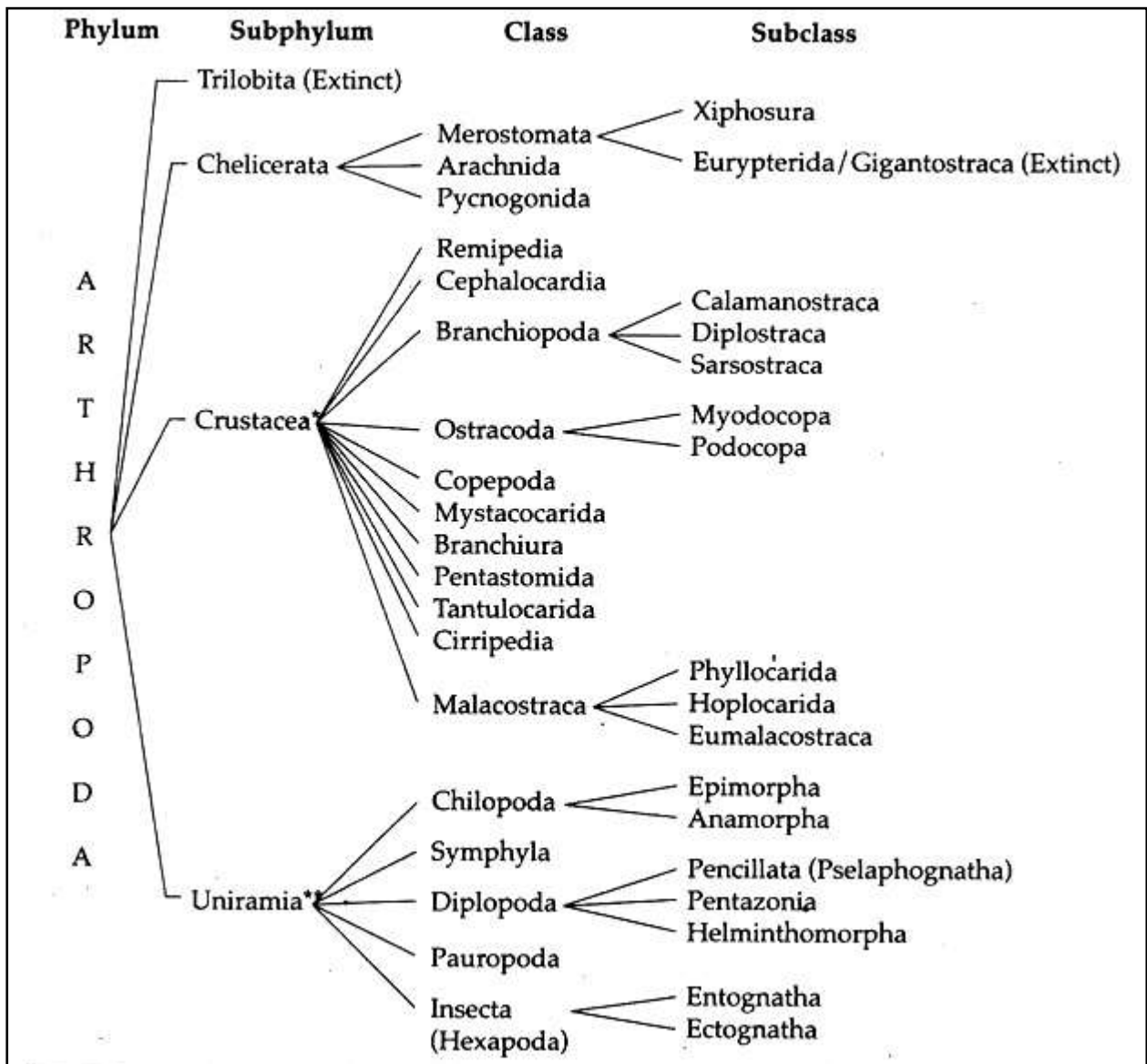


CLASSIFICATION OF THE PHYLUM – ARTHROPODA

(As outlined by Ruppert and Barnes, 1994)



A. Subphylum-1: Trilobita (extinct):

Trilobites were abundant and widely distributed in Paleozoic seas. They reached their height during Cambrian and Ordovician period and disappeared at the end of Palaeozoic era. From fossil specimens about 3900 species have been described.

B. Subphylum-2: Chelicerata (Greek: chele, talon; cerata, horns)

1. Bilaterally symmetrical. Body shape varying from elongated to almost spherical.
2. Body divided into an anterior cephalothorax or prosoma, which is wholly or partly covered by a dorsal carapace, and a posterior abdomen or opisthosoma without legs.

3. Appendages uniramous. Pro-somal appendages present, comprising of a pair of chelate 'chelicerae' (helps in feeding), one pair of chelate leg-like or feeler like 'pedipalps' (helps in various functions) and four pairs of walking legs.
 4. Chelicerates are the only arthropods which lack antennae.
 5. Mouth anteroventral. Gut straight. From the mid gut region arise two to many pairs of digestive diverticula which secrete enzymes that intracellularly digest and absorb food.
 6. Median ocelli are present.
 7. Development generally direct, juvenile with the full complement of limbs.
- Chelicerata contains about 63,000 described species placed in three classes.

Class-1: Merostomata:

1. Aquatic chelicerates with five or six pairs of abdominal appendages modified as gills.
2. Twelve segmented abdomen is sub-divided into a seven segmented meso- soma and a five segmented metasoma.
3. A prominent spike like caudal spine or telson is present at the end of the body.
4. Compound eyes fairly developed.

Subclass-1: Xiphosura:

1. Bottom dwellers, nocturnal, found in shallow coastal water and are commonly known as horse-shoe crabs.
2. Prosoma is covered by a large, horse-shoe shaped carapace.
3. Caudal spine is elongated, slender and pointed.
4. Abdominal segments fused and bear six pairs of appendages.
5. Lamellate gills or book gills are present in five pairs (on the appendages of ninth to thirteenth segments).
6. Excretion takes place by four pairs of coxal glands.
7. Development through trilobite larval stage.

This subclass contains 3 genera and four species.

Examples: Limulus, Tachypleus, Carcinoscorpius

Subclass-2: Eurypterida (Extinct):

This subclass is also known as Gigantostroma and comprises of the extinct giant arthropods. They were aquatic and existed from the Ordovician to the Permian period.

Class-2: Arachnida:

1. Except a few (secondarily aquatic) forms, the arachnida includes all living terrestrial chelicerates.
2. Predator arachnids use poison or silk in prey capture.
3. Prosoma un-segmented, usually covered dorsally by a solid carapace. The primitive abdomen is divided into a pre- abdomen and a post-abdomen.
4. Prosoma consists of a pair of chelicerae, a pair of pedipalps and four pairs of legs.
5. Respiratory organs are either book lungs or trachea.

6. The epicuticle is waterproof due to an external wax layer.
7. Excretion by malpighian tubules, coxal glands and nephrocytes.
8. Eyes usually simple. Compound eyes when present are degenerated.
9. Sexes separate, single or paired gonads that lie in the abdomen. Fertilization is internal.

The arachnids comprise of over 98% of living chelicerates and include over 62,000 species.

Examples: True scorpion (Buthus, Palamnaeus), Micro-whip scorpion (Koenenia), Pseudo-scorpion (Chelifer), True spi-ders (Aranea), Mites and ticks, Sarcoptes, Argas.

Class-3: Pycnogonida:

1. Small, benthic marine animals common-ly known as sea spiders.
 2. Opisthosoma much reduced.
 3. The head or cephalon bears four eyes and at its anterior end a cylindrical pro-boscis.
 4. A pair of palps, a pair of ovigerous legs and usually four pairs of walking legs are present.
 5. No special organs for gas exchange and excretion are present.
 6. Reproductive openings are multiple and are present on the ventral side of coxae (all legs in females, second and fourth pair in males).
 7. Dioecious. Development usually through a larva called protonymphon.
- More than 1,000 species have been described and placed in a single order.

Example: Nymphon, Pallene, Decolopoda, Pycnogonum

C. Subphylum-3: Crustacea (Latin: crusta, a rind or crust)

1. Primarily marine although several are freshwater (13%) and a few are terres-trial (3%).
 2. Head bears five pairs of appendages which comprise of two pairs of antennae (first pair being the antennules), one pair of mandibles and two pairs of maxillae.
 3. The cylindrical or leaf-shaped appen-dages are all typically biramous, the two branches are of different size and shape.
 4. Exoskeleton often calcareous.
 5. Respiration usually through gills, which are typically associated with the appendages.
 6. Excretory organs are paired and com-posed of an end sac, an excretory canal and a short exit duct, all located in the head.
 7. Head bears a pair of compound eyes, sometimes located on movable stalks and a small median dorsal naupliar eye.
 8. Dioecious. Copulation and egg brooding are very common. Development through different larval stages like nauplius, zoea etc.
- About 40,000 species of this subphylum are divided into eleven classes.

Class-1: Remipedia:

1. Marine animals with small, elongated, worm like and translucent body.

2. Body comprises of a short, carapace-less cephalothorax (head and first trunk segment) and a long trunk of over 30 similar segments, each with a pair of leaf-like, lateral limbs.
 3. They are carnivorous and the first pair of trunk appendages are modified as pre-hensile maxillipeds for feeding. Other trunk appendages help in swimming.
 4. Absence of eyes.
 5. Hermaphrodite. Development still unknown.
- They were first discovered in 1981 and is represented by nine species.
Examples: Lasionectes, Speleonectes.

Class-2: Cephalocarida:

1. Bottom dwelling, marine animals and are detritus feeder.
 2. Body small, elongated and cylindrical, terminating in a telson with a long furca.
 3. The body is divided into a horseshoe-shaped head, thorax and abdomen, without any development of cephalothorax or carapace.
 4. All eight pairs of thoracic limbs are identical and similar to the second maxillae.
 5. The eleven segmented abdomen lacks appendages, except the first which retains reduced limbs.
 6. Although compound eyes are present they are blind as these eyes are buried in the head.
 7. Hermaphrodite and development includes metanauplius stage.
- Discovered in 1955 and is represented by ten species.
Example: Hutchinsoniella.

Class-3: Branchiopoda (gill feet):

1. Small crustaceans mainly restricted to fresh water.
 2. Trunk appendages are flattened leaf like structures
 3. Coxa is provided with a flattened epipod that serves as a gill.
 4. First antenna and second maxilla are vestigial.
 5. The last abdominal segment bears a two terminal process called cercopods.
 6. Excretion by maxillary glands or shell glands.
 7. Branchiopods brood their eggs.
- This class comprises of about 850 living species.

Subclass-1: Calamanostraca:

1. Body composed of thorax with appendages and abdomen without appendages.
 2. Thorax covered by a carapace.
- Example:** Triops (tadpole shrimp)

Subclass-2: Diplostraca:

1. Body enclosed within a laterally compressed carapace.
 2. Trunk with appendages.
- Examples:** Lynceus (clam shrimp), Daphnia

Subclass-3: Sarsostraca:

1. Trunk composed of 11 to 18 segments with appendages.
2. Carapace absent.
3. Eyes compound and stalked.

Examples:

Artemia (brine shrimp), Branchinecta (fairy shrimp).

Class-4: Ostracoda:

1. Ostracods are small crustaceans some-times referred to as mussel or seed shrimp. They are widely distributed in the sea and in all types of freshwater habitats.
 2. Body enclosed within a hinged bivalve and often calcareous shell formed by the carapace.
 3. Head large, forms half of the body volume and contains four appendages- antennules, antennae, mandibles and first maxillae.
 4. Trunk reduced having no more than two pairs of appendages.
 5. Gills absent. Gas exchange is integumen-tary.
- Ostracods contain a total of 5,700 species divided in two subclasses.

Subclass-1 Myodocopa:

1. Shell valves with an antennal notch.
2. Second antennae usually adapted for swimming.
3. Two pairs of trunk appendages.

Examples: Cypridina, Gigantocypris.

Subclass-2: Podocopa:

1. Valves of the shell without an antennal notch.
2. One or two pairs of trunk appendages.

Examples: Cypris, Pontocypris, Candona, Cypridopsis.

Class-5: Copepoda:

1. Most copepods are aquatic and free living, and there are many parasitic species also.
2. Mostly small with cylindrical bodies.
3. Trunk composed of a thorax bearing five pairs of biramous appendages and a five segmented appendage-less abdomen.
4. The anterior end of the body is the head which is either rounded or pointed and with well- developed mouth parts and antennae.
5. First pair of antennae longer than second pair and held outstretched.
6. They lack a carapace and compound eyes, but the median naupliar eye is typical.
7. Absence of gills in free living copepods.
8. Excretion by maxillary glands.

About 8,400 species have been identified of which over 1,000 species are parasitic.

Examples:

Cyclops, Ergasilus (parasite), Diaptomus, Misophria, Harpacticus, Penella (parasite on flying fish).

Class-6: Mystacocarida:

1. Marine interstitial crustaceans with elongated, pigmentless body.
2. Head is divided into a small anterior and a large posterior portion.
3. Trunk is made of ten segments of which the first five bear appendages, the first one being the maxilliped.
4. Only naupliar eye is present.
5. Sexes separate, development through nauplius stage.

Mystacocarida was first described in 1943 and twelve species have been identified.

Example: Derocheilocaris

Class-7 Branchiura:

1. Branchiurans are small, ectoparasites of marine and fresh water fishes.
2. Body dorsoventrally flattened.
3. A shield-like carapace covers the head and thorax.
4. Abdomen small, bilobed and unsegmented.
5. Both pairs of antennae reduced and modified for attachment.
6. The bases of the first pair of maxillae is modified into two large suckers (for attachment), the rest of the appendages being vestigial.
7. The four thoracic appendages well developed and used for swimming.
8. Presence of a pair of sessile compound eyes.

There are about 150 species of Branchiurans.

Examples: Argulus, Dolops.

Class-8: Pentastomida (five mouths):

1. Pentastomids are parasites that live within the lungs or nasal passage ways of vertebrates which include about 90% reptiles.
2. Body worm like and bears five short, anterior protuberances.
3. Four of these projections are leg-like bearing claws, while the central fifth projection is a snout-like process bearing the mouth.
4. Body covered by a non-chitinous cuticle.
5. No circulatory, excretory and respiratory organs.
6. Sexes separate, fertilization internal, larval development requires an intermediate host.

There are about 90 parasitic species of pentastomids.

Examples: Cephalobaena (parasite on lung of a snake), Linguatula.

Class-9: Tantulocarida:

1. Tantulocarids are minute ectoparasites of marine crustaceans.
2. The adult male remains permanently attached to the host by an oral disc.
3. Head without appendage and eye.

4. Thorax six segmented bearing five pairs of biramous limbs and a posterior uniramous one.
5. Abdomen two to six segmented and limbless. About twelve species have been identified under this class.

Examples: Tantulocarids

Class-10: Cirripedia:

1. Cirripedes are either sessile or parasitic marine animals familiarly known as barnacles.
2. Body is poorly segmented and most lack an abdomen.
3. Body enclosed within a bivalved carapace.
4. Six pairs of biramous filamentous appendages are present.
5. Both pairs of antennae reduced or absent.
6. Gills are lacking and the excretory organs are maxillary glands.
7. Cirripedes development comprises of the nauplius larva that passes through a second larva, the cypris.

About 1,000 species have been identified.

Examples: Lepas (Goose barnacles), Balanus (Acorn barnacles), Dendrogaster, Sacculina (parasite), Verruca, Trypetesa

Class-11: Malacostraca:

1. Malacostraca (the largest class of crustacea) body comprises of a head, an eight segmented thorax and a six segmented abdomen.
 2. All the fourteen segments bear appendages.
 3. Thorax may or may not be covered by a carapace.
 4. The posterior thoracic limbs being walking legs (pereiopods), the first five pairs of abdominal ones forming swimming organs (pleopods).
- The foregut in most malacostracans is modified as a two-chambered stomach bearing triturating teeth and comb-like filtering setae.
6. Compound eyes present in most species.
 7. The female and male gonopores open onto the fifth and eighth thoracic segments, respectively.

This class comprises of about 23,000 species divided into three subclasses.

Subclass-1: Phyllocarida:

1. Presence of seventh abdominal segment lacking appendages.
2. Foliaceous appendages present in thorax.
3. Thorax enclosed within a bivalve carapace

Examples: Nebalia, Paranebolia.

Subclass-2: Hoplocarida (armed shrimp):

1. Marine crustaceans (about 300 species), called mantis shrimp that are highly specialized predators of fishes, crabs, shrimps and molluscs.

2. Body dorsoventrally flattened with a small shield like carapace that does not cover the last two thoracic segments.
3. The second pair of thoracic appendages large and sub-chelate which is adapted for capturing prey.
4. Pleopods well developed and bear filamentous gills.
5. First antennae with three flagella.
6. Compound eyes large, well developed and stalked.

Examples: Squilla, Gonodactylus, Lysiosquilla

Subclass-3 Eumalacostraca:

1. Antennae without three flagella.
 2. Seventh abdominal segment lacking.
- Examples: Euphausia (Antarctic krill), Penaeus, Lucifer, Macro-brachium, Lithodes, Hippa, Cancer, Mysis, Oniscus, Eupagurus.

D. Subphylum-4: Uniramia (Latin: unus, one; ramus, branch):

1. Body divided into head and trunk. The trunk either bear pairs of walking legs, or it may be differentiated into thorax and abdomen, with the abdominal appendages greatly reduced or missing.
2. Appendages uniramous.
3. Head appendages comprise of one pair each of antennae, mandibles and maxillae and in some groups a second pair of maxillae. In addition, it has an upper lip or labrum.
4. Head also comprises of lateral ocelli, frequently organised into compound eyes; sometimes also with median ocelli.
5. Gut straight lacking digestive diverticula.
6. Tracheae used for respiration.
7. Excretory organs are malpighian tubules. Uniramians consist of more than one million species distributed between five classes.

Class-1: Chilopoda (centipedes):

1. Members of this class are carnivorous and distributed throughout the world in both temperate and tropical regions, residing in soil and humus, beneath stones, bark and logs.
2. Body elongated and dorsoventrally flattened.
3. Trunk comprising of 15 to more than 181 leg-bearing segments, the last two segments being legless.
4. They attain lengths of up to 27 cm.
5. The first pair of legs (forcipules) are large commonly called poison claws. It terminates into a pointed fang, which is the outlet for the duct of a poison gland.
6. The sense organ, 'Organs of Tomosvary' is present as a single pair at the base of the antennae.
7. The genital segment of both sexes carries small appendages (gonopods) which help in reproduction.

There are about 3000 species distributed between two subclasses.

Subclass-1: Epimorpha:

1. Adults possess 21 or more pairs of legs.
2. Brooding of egg takes place.
3. Young's possess all segments on hatch-ing.

Examples: Scolopendra, Theatops, Geophilus, Strigamia

Subclass-2: Anamorpha:

1. Absence of brooding.
2. Full complement of segments are not possessed by the young's.
3. Adults possess 15 pairs of legs.

Example: Scutigera, Lithobius, Bothropolys.

Class-2: Symphyla:

1. The symphylans are small mainly herbi-vorous myriapods that live in soil and leaf mold in most parts of the world.
2. Body comprises of a head and a long trunk with twelve leg bearing segments and two terminal segments without leg. The last segment bears a pair of long sensory hair (trichobothria).
3. Mouth parts comprise of a pair of mandibles, a pair of long, first maxillae and a second pair of maxillae fused together forming a labium. This is appa-rently similar to that of insects.
4. There are more dorsal tergal plates (15 to 24) than the number of segments. This permit increased flexibility of the body.
5. Presence of a single pair of spiracles that open on the sides of the head.
6. Absence of eyes.
7. Sexes separate. Parthenogenesis is com-mon. Copulatory behaviour is unusual. The young's have six or seven pairs of legs.

This class comprises of 160 described species.

Example: Scutigarella

Class-3: Diplopoda (millipedes):

1. Diplopods commonly known as mille-pedes (thousand leggers), live beneath leaves, stones, barks, logs and in soil. They are distributed throughout the world.
2. Presence of double trunk segments, referred to as diplosegments, formed from the fusion of two originally separate somites. Each diplosegment bears two pairs of legs.
3. Trunk is composed of leg-less first seg-ment, followed by three segments each with single pair of legs and then from 5 to more than 85 segments (diploseg-ments), each with two pairs of legs, ganglia, heart, ostia etc.
4. The floor of the preoral chamber is formed by a fused pair of maxillae, called the gnathochilarium. Second pair of maxillae is absent.
5. Presence of calcified exoskeleton (the only among uniramians).
6. Repugnatorial glands present in many.

7. Eyes may be totally absent (flat-backed millipedes), or there may be 2 to 80 ocelli arranged about the antennae. Many possess 'Organs of Tomosvary'.
About 10,000 species have been identified and disposed in three subclasses.

Subclass-1: Pencillata (Pselaphognatha):

1. Minute with soft integument bearing tufts and rows of serrated scale-like setae.
2. Trunk bears 13 to 17 pairs of legs.
3. Absence of gonopods.
4. No repugnatorial glands.

Examples: Polyxenus, Lophoproctus

Subclass-2: Pentazonia

1. Arched tergal plates.
2. Last two pairs of legs modified for clasping.

Examples: Glomeridesmus, Glomeris

Subclass-3: Helminthomorpha:

1. Segments are either cylindrical or some-what flattened.
2. At least one pair of legs (gonopods) of the seventh segment in the male modified for sperm transfer.

Examples: Julus, Polyzonium, Polydesmus, Orthoporus, Narceus, Thyropygns.

Class-4: Pauropoda:

1. Pauropods constitute soft-bodied, grub-like animals that inhabit leaf mold and soil. They are widespread in both tropical and temperate regions.
2. Body comprises of a head and eleven segmented trunk, nine of which bear a pair of legs. The first and last two segments are legless.
3. The tergal plates present on the dorsal surface of trunk, are large and overlap adjacent segments. Five of them carry a pair of long, laterally placed setae.
4. Head bears a single pair of maxillae. The antennae are biramous, with one portion terminating in a single and the other in two flagella.
5. Head lacks median ocelli but bears the 'Organs of Tomosvary'.
6. Absence of heart and trachea.
7. Development is anamorphic.

There are approximately 500 described species.

Examples: Pauropus.

Class-5: Insecta (Hexapoda):

1. Head formed by the fusion of 6 segments typically bears a single pair of antennae and two pairs of maxillae.
2. The trunk in case of insects is subdivided into a three segmented thorax and an abdomen of eleven segments without walking legs.
3. The thoracic region bears three pairs of legs and usually two pairs of wings.

4. The head in addition, also possesses median ocelli as well as lateral ocelli or compound eyes.
5. Foregut is commonly subdivided into an anterior pharynx, an esophagus, a crop and a narrow proventriculus. The proventriculus is variable in structure and function, in different insects depending upon the nature of food taken.
6. Most insects possess a pair of salivary or labial glands.
7. Gas exchange takes place through a system of trachea.
8. The chief excretory organs are malpighian tubules which remain closely associated with alimentary canal.
9. Gonoducts open at the posterior end of the abdomen.

Insecta or Hexapoda comprises of more than 7,50,000 described species. It is three times larger than all the other animal groups combined. It is divided into two subclasses comprising of 26 orders.

Subclass-1: Entognatha:

1. Mouth parts sunk into a head pouch.
2. Malpighian tubules and compound eyes are either reduced or totally absent.
3. Absence of wings and this condition is primary.

Examples: Isotoma (Springtail), Acerentulus (telson tail), Campodea. Silver Fish, House Cricket, Springtail, Stick Insect and Leaf Insect

Subclass-2: Ectognatha:

1. Mouth parts are not sunk into a pouch.
2. Malpighian tubules are present.
3. Presence of compound eyes.
4. The orders are winged forms, except for two wingless orders Microcoryphia and Thysanura.
5. Presence of an ovipositor derived from the eighth and ninth abdominal segments.

Examples:

Wingless: Lepisma (Silver fish), Machilis.

Winged: Periplaneta, Carausius (stick insect), Bombyx, Anopheles, Apis, Formica (ant), Acheta (House cricket), Phyllium (leaf insect), Tachardia (Lac insect).

Reference: Ruppert, E. E. & Barnes, R. D. (1994). *Invertebrate Zoology*. Fort Worth: Saunders College Pub.