**CLASSIFICATION OF THE PHYLUM ARTHROPODA**

The classification of Arthropoda of Ruppert and Barnes (1994), shows that the phylum is divided into four subphyla, Trilobita, Chelicerata, Crustacea and Uniramia. The detailed classification of the phylum is mentioned below:

**1. SUBPHYLUM -TRILOBITA [Gk. tri = three, lobos = lobe, morphe = shape = three-lobed form]**

**CHARACTERS:**

1. Extinct marine arthropods.

2. Body more or less oval and flattened from above downwards.

**3. Body is divided into three regions,** the anterior head or cephalon, the middle region trunk or thorax and a posterior pygidium.

4. Each region of the body is divided into 3 lobes by two longitudinal furrows, hence the animals derive their name Trilobites or three-lobed form.

5. Size varies from 10 mm to 60 cm.

6. Head and pygidium were covered by an un-jointed calcareous exoskeleton, called carapace.

7. Presence of a pair of compound eyes, found laterally on the anterior part of the body.

8. A pair of many-jointed antennae represents the pre-oral appendage.

9. Post-oral appendages are uniform, biramous and unspecialized. The in­nermost branch of each appendage was without long setae and was prob­ably adapted for walking and the outermost branch had long filaments used for swimming or filtering food materials. The two branches are some­times called endopodite and exopodite also.

10. Jointed leg with 8 segments.

11. The anal opening on the last seg­ment of the pygidium.

The subphylum includes 4000 species which are grouped under 5 classes and the class Trilobita includes the largest number of species.

Examples:Agrestus, Ampyx, Mesonocis, Holmia, Trinucleus, etc.

**2. SUBPHYLUM- CHELICERATA [Gk. chele = claw]**

**CHARACTERS:**

1. Body is divided into two parts— cephalothorax (or prosoma) and ab­domen (or opisthosoma) with no dis­tinct head.

 2. Heterogenous group of arthropods, in all of which pre-oral antennules or first antennae are absent (nonantennate).

3. Cephalothorax (or prosoma) possesses five postoral segments, each with a pair of appendages.

4. First pair of appendages on the first postoral segment is called chelicerae and are feeding appendages. The che­licerae become pre-oral in position. First pair of appendages is not an­tennae but chelicerae, used in feeding.

5. Chelicerates have no jaws (mandibles); hence may be called amandibulates.

6. Each chelicera is jointed and bears a terminal chela.

7. Abdomen (opisthosoma) consists of 12-13 segments and a telson (telson and many abdominal segments are absent in certain forms).

8. Second abdominal segment bears genital aperture which remains cov­ered by a modified abdominal ap­pendage, called operculum.

9. Compound eyes in most cases degene­rated.

10. Median simple eyes present.

11. Development usually direct.

12. Primarily marine arthropods, although most living forms are terrestrial.

**This Sub-phylum includes 3 classes:** Merostomata, Arachnida and Pycnogonida.

**CLASS-I: MEROSTOMATA**

**CHARACTERS:**

1. Marine forms with fairly developed compound eyes, present laterally.

2. Head and thorax are fused into a sin­gle unit—the prosoma or cephalotho­rax covered by a single sheet of ex­oskeleton, the carapace.

3. First pair of appendages on the prosoma is the Chelicerae followed by 5 pairs of appendages, the walking legs.

4. Prominent caudal spine, called telson, present at the end of the body, used as a lever in pushing and balancing dur­ing locomotion.

5. Respiratory organs are gills (book- gills), which are borne on the plate­-like appendages of the mesosoma.

6. Adults crawl on earth with the face downwards, but young can swim ac­tively.

**The class is divided into two subclasses:** Xiphosura and Eurypterida.

**Sub-class: I Xiphosura:** It includes many fossil forms and 4 living species.

**CHARACTERS:**

1. Cephalothorax (prosoma) is covered by a broad, smooth, and horse-shoe shaped carapace which is convex above and bears 2 pairs of eyes, one compound and lateral, and the other pair simple and median in position.

2. Caudal spine is elongated, slender and pointed.

3. Dorsal ridge is visible in the abdomen.

4. Abdomen (opisthosoma) bears 5 pairs of book-gills.

5. Excretion is performed by a four-lobed coxal gland.

6. Development with a larval stage, called trilobite larva.

7. These marine, bottom dwellers are commonly called horse-shoe crabs.

**Examples:** Limulus, Tachypleus, Carcinoscorpius.

**Sub-class 2. Eurypterida**

**CHARACTERS:**

1. All are extinct forms.

2. Scorpion-like appearance.

3. Body is compressed dorsoventrally and protected by a chitinous exoskeleton.

4. Short prosoma is covered by dorsal carapace and consists of 6 segments fused together.

5. Trunk or abdomen is followed behind prosoma and consists of 12 free seg­ments.

6. At the end of the trunk or abdomen there is a post and tail-plate or spine which may be triangular (e.g., Eurypterus) or divided into two lobes (e.g., Pterygotus).

7. Mouth ventrally placed of the prosoma.

8. Five pairs of prosomal appendages except 1st pair are 6-8 joints each and are associated with locomotion.

**Examples:** Euryptarus (Ordovician- Permian), Pterygotus (Ordovician), Slimonia (Silurian).

**CLASS- II: ARACHNIDA**

**CHARACTERS:**

1. Body divided into two regions— cephalothorax (Prosoma) and abdomen.

2. Eyes usually simple.

3. Compound eyes when present are degenerated.

4. Two pairs of jointed cephalic append- ages-chelicerae and pedipalpi present. The first pair of cephalic appendages, known as chelicerae, which are preoral and the 2nd pair, the pedipalps, are postoral and serve partly as jaws.

5. Four pairs of thoracic legs present.

6. Abdominal segments often reduced and abdominal appendages not asso­ciated with locomotion.

7. Antennae absent.

8. In terrestrial forms, the respiratory organs are book-lungs or tracheae or both in some species.

9. Excretory organs are malpighian tubules or coxal glands or both.

10. Sexes separate.

11. Eggs yolky and centrolecithal.

12. Development not accompanied by metamorphosis.

13. Carnivorous and mostly terrestrial.

**The class Arachnida is divided into 10 orders:** Scorpionida, Uropygi, Amblypygi, Palpigradi, Araneida, Ricinulei, Pseudoscorpionida, Solifugae, Opiliones and Acarida. Examples: Palamnaeus, Mesobuthus, Buthus, Scorpio, Aranea etc.

**CLASS-III: PYCNOGONIDA**

**CHARACTERS:**

1. Partially sedentaric marine chelicerates, commonly called sea spi­ders.

2. Young’s are parasitic on different soft bodied invertebrates.

3. Externally segmented body.

4. Reproductive openings present on the leg segments and not abdominal.

5. Chelicerae short and pedipalpi seg­mented.

6. Head with proboscis.

7. Third pair of appendages in the male carries the eggs and is called the ovigers.

8. Trunk of 3-6 segments with long walk­ing legs.

9. Opisthosoma much reduced with a terminal anus.

10. Protonymphon larva in the life cycle of most pycnogonids.

**Examples:** Nymphon, Pycnogonum, Colossendeis.

**3. SUB-PHYLUM CRUSTACEA: [L. crusta – a hard shell]**

**CHARACTERS:**

1. Body divisible into 3 regions—head, thorax and abdomen.

2. Two pairs of antennae are a distin­guishing feature among crustaceans.

3. Other cephalic appendages are a pair of mandibles and two pairs of max­illae.

4. Thoracic and abdominal appendages are usually 8 pairs and 6 pairs, respec­tively, variable in lower crustacea.

5. Appendages typically biramous ex­cept of antennules.

6. Carapace covers all or part of the body.

7. Head bears a pair of compound eyes on movable jointed stalk.

8. Respiration takes place either by gills or by the general surface of the body when the exoskeleton is thin or by some of the limbs.

9. Vascular system consists of a contrac­tile heart, arteries and haemocoelomic spaces.

10. Excretory organs are the modification of coelomoducts may be either antennal glands (green glands) or shell glands (maxillary glands found in the second pair of maxillae).

11. Brain formed by the fusion of first four embryonic ganglia and is con­nected with ventral nerve cord by oesophageal connectives.

12. Sexes separate.

13. Distinct sexual dimorphism present.

14. Eggs usually centrolecithal, i.e., yolk present in the central part of the egg, or may be telolecithal, i.e., yolk occu­pies one-half of the egg, or alecithal, i.e., without yolk.

15. Development includes a larval form, the nauplius, bearing a single median eye and 3 pairs of appendages.

16. Mainly aquatic, mostly marine, many freshwater and some have invaded into terrestrial condition.

**The subphylum crustacea is divided into 11 classes:** Remipedia, Cephalocarida, Branchiopoda, Ostracoda, Copepoda, Mystacocarida, Branchiura, Pentastomida, Tantulocaride, Cirripedia and Malacostraca.

**CLASS I: REMIPEDIA:** This group was first recognised in 1983 with twelve known species.

**CHARACTERS:**

1. Small and worm-like bodies, range up to 30 mm in length.

2. Head covered by a head-shield, followed by a trunk of 20-30 similar segments.

3. Each segment of the body bears a pair of lateral biramous appendages.

4. Telson with caudal rami.

5. Hermaphrodite.

They are the inhabitants of tropical marine caves.

**Examples:** Lasionectes, Speleonectes.

**CLASS-II: CEPHALOCARIDA** The members of this group are consi­dered to be most primitive among living crustaceans and the first member was dis­covered in Long Island Sound in 1955. The all species are marine and have collected in the soft sediments of the bottom up to the depths of over 1,500 m.

**CHARACTERS:**

1. Small-sized animals exceeding 3.7 mm in length.

2. Horse-shoe shaped head followed by an elongated trunk.

3. First 8 trunk segments bear biramous appendages which are identical in ap­pearance.

4. The appendages are tripartite.

5. Exopodites of these appendages are four-jointed and leaf-like and bear lateral pseudoepipodite.

6. Endopodites are segmented, cylindri­cal and ambulatory in function.

7. Movements of the limbs produce wa­ter current for locomotion and also for collecting food.

8. Eyes are buried in the head.

9. Hermaphrodite.

**Examples:** Hutchinsoniella, Lightiella.

**CLASS-III: BRANCHIOPODA**

**CHARACTERS:**

1. Mostly freshwater species, a few are marine.

2. Trunk appendages are uniform and leaf-like.

3. Presence of one pair un-jointed or jointed caudal styles.

4. Carapace either absent or shield-like or bivalve.

5. First antennae and maxillae are small and in some cases absent.

6. Mandibular palp either rudimentary or absent.

**It has 3 living orders:** Anostraca, Notostraca and Diplostracs. Examples are Branchipus, Artemia, Triops, Daphnia etc.

**CLASS-IV: OSTRACODA**

**CHARACTERS:**

1. Small crustaceans and commonly called seed-shrimps.

2. Mostly marine or freshwater, a few in terrestrial habitats.

3. Body enclosed in a hinged bivalved carapace.

4. Trunk appendages never more than 2 pairs.

5. Mandible with a palp.

6. Both pairs of antennae modified for swimming.

7. Respiration usually cutaneous.

8. Eyes may or may not be present.

9. Males are rare and the second anten­nae of the males serve as clasping organs.

**The class Ostracoda includes 4 orders:** Mydocopa, Cladocopa, Platycopa and Podocopa. Examples: Cypridina, Philomedes, Polycope, Cytherella and Cypris

**CLASS-V: COPEPODA**

**CHARACTERS:**

1. Mostly small crustaceans.

2. Body with well-marked segments.

3. Trunk composed of a thorax bearing 5 pairs of biramous appendages used for swimming.

4. Abdomen without appendages.

5. Presence of a pair of caudal styles.

6. Head-shield present but no carapace.

7. Single median nauplius eye present but paired compound eyes absent.

8. Well-developed antennae may or may not be used for swimming.

9. Seventh segment of the body bears the reproductive apertures.

**It includes 7 orders:** Calanoida, Harpacticoida, Cyclopoida, Notodelphyoida, Monstrilloida, Caligoida and Lernaeopodoida. Examples: Canthocalanus, Eucalanus, Calanus, Paracalanus, Cyclops, Notodelphys, Lernaea, Lernaeocera etc.

**CLASS-VI: MYSTACOCARIDA**

**CHARACTERS:**

1. Marine and interstitial.

2. Length of the body always within 1 mm.

3. Cylindrical bodies with distinct ce­phalic appendages.

4. Trunk consists of 5 segments each with a pair of appendages.

5. Nauplius eye persists and the com­pound eyes absent.

6. Two caudal styles work as pincers.

**Examples:** Derocheilocaris.

**CLASS-VII: BRANCHIURA**

**CHARACTERS:**

1. Fish ectoparasites.

2. Dorsoventrally flattened body with suctorial mouth.

3. Broad shield-like carapace covers the cephalothorax.

4. Small, un-segmented and bilobed ab­domen.

5. Sessile compound eyes present.

6. Flagella present in the appendages of some body segments.

7. 5 pairs thoracic appendages.

8. Fifth body segment bears the genital apertures.

9. Males have two testes but females possess a single ovary.

10. Commonly called fish lice.

It includes a single order, having the same name and includes a single family.

**Examples:** Argulus, Dolops.

**CLASS-VIII: PENTASTOMIDA**

**CHARACTERS:**

1. All the members are parasitic and live mainly in the lungs and nasal pas­sages of reptiles, but some species parasitize amphibians, birds and mam­mals including dogs and man.

2. Worm-like body ranges 2 to 13 cm long, of which the females are 10 cm in length.

3. Larva possesses 2-3 pairs of un-jointed Legs.

4. Adults are legless but possess only 4 pairs of anterior chitinous hooks, used for clinging to the host tissues.

5. Body covered by a non-chitinous cuti­cle and exhibits annular markings over the abdomen in the adult.

6. Exoskeleton moulted periodically.

7. Muscles are striated and metamerically arranged.

8. Most of the systems, such as digestive, excretory and reproductive are modi­fied to adapt the endoparasitic life.

9. Completion of the life history requires intermediate host.

10. They are gonochoristic, i.e., the sexes are separate.

11. Fertilization internal.

12. Cleavage spiral.

13. Pentastomids are popularly known as Tongue worms or sometimes referred to as “five mouths”.

Raillietiela, Cephalobaena, Linguatula, Armillifer.

**CLASS-IX: TANTULOCARIDA**

**CHARACTERS:**

1. Ectoparasite on other deep water crus­taceans.

2. Deep water crustaceans.

3. Appendages absent in trunk segments.

**Examples:** Basipoplella.

**CLASS-X: CIRRIPEDIA**

**CHARACTERS:**

1. All are marine.

2. Adults are sedenteric.

3. Body poorly segmented.

4. Six pairs biramous filamentous ap­pendages present.

5. Abdomen almost absent, with only a pair of caudal style.

6. Body enclosed within a bivalve cara­pace with calcareous plates on it.

7. Adults without eyes and antennae.

8. Usually hermaphrodite.

9. Young passes through nauplius and cypris stage.

10. Commonly called barnacles.

**This subclass includes 5 orders:** Thoracica, Acrothoracica, Apoda, Rhizocephala and Ascothoracica. Examples: Lepas, Balanus, Proteolepas, Sacculina, Symagoga, Laura etc.

**CLASS-XI: MALACOSTRACA**

**CHARACTERS:**

1. Body consists of 20-21 segments.

2. Thoracic and abdominal appendages distinct from one another.

3. Carapace covers the head and at least some thoracic segments.

4. Mandible with a palp.

5. Presence of compound eyes on stalk.

6. Antennule with two-many-jointed flagella.

7. Male and female gonopores on the bases of 8th and 6th thoracic append­ages.

**The class includes five super orders:** Phyllocarida, Hoplocarida, Syncarida, Peracarida and Eucarida. Examples: Anaspides, Mysis, Hemimysis, Lucifer, Acetes, wood borer (Limnoria), the ectopara­site of the fish, the Cymothoidae; parasites on the gills of shrimps and crabs (Bopyrus), wood lice (Ligia, Liriopsis, Oniscus and Tylos, Adinda, Agnara, etc.).

**4. SUBPHYLUM- UNIRAMIA:**

**CHARACTERS:**

1. Un-branched appendages,

2. Mandibles un-jointed and without palp.

3. Presence of a single pair of antennae.

4. Gas exchange takes place with the help of tracheal system.

5. Excretory organs are Malpighian tubules.

The subphylum is divided into 5 classes: Chilopoda, Symphyla, Pauropoda, Diplopoda and Insecta or Hexapoda.

**CLASS-I: CHILOPODA**

**CHARACTERS:**

1. Body usually dorsoventrally flattened.

2. First pair of trunk appendages modi­fied as maxillipeds and work as poi­son claws.

3. Most of the trunk segments bear a single pair of uniramous walking legs.

4. Number of legs varies from 15 to more than 100 pairs but no form possesses even number of pairs.

5. Head bears a pair of antennae, a pair of mandibles and two pairs of maxillae.

6. Segment in front of telson is called genital segment.

7. Usually genital segment bears a pair of gonopods, help in reproduction.

8. Respiration takes place by trachea.

9. Excretion by a pair of Malpighian tubules.

10. Primarily carnivorous.

11. Nocturnal and stay in humid areas.

12. Generally called centipedes or hundred-leggers.

13. Terrestrial, surface dwellers or some burrowers.

It has four well-known orders: Scutigeromorpha, Lithobiomorpha, Scolopendromorpha and Geophilomorpha. Examples: Scutigera, Lithobius, Scolcrpendra, Geophilus.

**CLASS-II: SYMPHYLA**

**CHARACTERS:**

1. Mouth parts are directed forward.

2. Trunk composed of 12 legs bearing segments, covered by 15-24 terga.

3. Second maxillae are united to form the labium, similar to the insect.

4. Eyes are lacking.

5. The penultimate segment bears a pair of sensory bristles and a pair of spin­nerets.

6. Genital openings are located on the fourth trunk segment.

7. Telson absent.

8. Spiracles present only in the head and trachea extends posteriorly only up to first three anterior trunk segments.

9. It includes herbivorous and omnivo­rous forms.

10. They are terrestrial, live in soil or leaf litter, found throughout the world.

**Examples:** Scolopendrilla, Scutigerella.

**Class-III: Pauropoda**

**CHARACTERS:**

1. Length rarely exceeds 1 mm.

2. Head has 5 segments.

3. The floor of the preoral chamber is formed by the fused pair of maxillae, called the gnathochilarium.

4. Antennae branched.

5. Trunk contains 12 segments.

6. Heart and tracheae (except in some primitive species) absent.

7. Eyes absent.

8. Legs are present in segments second to tenth.

9. Gonopores on 3rd trunk segment.

10. Saprophytic, mainly found in forest litter.

They are distributed both in tropical and temperate regions.

**Examples:** Pauropus.

**CLASS-IV: DIPLOPODA**

**CHARACTERS:**

1. Elongated and segmented forms.

2. Trunk with a large number of leg- bearing segments.

3. First trunk segment (collum) is leg­less and next three segments with a single pair of legs in each segment and the rest doubled segments (diplosegments) bear 2 pairs of legs in each segment.

4. Antennae 7 segmented.

5. Maxillae are united to form gnathochilarium.

6. Tracheae are mostly un-branched tubes.

7. Gonads unpaired but reproductive ducts are paired.

8. Gonopores on the second pair of legs.

9. Usually vegetarian and found usually beneath leaves, logs, bark and stones.

10. They are commonly called Millipedes or thousandleggers

11. They are terrestrial and are mainly distributed in the tropics.

It includes two subclasses— Pselaphognatha (= Pencillata) and Chilognatha.

**Sub-class 1. Pselaphognatha (Pencillata):**

**CHARACTERS:**

1. The size of the body is very small.

2. Body is soft due to the absence of hard exoskeleton.

3. Gonopods are absent in males.

4. Head contains trichobothria.

5. Integument is often armed with lat­eral setae, hairs or bristles.

It includes a single order Pselaphognathae and the example is Polyxenus.

**Sub-class 2. Chilognatha:**

**CHARACTERS:**

1. The integument is provided with hard exoskeleton.

2. Head has no trichobothria.

3. Setae are not clustered.

4. Gonopods are present.

5. Presence of gnathochilarium.

The subclass includes seven orders: Platydesmida, Polyzoniida, Polydesmida, Chordeumida, Julida, Spirobolida and Spirostreptida. Examples are: Platydesmus, Polyzonium, Polydesmus, Julus, Thyropygus etc.

**CLASS-V: INSECTA OR HEXAPODA**

**CHARACTERS:**

1. Size varies from 250 pm—25 cm in length.

2. Body consists of three distinct tagmata (regions)—head, thorax and abdomen.

3. Head is formed by the fusion of six segments and its appendages are a single pair of antennae, a pair of mandibles and two pairs of maxillae.

4. In adults, the thorax includes 3 seg­ments—prothorax, mesothorax and metathorax and each segment bears one pair of walking legs. Hence, called Hexapoda for the three pairs of legs.

5. In winged insects, the mesothorax and metathorax bear a pair of wings in each segment.

6. A pair of compound eyes present.

7. Paried appendages absent in the adult abdomen.

8. Respiratory organs are in the form of tracheae which extensively developed.

9. Chief excretory organs are the Mal­pighian tubules closely associated with alimentary caual.

10. Development usually pass through complicated metamorphis but in some cases it may be direct. It has two subclasses Apterygota and Pterygota.

**Sub-class-I Apterygota**

**CHARACTERS:**

1. Wings absent.

2. Presence of terminal cerci.

3. Development direct.

Two super order—Entognatha and Ectognatha which include a total of four orders. Examples are Acerentomon, Podura, Orchesella, Bourletiella, Lepisma etc.

**Sub-class-II Pterygota**

**CHARACTERS:**

1. Adults possess wings which may be secondarily lost.

2. Excepting cerci, other appendages are absent in the abdomen.

3. Malpighian tubules are present.

4. Metamorphosis may be complete or incomplete.

This large subclass is subdivided into four sections—**Paleoptera, Polyneoptera, Oligoneoptera and Paraneoptera**. The section **Paleoptera** includes the animals in which the wings cannot be placed parallel to the abdomen when at rest. The wings originate as external buds and urface of the wing is thickened only in correlation with veins. There are two living orders under this section—Ephemeroptera and Odonata. **Examples are**: Ephemera, Hexagenia, Anax, Aeschna, Ischnura and Lestes. Section **Polyneoptera** is characterized by wings with rich supplies of veins. At the time of rest, the wings are always kept folded over the abdomen and numerous Malpighian tubules are present. This section includes nine orders: Dictyoptera, Isoptera, Zoraptera, Notoptera, Cheleutoptera, Orthoptera, Embioptera and Dermaptera. **Examples are** periplaneta, Mantis, Perla, Isoperla, Locusta, Schistocerca, Gryllotalpa, Forficula etc. Section **Oligoneoptera** is characterized by incomplete metamorphosis, limited number of Mulpighian tubules and biting or sucking type of mouth parts. It includes following eleven orders: **Coleoptera (**Photinus, Calandra, Adalia and Dineutus), **Megaloptera** (Sialis), **Raphidioptera** (Raphidia), **Planipennia** (Montispa, Myrmeleon), **Mecoptera** (Panorpa), **Trichoptera** (Rhyacophilia, Mayatrichia), **Lepidoptera**(Bombyx), **Diptera** (Culex Musca), **Siphonaptera** (Culex, Ctenocephalus), **Hymenoptera** (Apis (Honey bee), Vespa (Wasp), and Formica (Ant).), **Strepsiptera** (Stylops). Section **Paraneoptera** includes all the forms either parasites or pests and are included within the orders— Psocoptera, Mallophaga, Anoplura, Thysanoptera, Homoptera and Heteroptera. Examples: Psocus, Menopon, Heliothrips, Aphis, Tachardia (Lac insect), Cimex (Bed bug), Anasa, Leptocorisa (Rice bug), etc.

**ARTHROPODA CLASSIFICATION** (After Ruppert & Barnes, 2006)

**1. Subphylum TRILOBITOMORPHA** – The Trilobites

**2. Subphylum CHELICERATA** – With chelicerae and pedipalps

**Class Merostomata** – ex. Limulus

**Class Arachnida** – Spiders, scorpions, mites and ticks

**Class Pycnogonida** – Sea spiders

**3. Subphylum CRUSTACEA**

**Class Branchiopoda** – fairy shrimps, brine shrimps

**Class Maxillopoda** – Copepods

**Class Malacostraca** – Prawn, Crabs, Lobsters, Shrimps

**4. Subphylum UNIRAMIA**

**Class Insecta** – Dragon flies, Cockroach, Beetles, Bugs, Butterflies

**Class Chilopoda** – Centipedes

**Class Diplopoda** – Millipedes

**Class Symphyla** – Soft bodied Scutigerella

**Class Pauropoda** – Soft bodied Pauropus