Ministry of Environment, Forest and Climate Change

सत्यमेव जयते

LiFE
Lifestyle for Environment

TECHNICAL MANUAL

For

Identification of Freshwater Benthic Macroinvertebrates of India

CPCB

Central Pollution Control Board
Ministry of Environment, Forest and Climate Change
Delhi, 110032

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Disclaimer

The manual is based on field surveys in India and scientific literature published worldwide. While classification systems can provide a useful framework for understanding and organizing different groups of organisms, it is important to consider that there may be exceptions and overlap between categories due to the complexity and variability of invertebrates.

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अध्यक्ष
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Chairman

सत्यमेव जयते

LiFE Lifestyle for Environment

केन्द्रीय प्रदूषण नियंत्रण बोर्ड
पर्यावरण, वन एवं जलवायु परिवर्तन मंत्रालय, भारत सरकार
CENTRAL POLLUTION CONTROL BOARD
MINISTRY OF ENVIRONMENT, FOREST & CLIMATE CHANGE, GOVT. OF INDIA

Foreword

Biomonitoring using Benthic Macroinvertebrates integrates both the past and present environmental conditions and predicts the long-term impact of pollutants. It is the most reliable tool to determine cumulative impact of pollutants on the aquatic ecosystems to know the "Health of Water body". These organisms are usually relatively immobile, attached to the substratum (sedentary) thereby indicating local conditions of water body. It can help the environmentalists and policymakers for the sustainable management of both the aquatic ecosystems and the inhabiting biodiversity.

Proper identification of Benthic macroinvertebrates is a crucial part in biomonitoring, however, it is difficult to find all the distinguishing characteristics of a particular order (Adult & Larvae) and its families in a single work of literature. Considering the importance of identification, Bioscience Laboratory, CPCB has prepared taxonomic key for identification of Benthic macroinvertebrates which were validated by the experts of Zoological Survey of India. This is a unique document comprising of key identification features of 219 freshwater families belonging to 4 Phyla along with the descriptive labelled images.

I compliment the entire team of Bioscience Laboratory, CPCB and the contribution made by Team CPCB in preparing the manual. I am sure this work would facilitate in identification of Benthic macroinvertebrates for biological water quality assessment and will be useful for researchers, SPCBs and environmentalists.

(Vir Vikram Yadav)

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All Staff of the Bioscience Laboratory, CPCB for their diligent efforts in collecting samples of benthic macroinvertebrates; Mr. Ravi Kumar, JLA for his contribution to the photography of insects, is appreciated.

PR Division, CPCB made necessary arrangements for successful conduction of Interaction-cum-training programs and publication of the Manual.

CONTENTS

1

INTRODUCTION

Family- Ampullaridae

Introduction

Ecosystem includes a community of living organisms (biotic components) and their physical environment (abiotic components) that interact with each other within a particular area or habitat. Aquatic ecosystem such as streams and rivers are among the most significant ecosystems worldwide and supports a wide diversity of flora and fauna. Because of ever increasing load of pollution, a sharp decline in river ecosystem has been observed. This, in turn, raises urgent demand for comprehensive methodological approaches to evaluate the health of these ecosystems and to continuously monitor the changes. Physico-chemical parameters alone cannot define the absolute water quality and only give a short-term picture of the riverine health. However, in lotic system such as rivers, where hydrological changes occur rapidly and are challenging to predict, these parameters may not be able to fully assess the long-term sustainability of river ecosystems due to their instantaneous nature.

Alternatively, biological monitoring provides an effective method to determine cumulative impact of pollution in surface water bodies. Biomonitoring, or biological monitoring, is generally defined as "the systematic use of living organisms (bioindicators) or their responses to determine the condition or changes of the environment". The responses of different bio-indicators, also known as biological indicators such as periphytons, benthic macro-invertebrates, microorganisms and fishes etc. to environmental alterations provide information about the health of the ecosystem.

Benthic macroinvertebrates play a crucial role in aquatic food webs by connecting organic matter and nutrient resources (such as leaf litter, algae, and detritus) with higher trophic levels. These organisms typically have sedentary behaviour which makes them representative of specific ecological conditions at a given site. Due to their sensitive life stages and relatively long lifecycle, they are capable of integrating the impacts of short-term environmental changes. Furthermore, their low rate of dispersal makes them an ideal indicator for determining the cumulative impact of pollution in surface water as their limited mobility makes them quite sensitive to local environmental conditions. Therefore, monitoring the presence and/or absence of certain benthic microorganisms can provide valuable insights into the health and pollution level of particular river system and this is why it has been called as "bio monitoring".

Biomonitoring is conducted using a combination of tool such as field study and laboratory analysis. Field study includes collection of organisms from different substratum of water bodies and laboratory analysis involving the identification of organisms using taxonomic keys. The macroinvertebrates families have been assigned a score according to their sensitivity towards pollution. Further, these sensitivity scores are used to evaluate the biological water quality class of a surface waterbody.

Identification of the collected organisms is an important step in order to precisely classifying the Biological water quality. Hence, correct identification forms the basis and allow users to correctly interpret the results and make strategies about environment conservation. This is commonly done using standard reference taxonomic keys. These keys are useful in categorising organisms according to their morphological, physiological, and behavioural traits and provide a standardized approach for taxonomic identification.

The identification of larval stages of the benthic macroinvertebrate groups is important for monitoring the ecosystem health because they spend much of their lives as larvae in water. Currently, there are limited identification keys available for insect larvae in India.Standard keys such as, Thorp and Covich, 1991, Jessup, B.K. et al, 2003, Graf, W. et al., 2006 and Nesemann, H. et al, 2007 etc. are available but they provide information about the limited number of families which are identified in their respective Countries. Additionally, it is difficult to find all the distinguishing characteristics of a particular order (Adult & Larvae) and its families in a single work of literature.

In order to overcome these difficulties, attempts have been made for the first time to construct a comprehensive guide for identification of benthic macro-invertebrates for Larvae and Adults found in the Indian subcontinent. The presented manual is a unique document which comprises key identification features upto family level of 219 freshwater families* belonging to 4 Phyla along with the descriptive labelled images.

This manual is in the form of a dichotomous key, whereby groups of organisms are divided into two categories repeatedly based on a particular morphological character. With each consecutive division, more information is revealed about the specific features of a particular organism and hence, a different family is identified at each step.

All keys are validated and authenticated by taxonomists and subject experts. This manual will provide a standardized and systematic approach of identification, reducing the risks of errors due to misidentification or subjective interpretation. Additionally, this guide of taxonomic keys will be useful in providing a basis for quality control in biomonitoring, ensuring that accurate identification is achieved, and lead to more robust and reliable biomonitoring data.

Taxonomic keys are dynamic and evolving tools that are updated as new scientific knowledge is acquired. As taxonomists continue to discover new families and other taxonomic groups, these new findings can be incorporated into the keys from time to time.

**In Class Polychaeta, both freshwater & few marine families are included.*

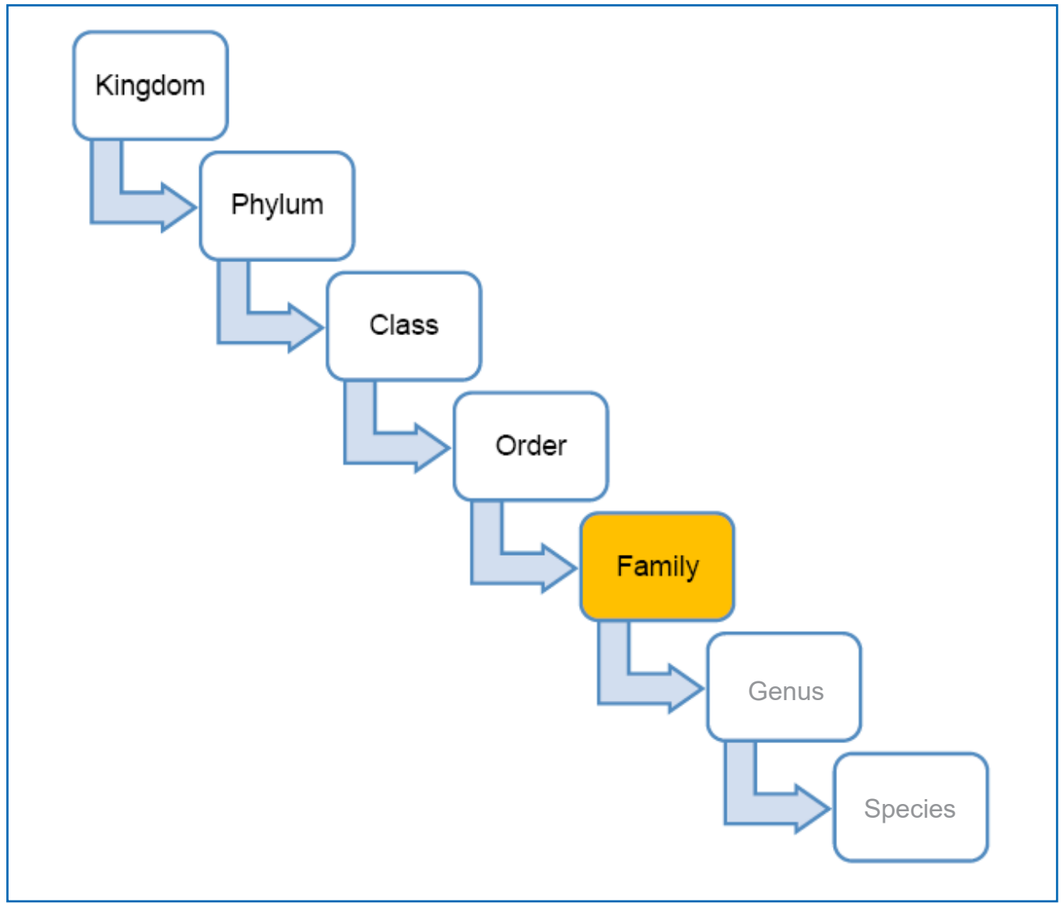
2

GUIDE TO RUN THE KEY

Family-Sesarmidae

Guide to run the Key

Taxonomy is the scientific term for the process of classifying creatures. The terms **"taxis"** and **"nomos,"** together stand for **"arrangement"** and "**method**," correspondingly. The Swedish botanist Carolus (Carl) Linnaeus developed the taxonomic system in the 18th century and following figure illustrates the taxonomic hierarchy used to classify animals:



The taxonomic keys in the manual are focused on family-level identification. Each key is divided into several numbered steps and sub-steps, consisting of two contrasting features.

STEPS TO RUN THE IDENTIFICATION KEY

01 Observe the organism based on its morphological character and identify Phylum/Order

02 Once the Phylum/Order is confirmed, follow its respective key to identify the family to which it belongs

03 Start the family level key by observing the organism preferably under microscope to thoroughly examine its characteristics

04 Match the organism with the characters mentioned in step 1 of the respective key

05 Choose the substep of step 1 to which the character belongs

06 Then follow the path till the family of the organism is identified

Example

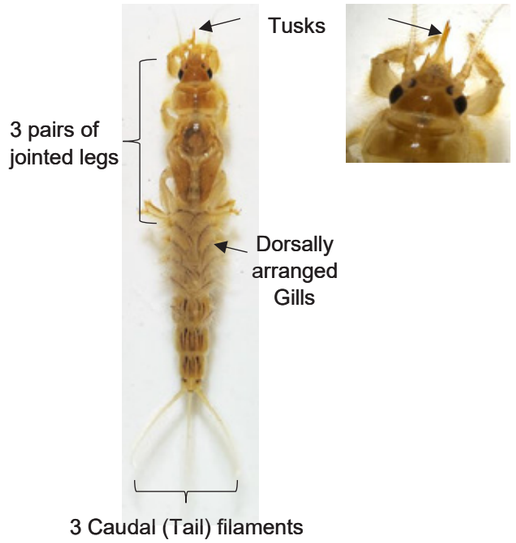


Fig. 1: Organism 'A'

Follow the **Phylum/Order Key**, Organism '**A**' has jointed Legs,
Organism belongs to Phylum **Arthropoda**

⬇ *Observe the next character & follow as per key*

3 pairs of jointed legs present

⬇ *Refer point no. 3*

Tail filaments present

⬇ *Refer point no. 4*

3 Tail filaments present

⬇ *Refer point no. 5*

Gills on abdomen present

⬇

Organism '**A**' belongs to **Order Ephemeroptera**

⬇

Follow the **Order Ephemeroptera Key** to the Family level

⬇

Organism '**A**' has mandibles with large tusks

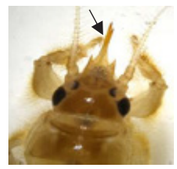
⬇ *Refer point no. 3*

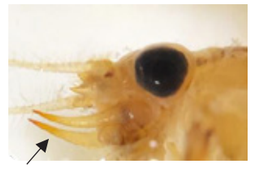
Dorsally arranged abdominal gills

⬇

⬇ *Refer point no. 4*

Mandibular tusks curving outward (dorsal view) and upward apically (lateral view)





⬇

The family of organism '**A'** is identified as **Family Ephemeridae**

3

IDENTIFICATION OF PHYLA/ ORDERS

IDENTIFICATION OF PHYLA/ORDERS

1. Jointed legs present (Fig. 1a)……..……..2

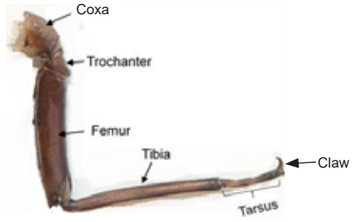


Fig. 1a

- Jointed legs absent (Fig.1b)……..……..……..……17

Fig.1b

2. Three pairs of legs present (Fig. 2a)…….…….....3

Fig. 2a

- More than three pairs of legs present (Fig. 2b)..……..……13

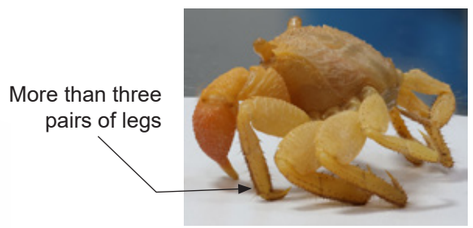


Fig. 2b

3. Tail filaments present# (Fig. 3a)……..4

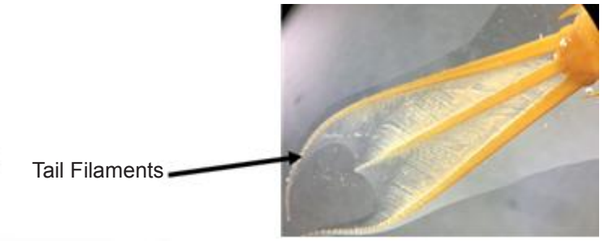


Fig. 3a

- Tail filaments absent (Fig. 3b)……..……..……..…8

Fig. 3b

4. Three tail filaments (Fig. 4a)…..……5

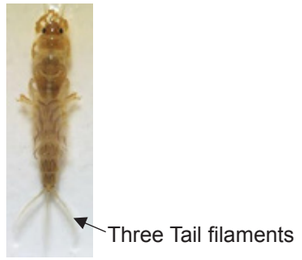


Fig. 4a

- One tail or two tail filaments (Fig. 4b)..……..……..……6

Fig. 4b

#Respiratory siphon of Family Nepidae (Order Hemiptera, Fig. 3) shall not be considered as tail filament.

5. Gills present on dorsal and lateral side of abdomen (Fig. 5a)……..…..**Order Ephemeroptera**

(Refer Page No. 111)

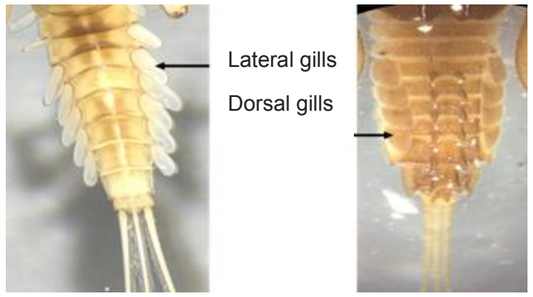


Fig. 5a

-Gills absent on abdomen (Fig. 5b)……..**Order Odonata (Suborder Zygoptera)**

(Refer Page No. 143 & 148)

Fig. 5b

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6. One tail with lateral filaments (Fig. 6)……..……**Order Megaloptera**

(Refer Page No. 139)

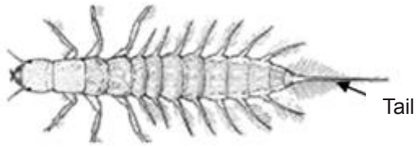


Fig. 6

- Two tail filaments present (Fig. 4b)..……..……7

---

7. Wingpads present, gills present or absent on thorax (Fig. 7a)…...……..……..**Order Plecoptera**

(Refer Page No. 157)

Fig. 7a

- Wingpads absent, gills always absent on throax (Fig. 7b)……..……..**Order Coleoptera**

(Refer Page No. 52 & 66)

Fig. 7b

---

8. Wing or wing pads absent……..……..9

- Wing or wing pads present (Fig.7a & 12 C)...……..……..……..12

---

9. A set of hooked prolegs present on the last segment of the abdomen (Fig. 9)……...……...10

Fig. 9

- Hooked prolegs absent on the last segment of the abdomen……..……11

---

10. Lateral processes present on abdominal segments, branched gills always absent on thorax and abdomen (Fig. 10a)..……..……..…..**Order Megaloptera**

(Refer Page No. 139)

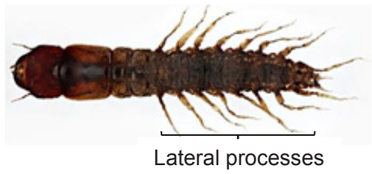
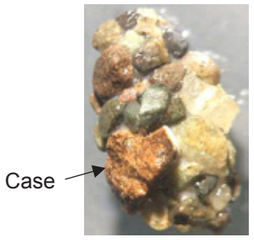


Fig. 10a

- Lateral processes usually absent (except Genus *Himalopsyche* of family Rhycophilidae which exhibit gills on thorax), branched gills present or absent at the abdomen (Fig. 10b)……..……..**Order Trichoptera**

(Refer Page No. 165)



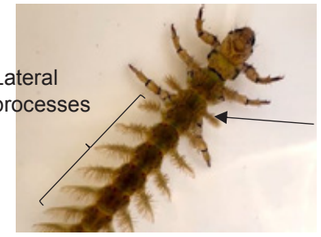


Fig. 10b

11. Prolegs present on each abdominal segment (Fig. 11).....**Order Lepidoptera**
(Refer Page No. 135)

Fig. 11

- Prolegs absent on abdominal segments.....**Order Coleoptera**
(Refer Page No. 52)

12. Fore wings modified to hard elytra, meeting in the midline, mouthparts for biting (Fig. 12a).....**Order Coleoptera (adult)**
(Refer Page No. 52 & 56)

Fig. 12a

- Fore wings (leathery) overlapping and not meeting in midline or only wing pads present, with beak or needle shape mouth parts for piercing (Fig. 12b).....**Order Hemiptera**
(Refer Page No. 123)

Fig. 12b

- Only wing pads present with mouth parts having different shapes other than beak or needle shape (Fig. 12c).....**Order Odonata (Sub order- Anisoptera)**
(Refer Page No. 143 & 153)

Fig. 12c

13. Eight legs present (Fig. 13a).....**Class Arachnida***

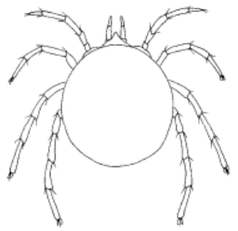


Fig. 13a

- More than eight legs present (Fig. 13b) ..... **Subphylum Crustacea** **14**

Fig. 13b

**Class Arachnida does not act as Bioindicator.*

14. Twelve legs present (Fig. 14)……..……..……..**Order Mysida**

(Refer Page No. 82)

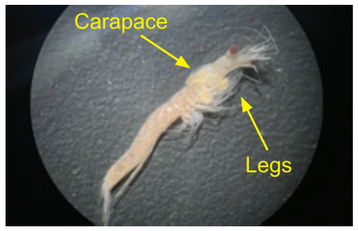


Fig. 14

- Ten legs present……..……..……...……15

---

15. Carapace present and completely covering dorsal and lateral parts of thorax (Fig. 15)..……..……..……..……..**Order Decapoda**

(Refer Page No. 75)

Fig. 15

- Carapace absent ……..……16

---

16. Body laterally flattened; 3 pairs (rarely 2) of uropods; 3 pairs of pleopods all slender and not plate-like (Fig. 16a)……..…..……**Order Amphipoda**

(Refer Page No. 89)

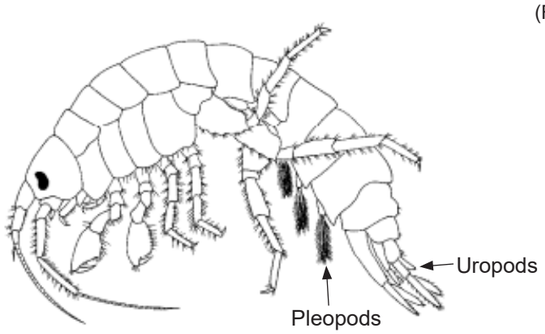


Fig. 16a

- Body either laterally or dorsoventrally flattened; 1 pair of uropods ; 5 pairs of pleopods, not slender, often plate-like, sometimes reduced (Fig. 16b)..……..**Order Isopoda**

(Refer Page No. 85)

Fig. 16b

---

17. Body enclosed in a hard shell (Fig. 17)..……..……**Phylum Mollusca..**18

Fig. 17

- Body not enclosed in a hard shell……..……..19

---

18. Body in a single shell usually spiralled (Fig. 18a)…..……..…...**Class Gastropoda**

(Refer Page No. 193)

Fig. 18a

- Shell consists of two hinged valves (Fig. 18b)..……**Class Bivalvia**

(Refer Page No. 203)

Fig. 18b

---

19. Body segmented (Fig.19a)……..20

Fig. 19a

-Body not segmented, dorsoventrally flattened, bilaterally symmetrical (Fig. 19b) ……..……..**Phylum Platyhelminthes**…23

Fig. 19b

---

20. Body with 12-15 segments; head sclerotized or retractable (Fig. 20a)…… ……..**Order Diptera**

(Refer Page No. 91)

Fig. 20a

- More than 15 segments; head never sclerotized (Fig. 20b) .. **Phylum Annelida**…21

Fig. 20b

---

21. Anterior and posterior suckers present (Fig. 21)…….…… **Subclass Hirudinea (Class Clitellata)**

(Refer Page No. 26)

Fig. 21

- Suckers absent……..……..……..22

---

22. Body with paired lateral outgrowths with bundle of setae along full length (Fig. 22 a)……..……..**Class Polychaeta**

(Refer Page No. 40)

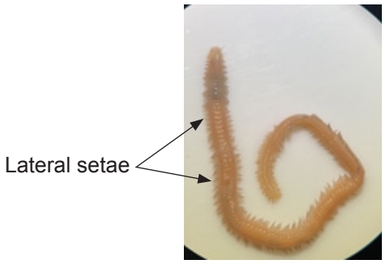


Fig. 22a

- Body usually without paired lateral outgrowths but few worms have lateral setae (Fig. 22b)……..……..**Subclass Oligochaeta**

(Refer Page No. 34)

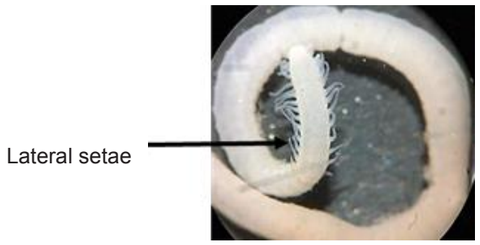


Fig. 22b

---

23. Flattened forms, moderately elongate, tentacles absent (Fig. 23a)….**Order Tricladida**

(Refer Page No. 213)

Fig. 23a

Flattened forms, short, oval, 2 -6 tentacles at anterior end (Fig. 23b).....**Order Temnocephalida**

(Refer Page No. 212)

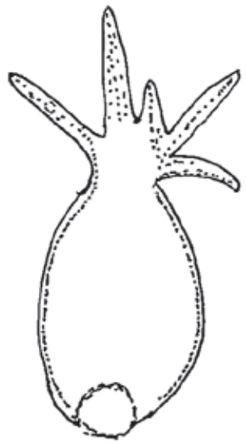


Fig. 23b

Hanuman Chatti, Uttarakhand

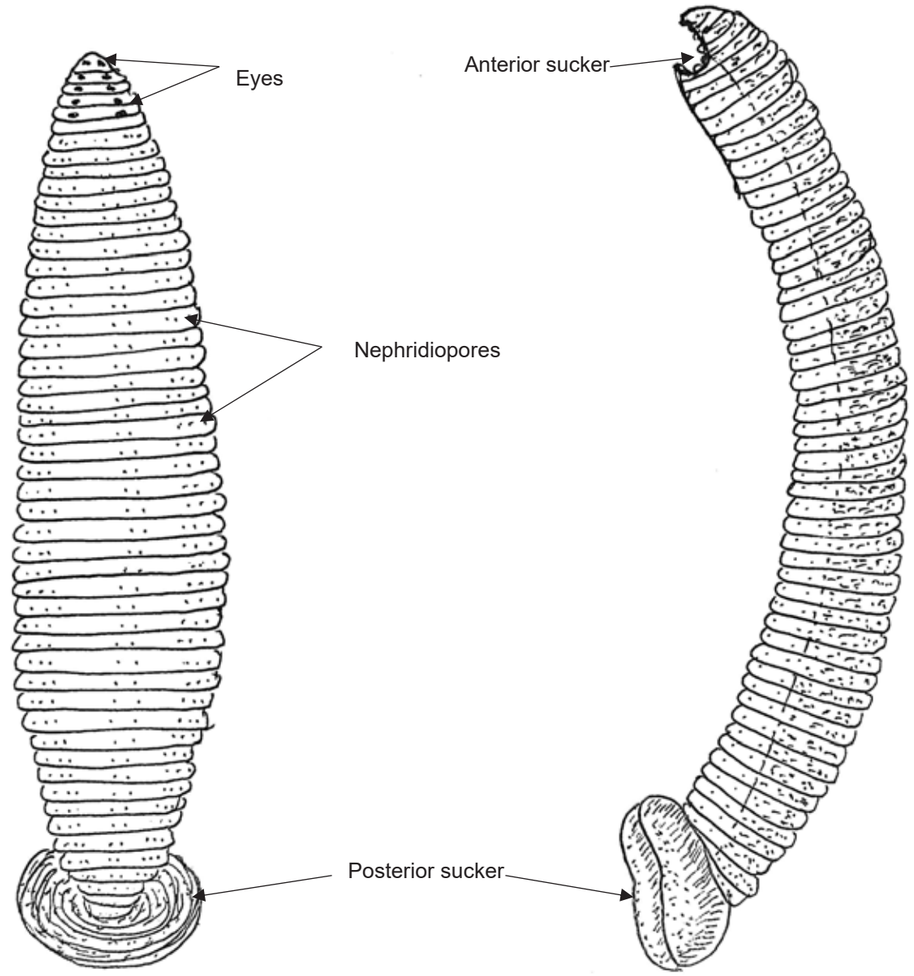
4

PHYLUM ANNELIDA

Family-Nephtyidae

SUBCLASS HIRUDINEA

Family - Erpobdellidae



Morphological Features (Adult)

Image source: H. Nesemann, 2007

Key Points

Family: Hirudidae *(Representative Hirudinea)*

1. Common name- True Leech
2. Origin of the name- Latin Hirudo (Genitive hirudinis), a leech
3. Characteristics:

- Segmented worms closely related to the oligochaetes (soft, muscular segmented bodies like earthworm),
- Leeches typically differ from the annelid groups (oligochaetes) by the presence of an anterior & posterior circumoral sucker (at both ends).
- The majority of leeches live in freshwater habitats, while some species can be found in terrestrial and marine environments.
- These are parasitic or predatory worms as they are attaching themselves to a host with a sucker and feeding on blood so called are hematophagous, secrets the peptide hirudin to prevent the blood from clotting.

List of Families

1. **Glossiphonidae**
2. **Piscicolidae**
3. **Erpobdellidae**
4. **Salifiidae**
5. **Hirudidae**

Keys for Orders of Subclass Hirudinea

Mouth small (pore like) (Fig. 1 a), proboscis present, Jaws absent……..**Order: Rhynchobdellida**

Fig. 1 a

- Mouth large (Fig. 1 b), occupying entire cavity of the sucker; proboscis absent, Jaws present or absent……..…..…….**Order: Arhynchobdellida**

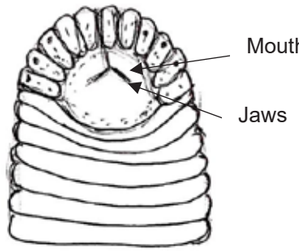


Fig. 1 b

Key for Families of Order Rhynchobdellida

1. Body is flattened and oval shaped, eyes confined to head, anterior sucker fused with the body and posterior sucker cupuliform, rows of papillae present (Fig 1a)…….……**Glossiphonidae**

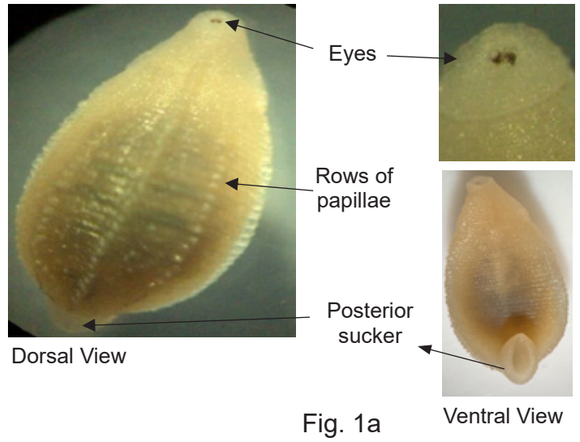


Fig. 1a

- Body cylindrical, anterior discoid sucker and posterior sucker cupuliform are distinct from the body (Fig. 1b) ……..……..**Piscicolidae**

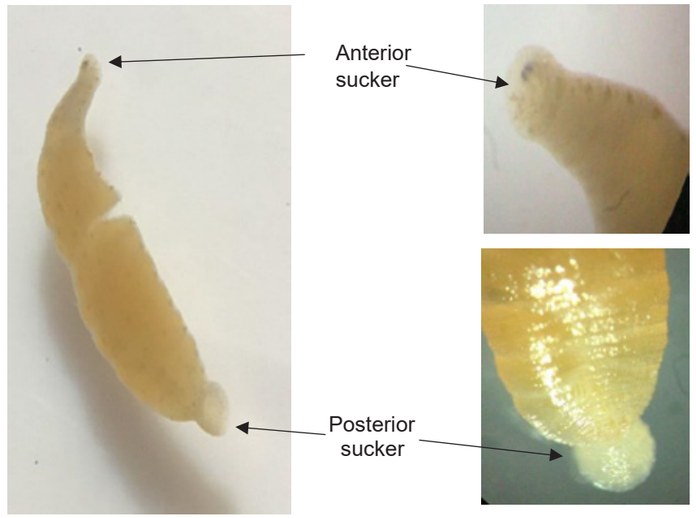


Fig. 1b

Key for Families of Order Arhynchobdellida

1. Eyes 3-6 pairs but never arranged in a regular arch on contiguous somites, mouth with muscular ridges (Fig. 1)……..…….....**Erpobdellidae**

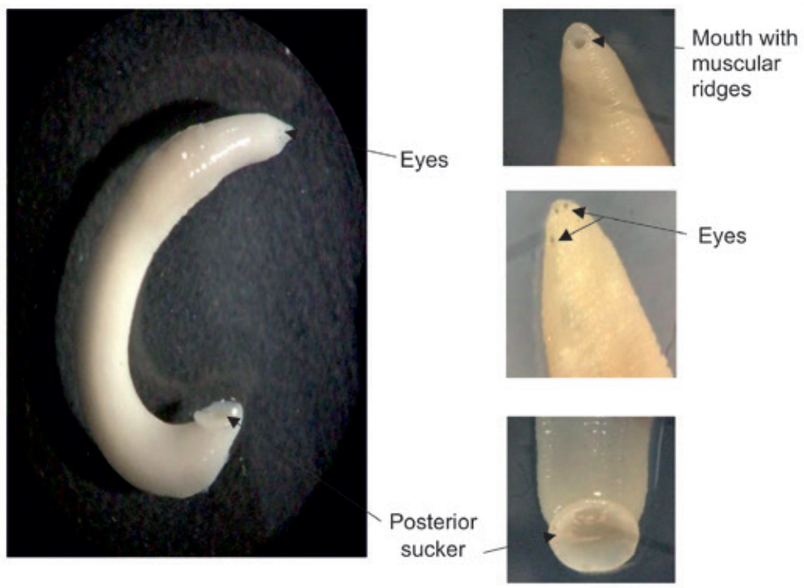


Fig. 1

- Eyes forming always a regular arch on contiguous somite (Fig. 2b)……...2

2. Three pairs of eyes in larval stage (Fig 2a); but in adult, eyes are reduced ……
.....……..……..……..……**Salifidae**

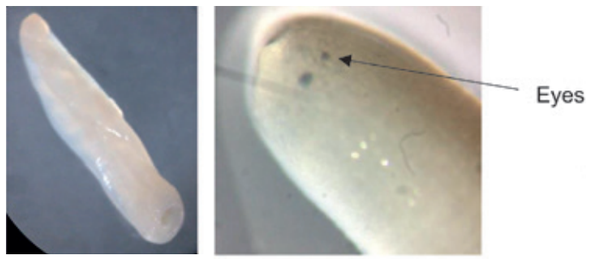


Fig. 2a

- Five pairs of eyes forming lateral crescents, mouth with 3 pairs of toothed jaws (Fig. 2b)……..……..**Hirudidae**

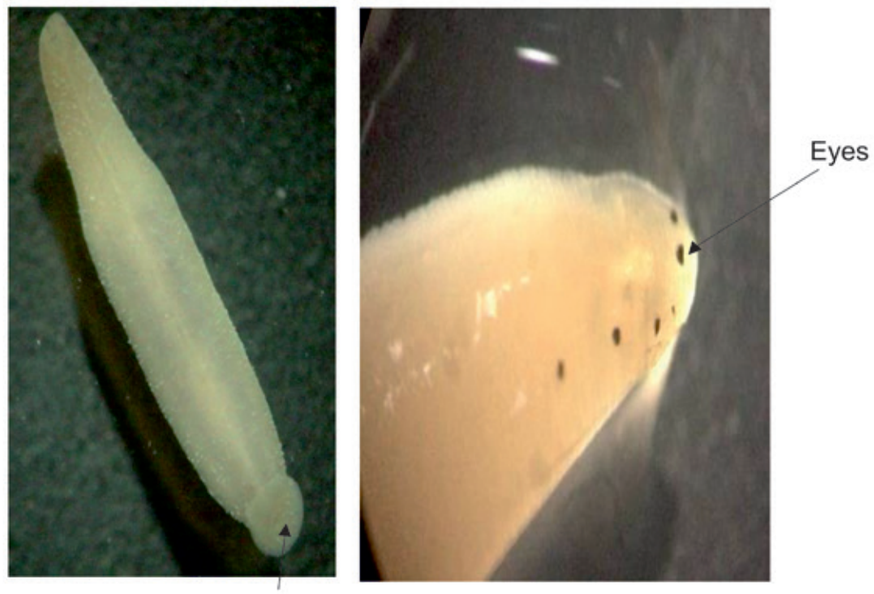
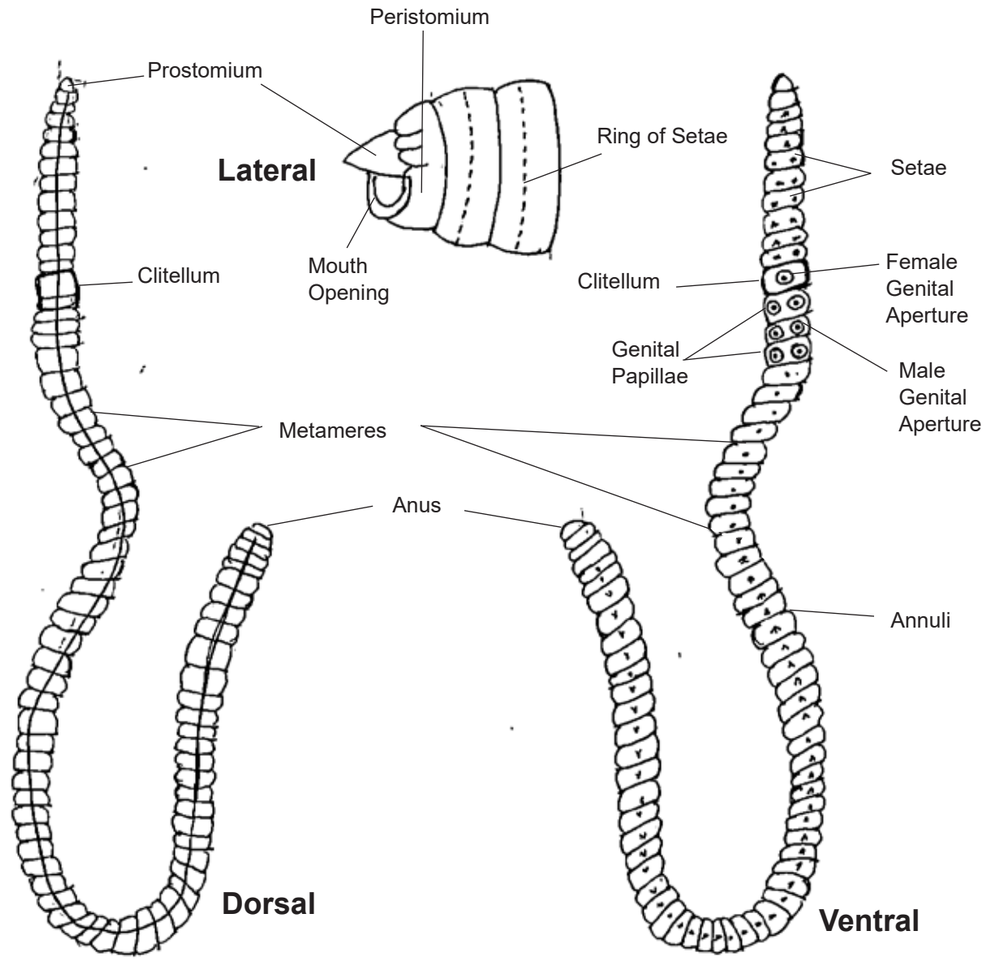


Fig. 2b

SUBCLASS OLIGOCHAETA

Family- Almidae



Morphological Features (Adult)

Key Points

Family: Naididae *(Representative Oligochaeta)*

1. Most familiar are -Aquatic worms or Earthworm**.**
2. Origin of the name- Greek- meaning few long hairs or bristles.
3. Characteristics:

- They are mostly freshwater and terrestrial organisms.
- Oligochaetes are coelomate invertebrates that display both internal and external metameric division resulting in a repeating pattern of body parts along their length.
- They do not have suckers or parapodia but possess setae throughout the body except first and last segments.
- They are hermaphroditic, but they typically practice cross-fertilization.
- Fertilization is external and development takes place inside the cocoons.

List of Families

1. **Naididae**
2. **Lumbriculidae**
3. **Enchytraeidae**
4. **Almidae**
5. **Ocnerodrillidae**

Key for Families of Subclass Oligochaeta

1. Smaller & thin worms, size about 1-50mm; setae in bundle (Microdrile) ……..…..**2**

- Large & robust worms, size more than 50mm; setae lumbricine arrangement, 8 on each segment (Megadrile)……..……..……..…….....**4**

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2. Hair setae present in ventral bundles; dorsal setae absent on segments II to V; eyespot may be present or absent; proboscis may be present or absent; tail gills may be present (Fig. 2) ……..…….... **Naididae**[1]

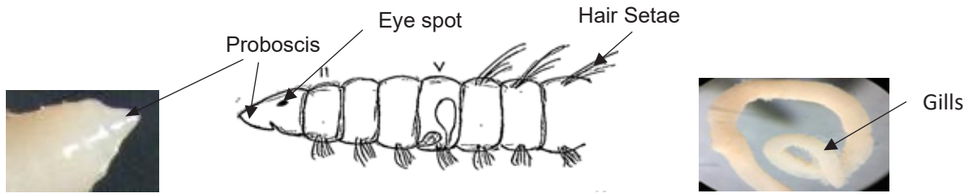

Fig. 2

- Hair setae absent in ventral bundles ……..... **3**

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3. All setae paired, pointed or bifid with upper jaw tooth; thin bodied worms (larger worms with sigmoid); clitellum in region of gonophores (VI) VII-X (XI) (Fig. 3a) ……..……..…….... **Lumbriculidae**

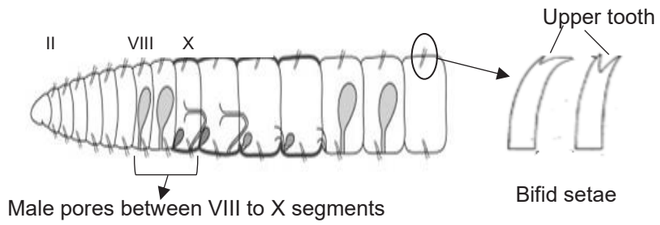

Fig. 3a

[1]*Tubificidae is a sub-family of Naididae (WoRMS (2024), Timm2017)*

- All setae simple pointed; setae usually in 4 bundles on each segment; spermathecae usually in segment 5, clitellum on segments XI & XII (Fig. 3b) ..... **Enchytraeidae**

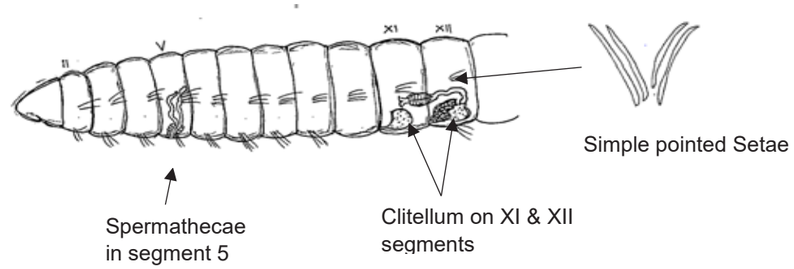

Fig. 3b

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4. Clitellum flared laterally in to wing like structure; quadrangular body; lumbricine setal arrangement; male pores inconspicuous (Fig.4a)……..... **Almidae**

Fig. 4a

- Wings like structure absent on clitellum region; male pores in segments 17-18 or 18-19, present only in clitellum region (Fig.4b) ……..……..…… **Ocnerodrilidae**

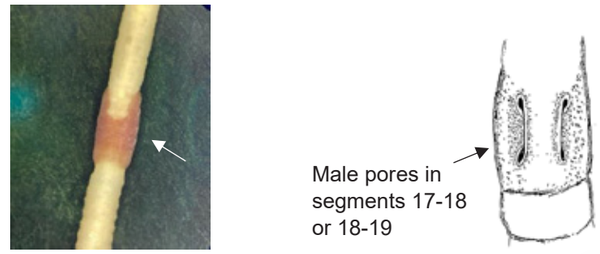
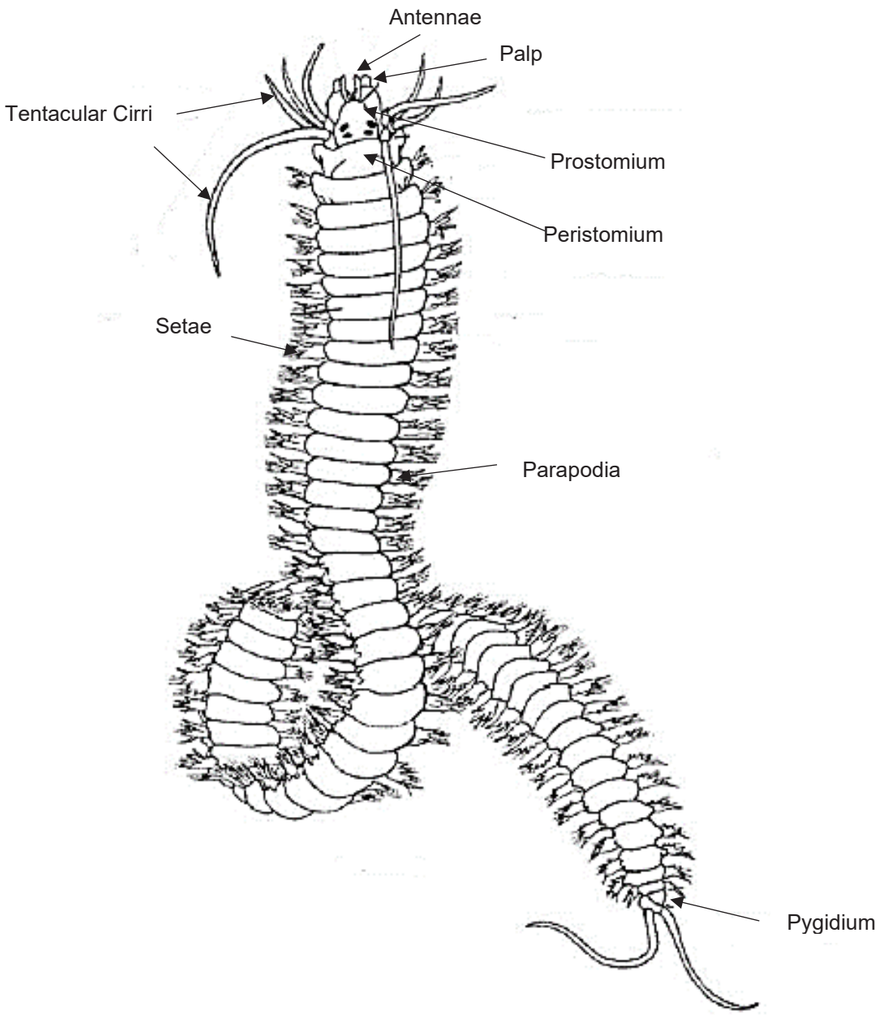


Fig. 4b

Harsil, Uttarakhand

CLASS POLYCHAETA

Family-Nephtyidae



Dorsal View

Morphological Features (Adult)

***Image Source: Loo, M.G.K. et al, 2006*.**

Key Points

Family: Nereididae *(Representative Polychaeta)*

1. Common name- Bristle Worm
2. Origin of the name- Greek- meaning having much Hair
3. Characteristics:

- Polychaetes are primarily marine but some are freshwater tolerant species.
- Small marine worms are parasitic on echinoderms.
- The morphology of polychaeta is composed of 3 body regions.
- Head end is consisting of prostomium and peristomium.
- Head end may have eyes, cirri, tentacles, palps, or antennae attached to the peristomium or prostomium.
- Entire body have segments that are repeated in series.
- The pygidium is part of the posterior region.

List of Families

1. **Nereidae**
2. **Hesionidae**
3. **Capitellidae**
4. **Spionidae**
5. **Nephtyidae**
6. **Cirratulidae**
7. **Ampharetidae**
8. **Serpulidae**
9. **Sabellidae**

Keys for Families of Class Polychaeta

1. Body not separated into segments (head, thorax and abdomen); uniform segments; prostomium not reduced (Fig. 1a).....2

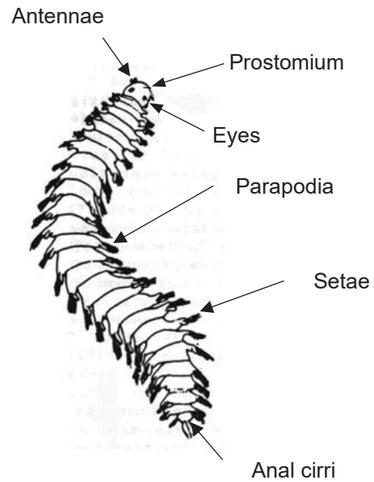


Fig. 1a

- Thoracic and abdominal parts of the body are separate, with a branchial crown or several dorsal branchial pairs around the mouth; prostomium reduced (Fig. 1b)..... 6

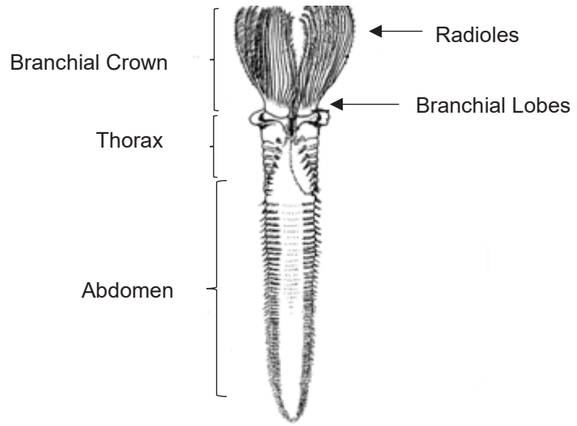


Fig. 1b

2. Pharynx muscular and well-developed, either jaws present or absent; head end containing palps and/or antennas; parapodial lobes are fully formed (Fig. 2)..……..…..…3

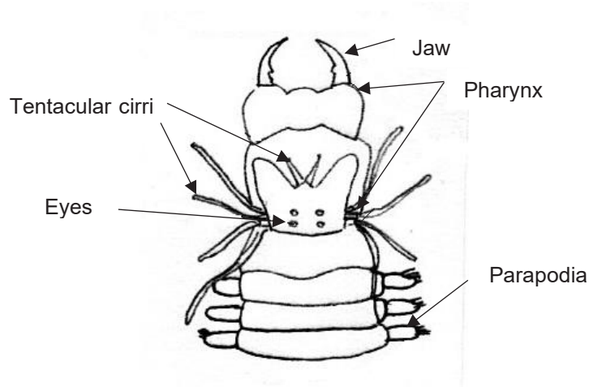


Fig. 2

- Reduced prostomium, lacking antenna; if palps are present, appear as one pair on dorsal side; lobes of parapodia reduced to hooks or capillary setae.....4

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3. Adults are large in size greater than five mm; presence of two antennae; tentacular cirri in two pairs (Fig. 3a)……..…….....**Nereididae**

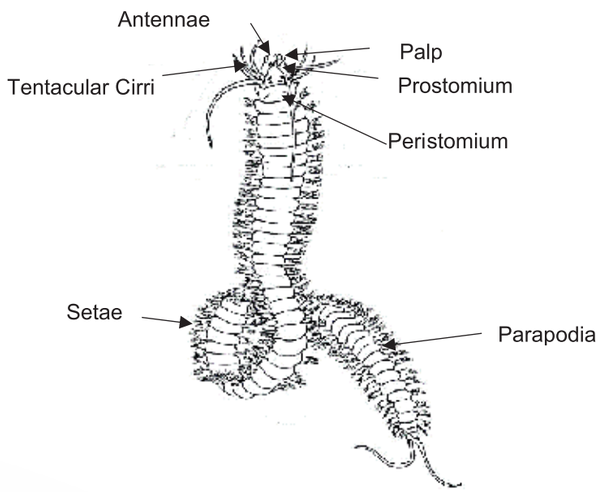

Fig. 3a

- Adults are small in size less than five mm; presence of three antennae; tentacular cirri in four pairs (Fig. 3b)……..……..…..…….……...**Hesionidae***

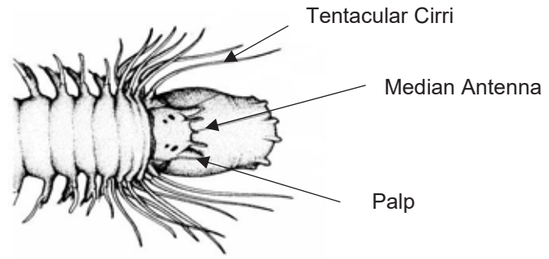

Fig. 3b

- Prostomium flattened, shield-shaped or sub-rectangular with small antennae; tentacular cirri absent; body sub-rectangular in cross section (Fig. 3c)……..…..…...**Nephtyidae**

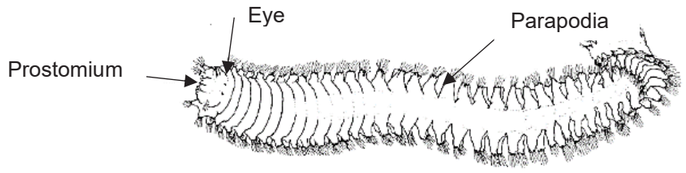

Fig. 3c

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4. Head-end having grooved tentacles on anterior segments or paired palps.....5

- Head-end not having grooved feeding tentacle or palps (Fig. 4)..... **Capitellidae**

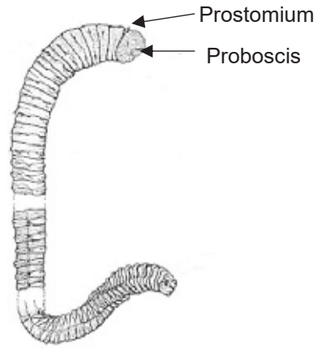

Fig. 4

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5. Paired palps and conical or frontal horns are present on the anterior end; branchiae present on one or more segments that are pinnate or cirriform (Fig. 5a)..... **Spionidae**

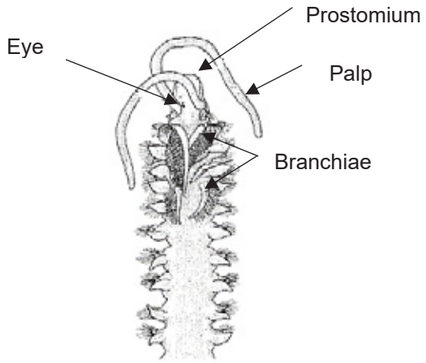


Fig. 5a

- A large number of simple elongate filaments along the body; anterior end lacking appendages; biramous parapodia reduce in size to capillary setae (Fig. 5b).....**Cirratulidae***

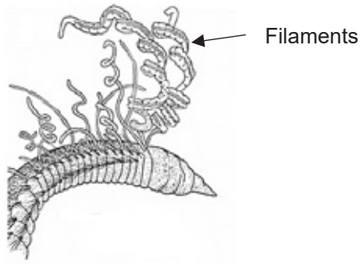


Fig. 5b

6. A branchial crown made up of many radioles is present on the anterior 7

- Dorsally several branchial pairs present on the anterior segments but no branchial crown on the anterior (Fig. 6).....**Ampharetidae***

Fig. 6

7. Anterior consisting of stalk operculum; thoracic collar is present; habitat tube build with calcareous (Fig. 7a)……..……..……...**Serpulidae**

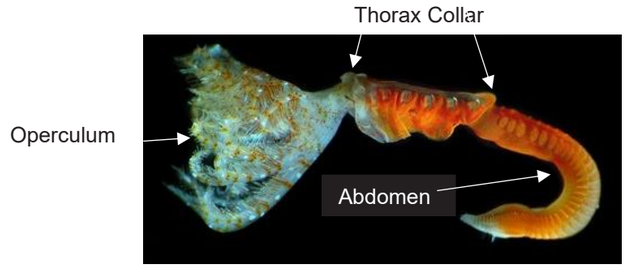


Fig. 7a

- Anterior lacking stalk operculum; thoracic collar is not present; habitat tube build with sand or mud (Fig.7b)……..……..……..……**Sabellidae**

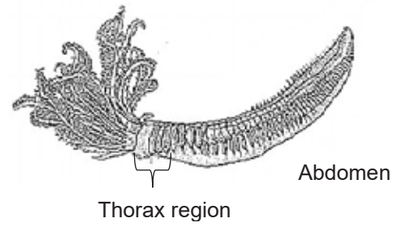


Fig. 7b

*marine families

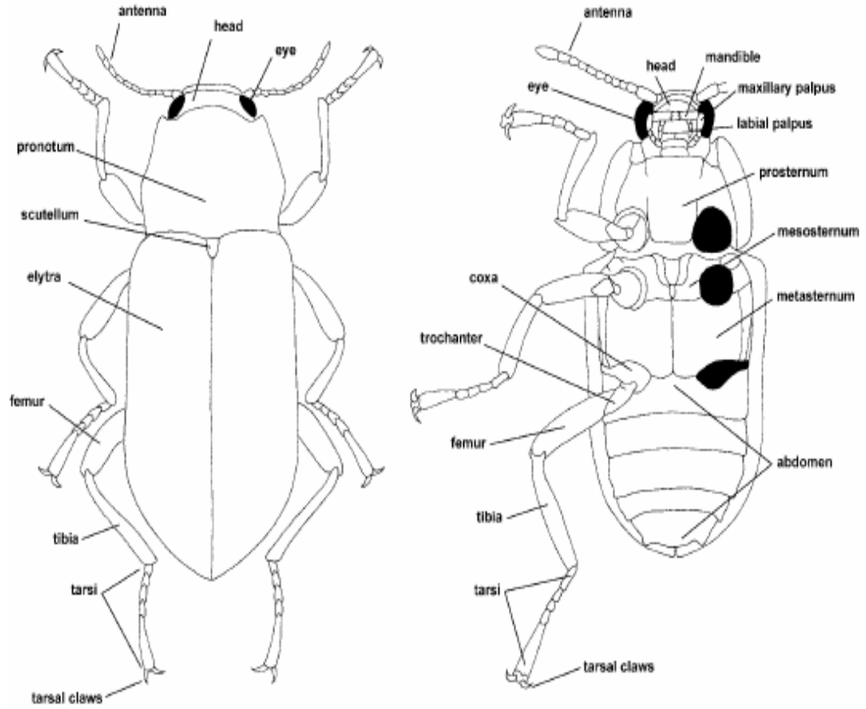
5

PHYLUM ARTHROPODA

Family-Belostomatidae

ORDER COLEOPTERA

Family -Dytiscidae



Dorsal View **Ventral View**

Morphological Features (Adult)

Image source: Bouchard, 2004.

Key Points

Family: Hydrophilidae *(Representative Coleoptera)*

1. Common Name: Beetles
2. Origin of the name- from Greek koleopteros, formed of two words: ‘koleos’ means ‘sheath’ and ‘pteron’ means ‘wing’ together means "sheath wing,"
3. Characteristics:
   - Usually hard body form.
   - Elytra (fore-wings) meet in a straight line down the middle of the back in resting position.
   - Mandibulate mouthparts adapted for chewing and biting.
   - Presence of 3 pairs of jointed legs.
   - Hind wings are entirely membranous and are covered by fore-wings (elytra). which are sclerotized with no veins.

List of Families

1. **Carabidae**
2. **Gyrinidae**
3. **Haliplidae**
4. **Noteridae**
5. **Dytiscidae**
6. **Sphaeriusidae**
7. **Staphylinidae**
8. **Hydroscaphidae**
9. **Curculionidae**
10. **Chrysomelidae**
11. **Heteroceridae**
12. **Dryopidae**
13. **Elmidae**
14. **Byrhiidae**
15. **Psephenidae**
16. **Scirtidae**
17. **Histeridae**
18. **Hydraenidae**
19. **Spercheidae**
20. **Hydrochidae**
21. **Georissidae**
22. **Helophoridae**
23. **Hydrophilidae**
24. **Epimetopidae**

Key For Families of Order Coleoptera (Adults)

1. Metacoxae completely dividing 1st ventrite (Fig. 1a).....2

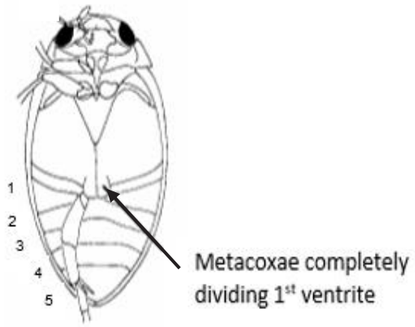


Fig. 1a

- Metacoxae not completely dividing 1st ventrite (Fig.1b).....6

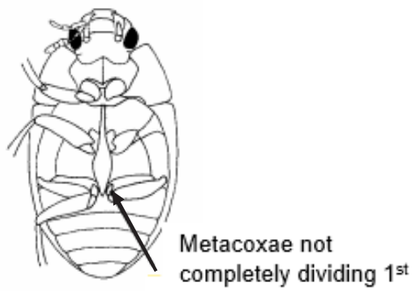


Fig. 1b

2. Long hair (adapted for swimming) absent on hind legs; prosternum not extended as a keel in the centre (Fig. 2a).....**Carabidae**

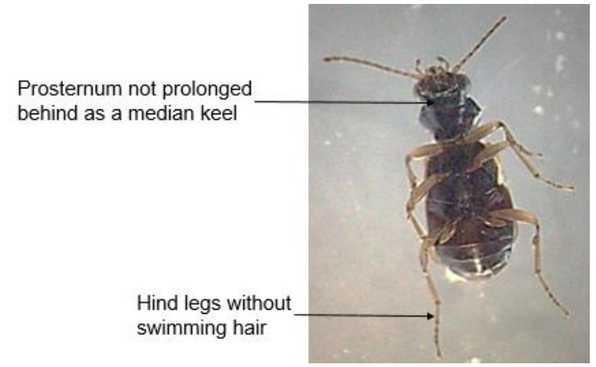
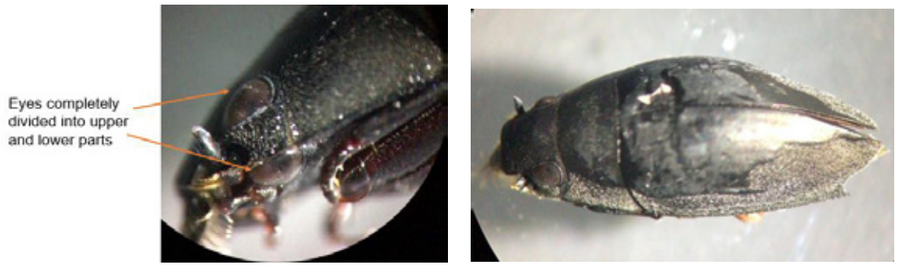


Fig. 2a

- Long hair (adapted for swimming) present on hind legs; prosternum extended as a keel in the centre (Fig. 2b).....3

Fig. 2b

3. Eyes completely divided (upper and lower parts) (Fig. 3).....**Gyrinidae**



Lateral View Dorsal View

Fig. 3

- Eyes not divided.....4

4. Meta coxae extended greatly, forming broad plates which cover 1-3 abdominal segments along with bases of hind femur (Fig. 4)…..……**Haliplidae**

Fig. 4

- Meta coxae not extended……..……5

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5. Noterid platform (formed by apophyses of prosternum, mesosternum and extended meta coxal plates) present (Fig. 5a)……..**Noteridae**

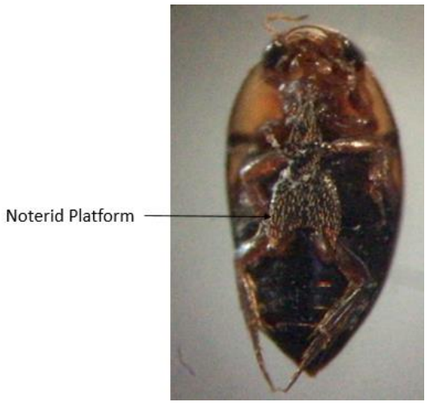

Fig. 5a

- Noterid platform absent (Fig. 5b)……**Dytiscidae**

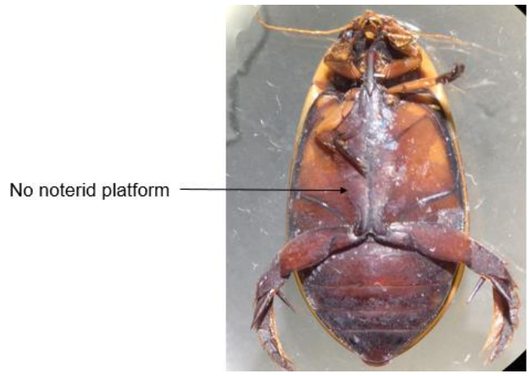

Fig. 5b

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6. Meta coxae extended, forming narrow plates which cover 1-2 abdominal segments only, but exposed them laterally……..……..…**Sphaeriusidae**

- Meta coxae not extended……..……7

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7. Elytra very short, exposing 4-7 abdominal segments dorsally (Fig. 7a) ..... ……**Staphylinidae**

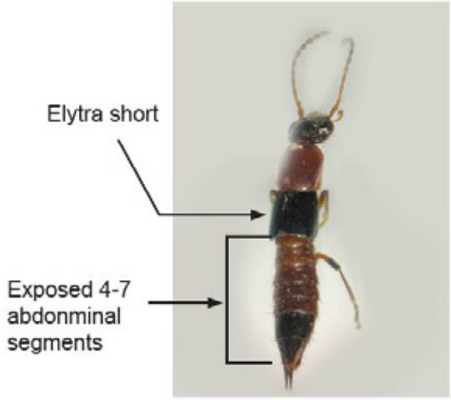

Fig. 7a

- Elytra short, exposing 2-4 abdominal segments dorsally; size small, less than 1.5 mm; all tarsi 3 segmented (Fig. 7b)……..**Hydroscaphidae**

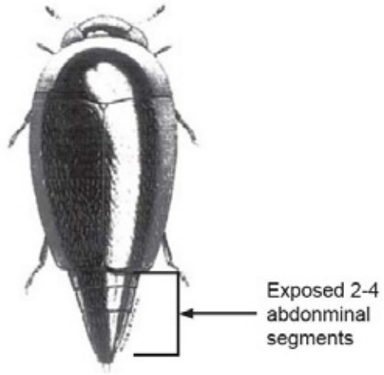

Fig. 7b

- Elytra exposing no abdominal segments or exposing 1-2 segments dorsally…..…..8

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8. Tarsal formula 5-5-5, but appearing 4-4-4, with 3rd segment bilobed and 4th segment reduced (Fig. 8).....9

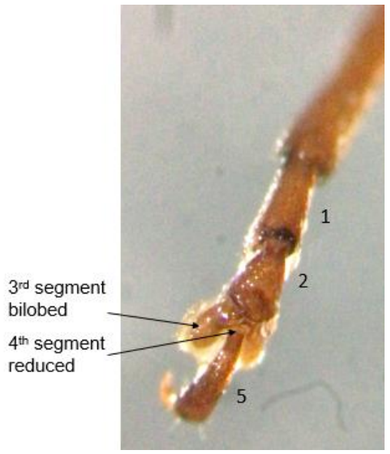

Fig. 8

- Tarsi not as above..……..……10

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9. Head extended to form a rostrum/ snout (Fig. 9)..……..…**Curculionidae**

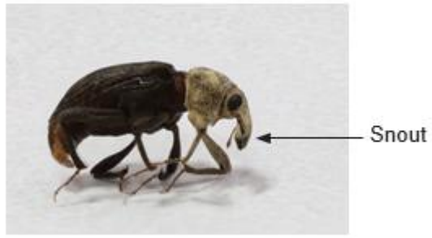

Fig. 9

- Head not extended to form a rostrum/ snout……..**Chrysomelidae**

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10. All tarsi clearly 4-segmented, tibia of foreleg dilated armed with row of spines, fit for digging (Fig. 10)……..……...**Heteroceridae**

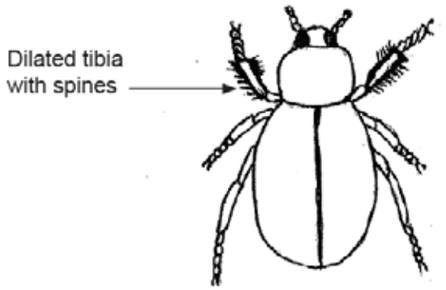

Fig. 10

- All tarsi 5-segmented; 5th tarsomere very long (sometimes longer than collective length of all other tarsomeres) with long claws; body oval, convex; head curving downwards, may be concealed by pronotum; legs foldable into body cavities…….11

- All tarsi other than 5-segmented, or if 5-segmented, then 5th tarsomere not very long; sometimes 4th tarsomere reduced and all tarsi appear 4-segmented; other characters not as above ……...12

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11. Antennae shorter than pronotum, comb-like, often concealed (Fig. 11)……..……**Dryopidae**

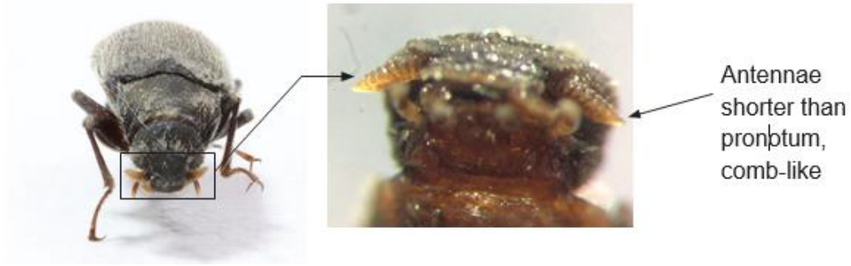

Fig. 11

- Antennae longer than pronotum……13

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12. Body narrowly elongate; elytra with lateral margins sub-parallel (Fig. 12)……..…**Elmidae**

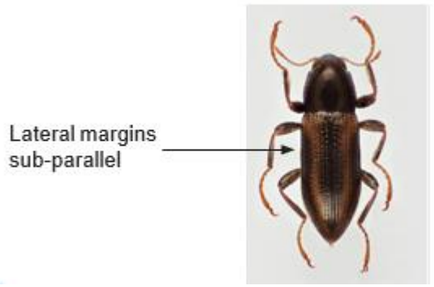

Fig. 12

- Body widely elliptical; lateral margins of elytra generally curved…..… **Byrrhiidae**

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13. Antennae serrate to pectinate; anterior coxae with exposed trochantin (Fig. 13)……..……..…**Psephenidae**

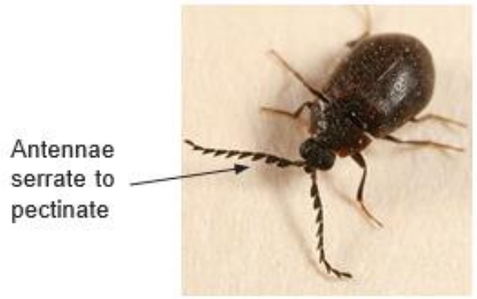

Fig. 13

- Antennae filiform, body brown to black, compact and elliptical, greatly enlarged metathoracic coxal plates……**Scirtidae**

- Antennae slender, saw-toothed, sometimes weakly clubbed……14

---

14. Antennae usually 11-segmented, with a 3-segmented club; maxillary palps shorter than antennae, not clearly visible……..……**Histeridae**

- Antennae 7-11-segmented with a 2-5-segmented club; maxillary palps usually longer than antennae…..……..…15

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15. Abdomen with 6 or 7 abdominal sternites; antennae with 5-segmented pubescent club (Fig. 15)……**Hydraenidae**

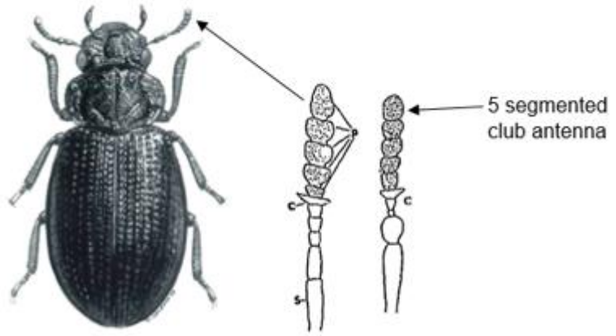

Fig. 15

- Abdomen with 5 visible abdominal sternites; antennae 3-segmented pubescent club……16

---

16. Antennae with not more than 3 segments before the capule; front coxal cavities more or less evidently closed behind ……..17

- Antennae with 5 well developed segments before capule; front coxal cavities apparently open behind……..……18

---

17. Antennae with pubescent capule and 3 segmented pubescent club; former appearing as part of club (Fig.17a)……**……..Spercheidae**

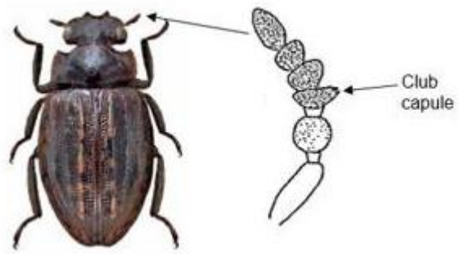

Fig. 17a

- Antennae with normal capule and 3 segmented pubescent club (Fig. 17b) **……..…..Hydrochidae**

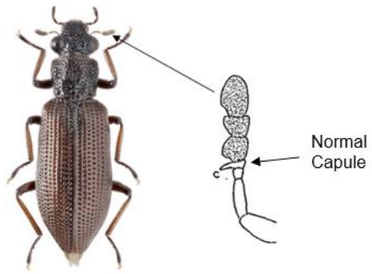

Fig. 17b

18. Tarsi 4-4-4; front coxae very large, concealing pro-sternum (Fig. 18)……....**Georissidae**

Fig. 18

- Tarsi 5-5-5; front coxae smaller, not concealing prosternum……...19

19. Prothorax broadest in front of middle, with 5 characteristics longitudinal grooves (Fig. 19a)……..…**Helophoridae**

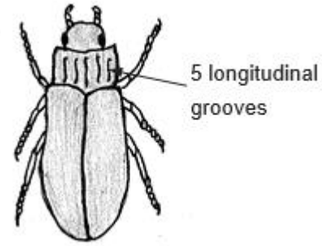

Fig. 19a

- Prothorax without longitudinal grooves, usually broad (Fig. 19b)…… **Hydrophilidae**

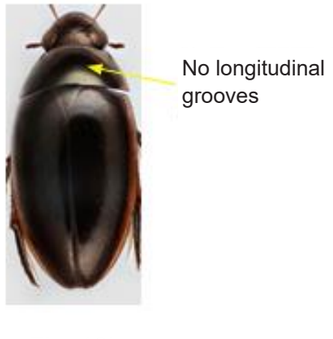

Fig. 19b

- Prothorax with pronounced antero-median projection forming shelf above head (Fig. 19c)……....**Epimetopidae**

Fig. 19c

Key for Families of Order Coleoptera (Larvae)

1. Two claws at the end of each tarsi (Fig. 1a)……..2

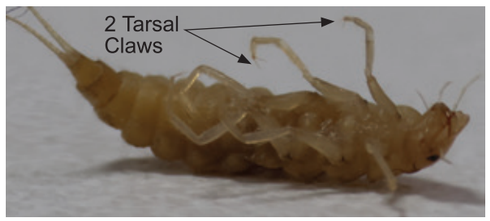

Fig. 1a

- One claw at the end of each tarsi (Fig. 1b).....3

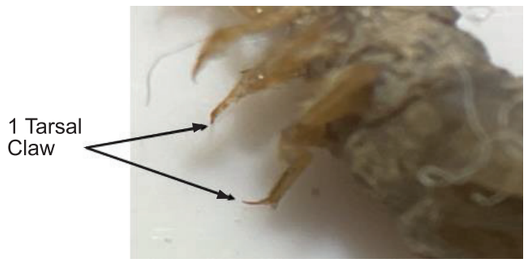

Fig. 1b

2. Two pairs of hooks at the last abdominal segment; 10 pairs of filaments on lateral sides of abdomen (Fig. 2a)……..……**Gyrinidae**

Fig. 2a

- No hooks on terminal abdominal segment; No filaments on lateral sides of abdomen; terminal filaments (tail cerci) present (Fig. 2b)……...**Dytiscidae**

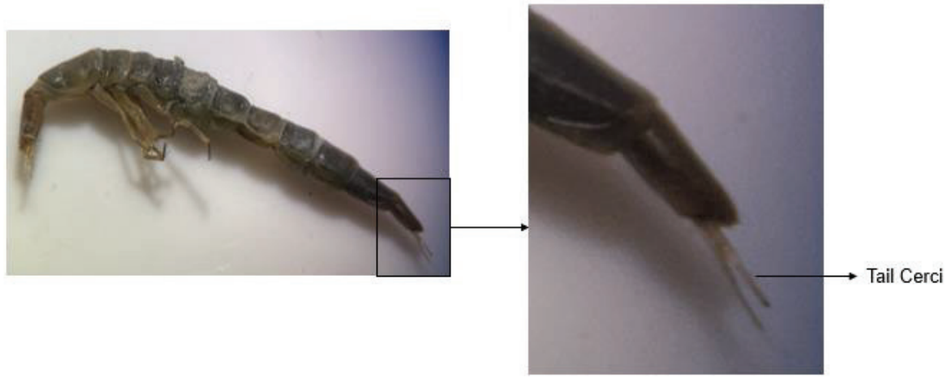

Fig. 2b

3. One to two long filaments are present at the end of abdomen; Legs divided into 5-segments (Fig. 3a) ……..……..…..**Haliplidae**

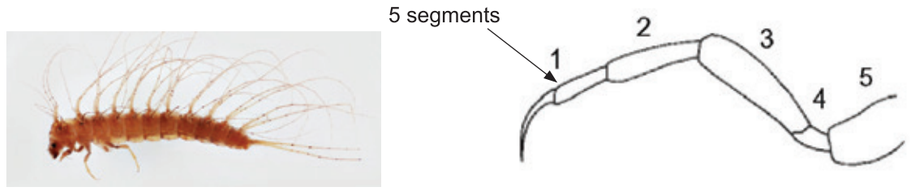

Fig. 3a

- One to two long filaments are absent at the end of abdomen; Legs divided into 4-segments (Fig. 3b)……..……..….4

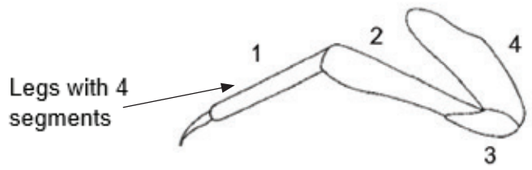

Fig. 3b

4. Large-sized mandibles present, clearly visible from above (Fig. 4)……**Hydrophilidae**

Fig. 4

- Mandibles small, not clearly visible from above ……...5

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5. Long antennae extending beyond the head (Fig. 5)……..**Scirtidae**

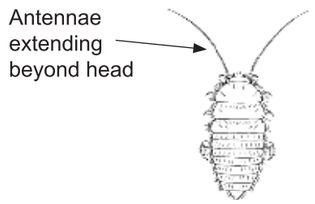

Fig. 5

- Short antennae not extending beyond the head……..……..6

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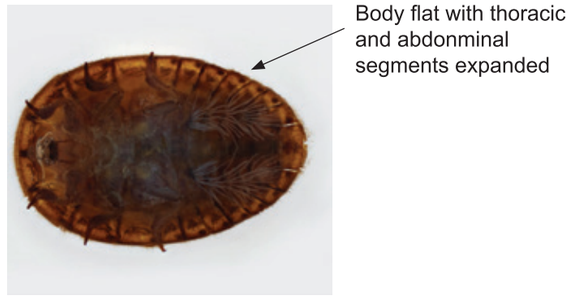
6. Body flat; thoracic and abdominal segments are expanded in such a way that head and legs are not visible dorsally (Fig. 6a)…….....….**Psephenidae**



Ventral view

Fig. 6a

- Body cylindrical or sub-cylindrical; thoracic and abdominal segments are not expanded, head and legs are visible dorsally (Fig. 6b)……..…..…. **Elmidae**

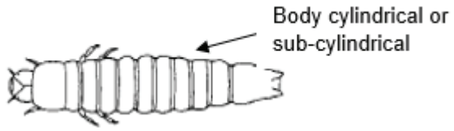


Fig. 6b

SUBPHYLUM CRUSTACEA

Family-Palaemonidae

Dorsal View

Ventral View

Morphological Features (Adult)

Key Points

Family: Potamidae *(Representative Crustacea)*

1. Common Names: Crabs, Shrimps
2. Origin of the name- Latin crusta means crust
3. Characteristics:

- Exoskeleton is hard and formed of chitin, calcified in some group as in Decapoda
- Body is divisible into 3 parts: head, thorax, and abdomen
- Head may bear appendages as, 2 pairs of antennae, mouth parts as mandibles and maxillae
- Body may bear appendages as: legs and pereiopods modified for locomotion; claws and chelipeds for grasping; pleopods for swimming
- Gills for respiration may be absent or present

List of Families

1. **Potamidae**
2. **Gecarcinucidae**
3. **Varunidae**
4. **Sesarmidae**
5. **Dotillidae**
6. **Hymenosomatidae**
7. **Palaemonidae**
8. **Atyidae**
9. **Mysidae**
10. **Anthuridae**
11. **Idoteidae**
12. **Sphaeromatidae**
13. **Cymothoidae**
14. **Aegidae**
15. **Cirolanidae**
16. **Corallanidae**
17. **Niphargidae**
18. **Talitridae**
19. **Gammaridae**

Key for Infraorders of Decapoda

Abdomen folded beneath thorax. Body rather flattened and rounded. Rostrum reduced or lacking. Tail fan absent (Fig. 1)…….. **Brachyura (Crabs)**

Fig. 1

Abdomen extended and well developed. Tail fan present. Conspicuous rostrum projecting in front of eyes (Fig. 2)……**Caridea (Prawns/Shrimps)**

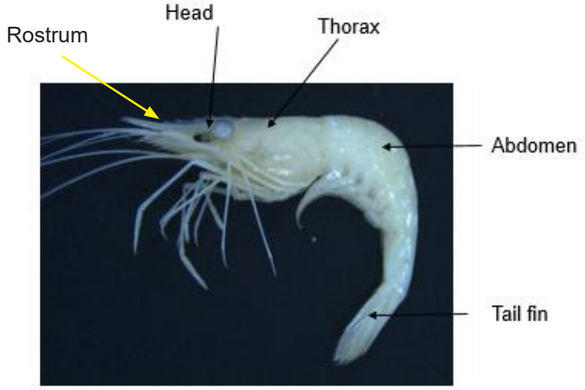


Fig. 2

Infraorder Brachyura

Dorsal View

Morphological Features (Adult)

Key for Families of Infraorder Brachyura

1. Carapace oval in shape; anterolateral margins convex……2

- Carapace oval or quadrangular/ sub-quadrangular/ pyriform (pear-shaped), sub-pyriform, triangular, circular, or sub-circular……3

---

2. Mandibular palp with 3 articles; 3rd article single lobed. Male pleon triangular in shape (Fig. 2a)..... **Potamidae**

Fig. 2a

- Mandibular palp with 2 articles; 3rd article bilobed. Male pleon clearly T-shaped, sometimes roughlly triangular (Fig. 2b)..... **Gecarcinucidae**

Fig. 2b

3. Medium size crabs with Carapace ovate to quadrangular/ sub quadrangular and width of the adult carapace more than 2cm……4

- Small size crabs with Carapace round/ pyriform, sub-pyriform, triangular, circular, or sub-circular and the width of the adult Carapace less than 2 cm ……5

---

4. Carapace oval or quadrangular in shape; frontal margin without cleft to receive antennules; pleon (in male) has seven free somites and telson; eye orbits has lateral opening; third maxillipeds close with a small gap, with distinct sulci on merus and ischium respectively (Fig. 4a)……..…**Varunidae**

Fig. 4a

- Carapace sub quadrangular or quadrangular; suborbital crest with small granules; pterygostomial region bear glabrous to moderate setae arranged as reticulate manner; ambulatory legs unarmed or with small chitinous spines on dactlyi; merus and ischium of third maxilliped with oblique setose ridge (Fig. 4b)…**Sesarmidae**

Fig. 4b

---

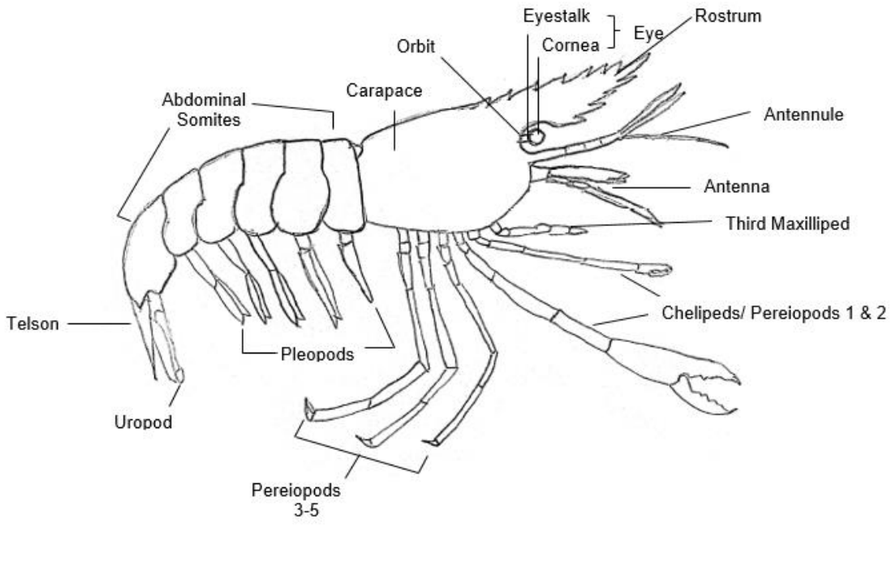
5. Carapace round; eyestalks relatively long; orbits diagonally ovate (Fig. 5a) .... **Dotillidae**

Fig. 5a

- Carapace usually broader than long sometimes weakly clacified; pyriform, sub-pyriform or circular; eye orbits absent (Fig. 5b)…..... **Hymenosomatidae**

Fig. 5b

Infraorder Caridea



Lateral View

Morphological Features (Adult)

Image Source: Yule and Sen, 2004

Key for Families of Infraorder Caridea

1. Rostrum serrated; first and second Chela in the first and second pereiopods without tuft of hair (Fig. 1a)…….…… **Palaemonidae**

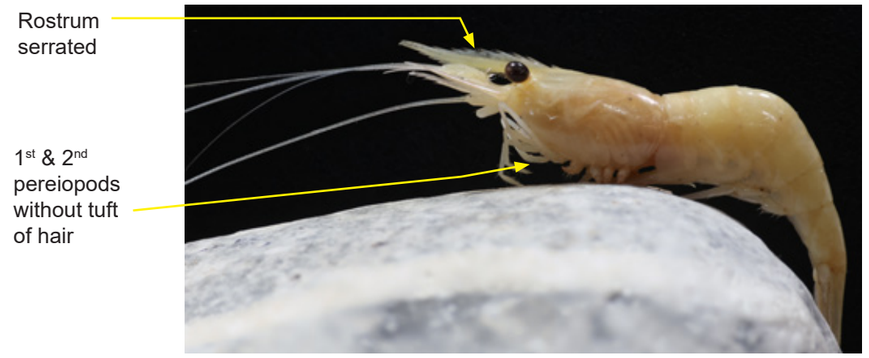


Fig. 1a

- Rostrum with small spines; Chela in the first and second pereiopods with tuft of hair (Fig. 1b)…….. **Atyidae**

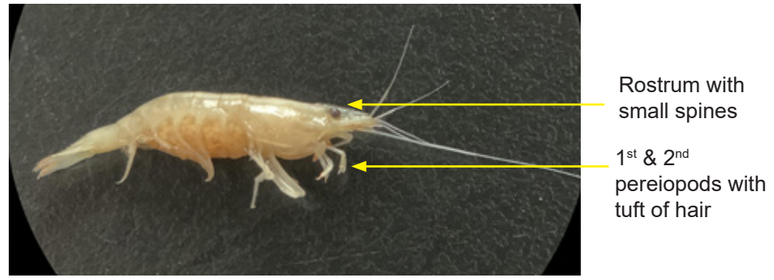
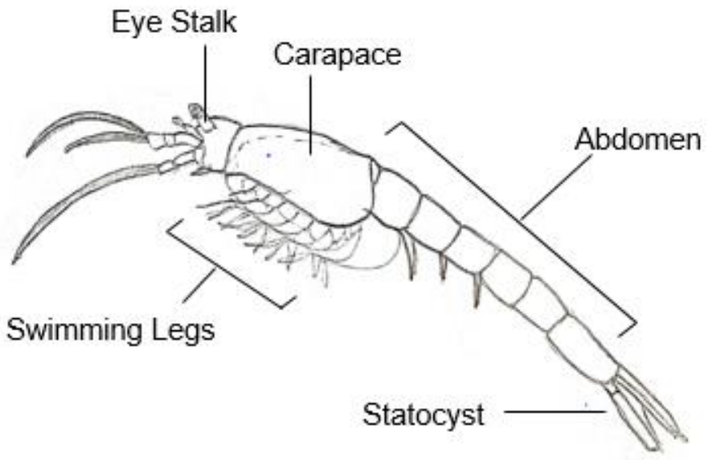


Fig. 1b

Order Mysida



Morphological Features (Adult)

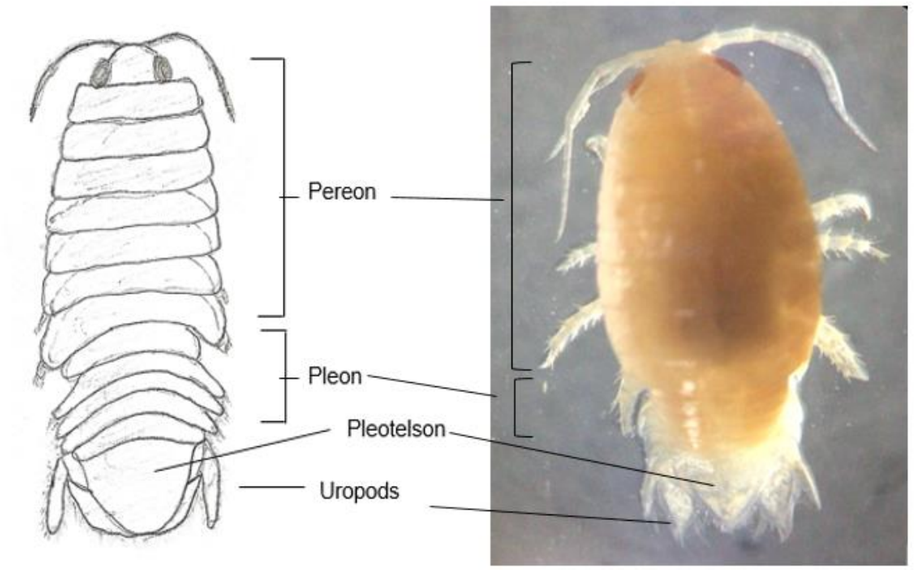
Key for Family of Order Mysida

1. Rostrum absent; no abdominal appendages (Fig. 1)……**Mysidae**

Fig. 1

Lanka Bridge, Uttarakhand

Order Isopoda



Dorsal View

Morphological Features (Adult)

Key for Families of Order Isopoda

1. Body long, 6 times longer than wide; uropodal exopod curved over pleotelson dorsally (Fig. 1)……..……**Anthuridae**

Fig. 1

- Body not long, < 6 times longer than wide; uropodal exopod not curved over pleotelson dorsally……..……..…2

---

2. Modified uropods present as a pair of ventral opercula forming a sheath over pleopods; Body dorso-ventrally depressed; 7 free pereonites (segments of pereon) (Fig. 2)…… **Idoteidae**

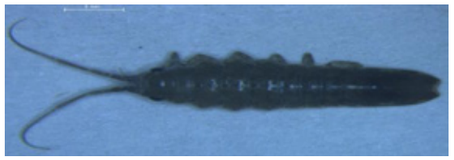


Fig. 2

- Modified uropods not present as a pair of ventral opercula over Pleopods but are placed on lateral sides……...…3

---

3. Pleon is formed of 1 or 2 free pleonites dorsally and pleotelson; cephalon not fused with 1st pereonite; body form convex dorsally capable of rolling like a ball (Fig. 3)……**Sphaeromatidae**

Fig. 3

- Pleon is formed of 4 or 5 free pleonites dorsally and pleotelson……..4

---

4. All pereopods prehensile (dactyli longer than propodi); antennae reduced, without clear distinction between peduncle and flagellum (Fig. 4)……**Cymothoidae**

Fig. 4

- At least pereopods 4-7 ambulatory (dactyli not longer than propodi); antennae not as above, longer with clear distinction between peduncle and flagellum……..5

---

5. Pereopods 1-3 strongly prehensile (dactyli longer than propodi); maxillipeds and maxillules and maxillae with stout, curved, apical setae; lacinia and molar process of mandible reduced or absent; maxilla reduced to a single slender stylet; Antenna not extends beyond 3rd segment of the pereon (Fig. 5)……..**Aegidae**

Fig. 5

- Pereopods 1-3 weakly prehensile at best; maxillipeds without stout, curved setae; mandible with or without lacinia and molar process; maxilla not a slender stylet; Antenna extends beyond the 3rd segment of the pereon……..6

---

6. Mandible with distinct lacinia and large bladelike molar process; mandibular incisor generally broad, 3-dentate; maxillule lateral (outer) lobe often with several (ten to fourteen) stout spines, never stylet-like or falcate; maxilla well-developed; pereopods 1-3 not prehensile (dactyli no longer than propodi); Head with smaller eyes (Fig. 6a)……..……**Cirolanidae**

Fig. 6a

- Mandible with lacinia and molar process greatly reduced, vestigial, or absent; mandibular incisor narrow; maxillule lateral (outer) lobe simple and falcate; maxilla reduced; pereopods 1-3 weakly prehensile or ambulatory; Head with large eyes (Fig. 6b)……...**Corallanidae**

Fig. 6b

Key for Families of Order Amphipoda

1. First antenna lacking an accessory flagellum (Fig. 1) .....**Niphargidae**

Fig. 1

- First antenna bearing an accessory flagellum……. ……...2

---

2. Pereopod-I simple, pereopod-II a gnathopod or subchelate (Fig. 2a)…..... ..... **Talitridae**

Fig. 2a

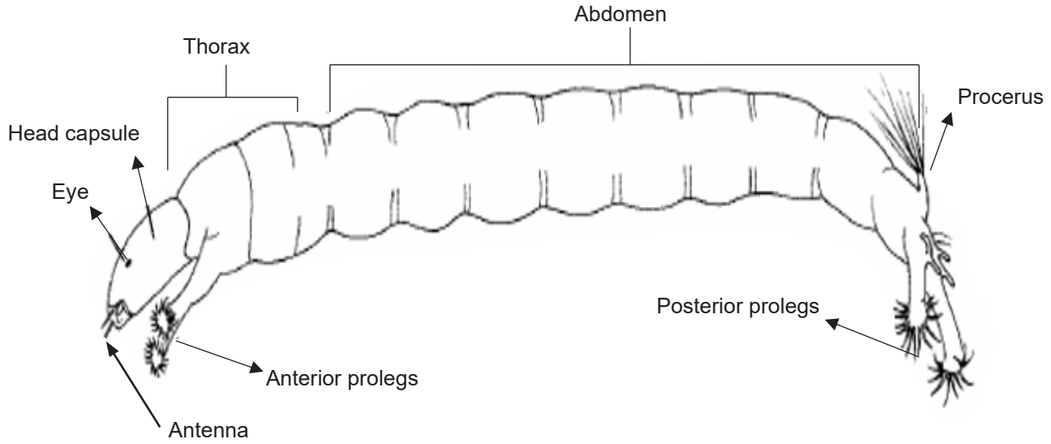
- Gnathopods large (first 02 leg pairs); First antennae shorter than body; First antenna accessory flagellum consisting of two to seven distinct flagellomeres (Fig. 2b)……..... **Gammaridae**

Fig. 2b

Note- *This key contain the taxonomic features of all the crustacean families which are benthic, macro in size and found in Ganga river system.*

ORDER DIPTERA

Family-Athericidae



Lateral View

Morphological Features (Larva)

Image source: Bouchard, 2004.

Key Points

Family: Blephariceridae *(Representative Diptera)*

1. Common name- True flies
2. Origin of the name- Greek- di' meaning two and 'ptera' meaning wings,
3. Characteristics:

- The thorax of all dipteran larvae lacks divided legs and wing pads
- Aquatic dipteran larvae are typically identified by the following diagnostic features:

a. Prolegs arrangement and number

b. Morphology of the terminal structures

c. Head structure (e.g., distinct, reduced, or absent head capsule)

List of Families

1. **Tipulidae**
2. **Limoniidae**
3. **Pediciidae**
4. **Cylindrotomidae**
5. **Blephariceridae**
6. **Deuterophlebiidae**
7. **Scatopsidae**
8. **Thaumaleidae**
9. **Trichoceridae**
10. **Ptychopteridae**
11. **Culicidae**
12. **Chaoboridae**
13. **Corethrellidae**
14. **Dixidae**
15. **Simuliidae**
16. **Ceratopogonidae**
17. **Chironomidae**
18. **Tanyderidae**
19. **Psychodidae**
20. **Stratiomyidae**
21. **Tabanidae**
22. **Athericidae**
23. **Pelecorhynchidae**
24. **Rhagionidae**
25. **Empididae**
26. **Dolichopodidae**
27. **Syrphidae**
28. **Canacidae**
29. **Sepsidae**
30. **Sphaeroceridae**
31. **Anthomyiidae**
32. **Phoridae**
33. **Sciomyzidae**
34. **Sarcophagidae**
35. **Ephydridae**
36. **Muscidae**
37. **Scathophagidae**

Keys for Suborders of Order Diptera

Head capsules are often complete and apparent (with a few exceptions) (Fig. 1)..... **Nematocera**

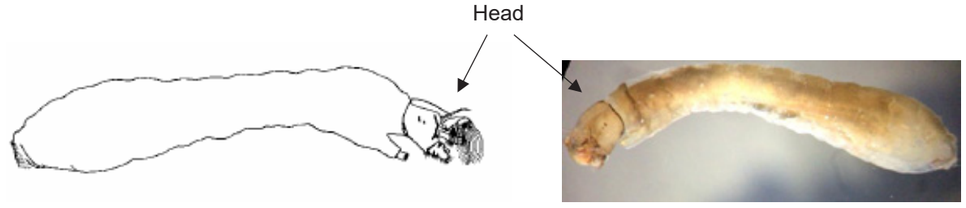


Fig. 1

Head capsule reduced, retracted within thorax (partly or nearly completely) Fig. 2)..... **Brachycera**

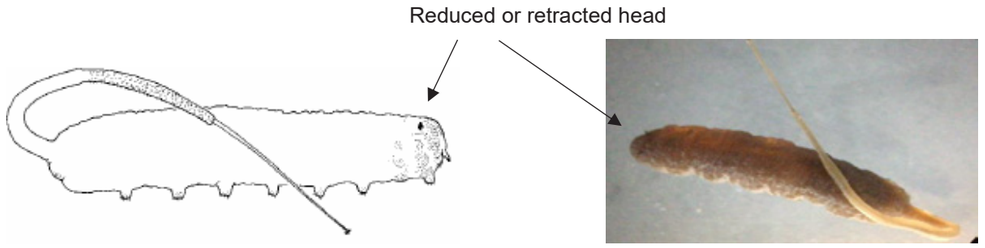


Fig. 2

Key for Families of Suborder Nematocera

1. Head capsule not fully exposed, retracted partially to completely into the thorax (Fig. 1a)……2

Fig. 1a

- Fully exposed head capsule (except reduced dorsally in family: Blephariceridae) (Fig. 1b) ……5

Fig. 1b

2. Spiracular disk with subconical lobes (on posterior side) present……3

- Spiracular disk with subconical lobes absent……4

3. Six (rarely eight) subconical lobes encircle the spiral disk, typically consisting of dorsal, dorsolateral and ventral spiracles 2 each (Fig. 3a).....**Tipulidae**

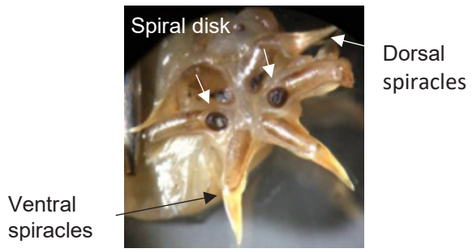


Fig. 3a

- Five (occasionally seven) or lesser lobes encircle the spiral disk (Fig. 3b).....**Limoniidae**

Fig. 3b

4. Terminal end of the abdomen with one pair of backward-directed extensions; abdominal segments with four or five pairs of prolegs (Fig. 4a)……..…**Pediciidae**

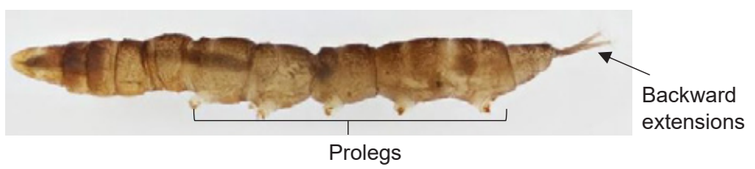


Fig. 4a

- Branched or toothed soft extensions present; prolegs absent (Fig. 4b) ……..……**Cylindrotomidae**

Fig. 4b

5. Body with deep constrictions within six apparent segments, each with a characteristic sucker on the ventral side (Fig. 5a)……..……..…….. **Blephariceridae**

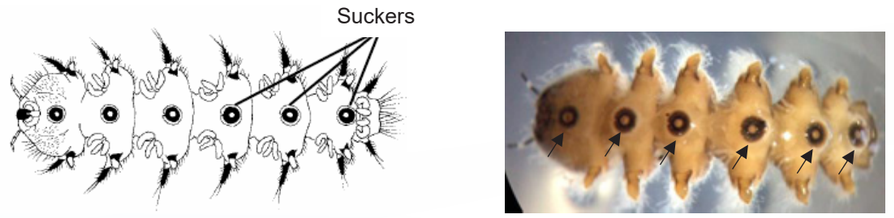


Fig. 5a

- Body flat; antennae fork type, extending beyond head; 7 pairs of prolegs with sucker-like lobes (Fig. 5b)……..**Deuterophlebiidae**

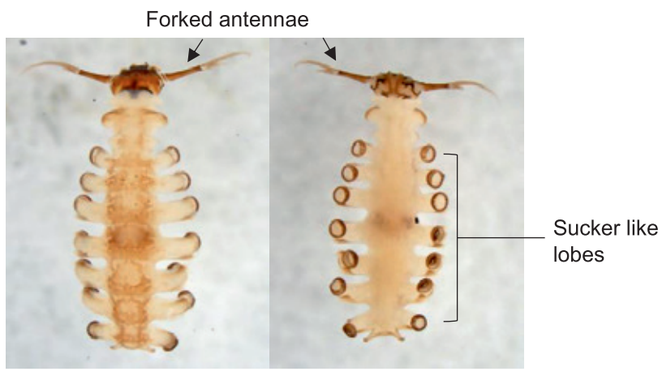


Fig. 5b

- Ventral suckers absent……..…….6

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6. Larva with peripneustic respiratory system: 8 pairs of abdominal spiracles (Fig. 6a); the posterior spiracles larger than the other pairs ……..**Scatopsidae***

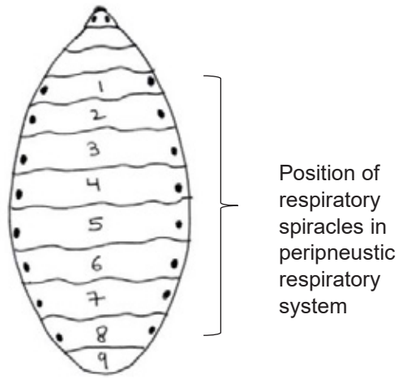

Fig. 6a

- Respiratory system amphipneustic (Fig. 6b)……..……..7

not reported in Indian aquatic fauna (Chandra et al, 2007)

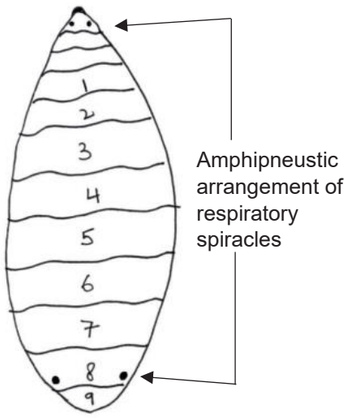

Fig. 6b

- Respiratory system not as above……..……8

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7. Upto 15mm long; head with a bump present in forepart (Fig. 7); anterior prolegs fused……..**Thaumaleidae**

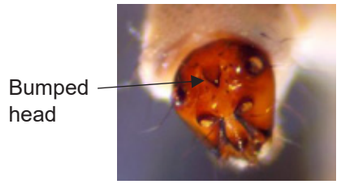

Fig. 7

- Size ~7mm; four lobes on terminus; mandible orientation oblique/vertical……...**Trichoceridae**

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8. Typically, the abdomen appears as discrete circular rings, marked by the elevated borders of each segment, abdomen ends in a prolonged narrow siphon (Fig. 8), frequently with pair of small circular structures at the base.....**Ptychopteridae**

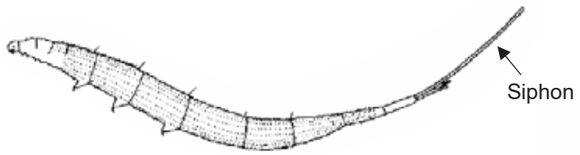

Fig. 8

- Abdomen not as above……..9

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9. Thoracic segment fused and wider than abdominal segments ……10

- Individually distinct thoracic segment, as broad as the abdomen ……..……..12

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10. Small antennae, not able to grasp things, having extremely small apical setae; labrum with notable oral brushes on either side; a siphon for respiration may be present (Fig. 10a) .....**Culicidae**

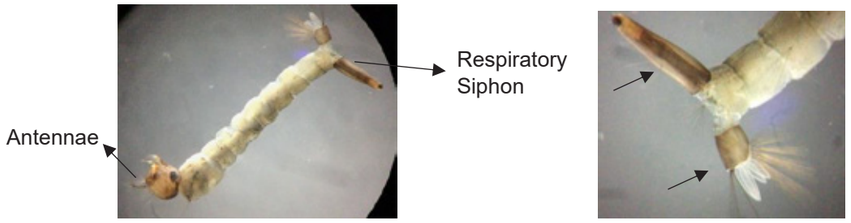

Fig. 10a

- Antennae able to grasp things, with long apical setae (Fig. 10b); labrum without brushes ……..……..……..……11

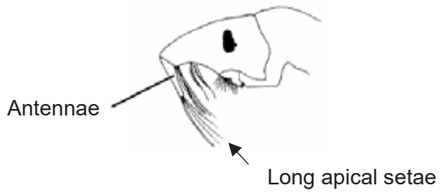

Fig. 10b

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11. Linear setal row present on terminal abdominal segment (Fig. 11); antennae with long setae inserted far apart (Fig. 11); transverse setae (lateral) absent on head; thoracic air sacs present or absent.....**Chaoboridae**

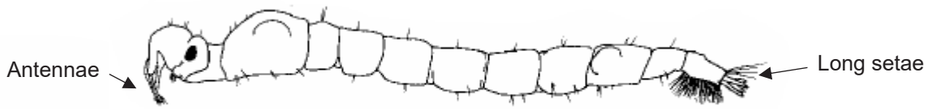

Fig. 11

- Long bunch of setae located ventrally on the terminal section; antennae are positioned closely together; lateral head featuring a transverse row of setae; thoracic air sacs absent..... **Corethrellidae***

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12. First two abdominal segments with prolegs; two setose-margined, flat dorsolateral post-spiracular lobes present on the terminal end of the abdomen (Fig. 12).....**Dixidae**

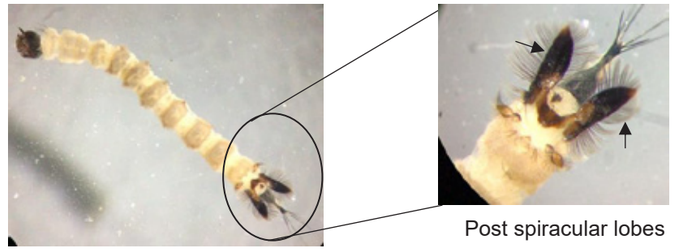

Fig. 12

- First two abdominal segments without prolegs; abdomen lacking flat post spiracular lobes……..……..……..……13

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13. Prothorax with prolegs (Fig. 13)……..14

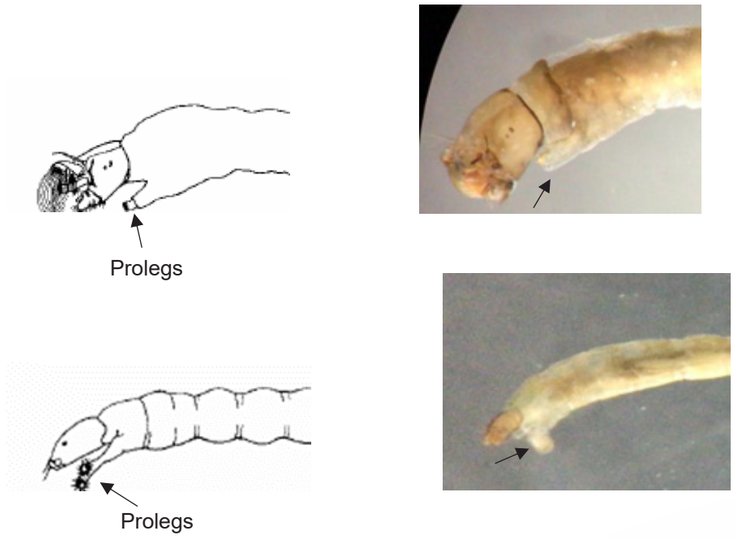

Fig. 13

- Prothorax without prolegs……..16

not reported in Indian aquatic fauna (Chandra et al, 2007)

14. Pair of prominent labral fans generally present on the head (Fig. 14a); wide posterior abdominal segments that terminate in a ring of hooks (Fig. 14b)....**Simuliidae**

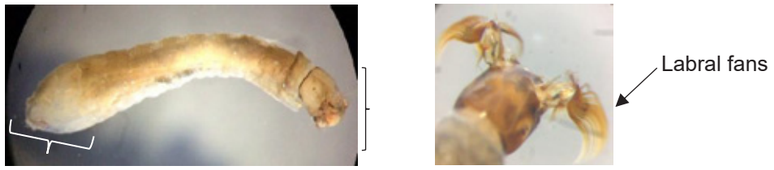

Fig. 14a

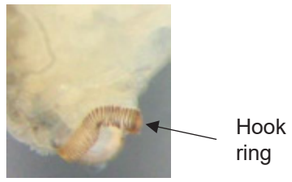

Fig. 14b

- Head lacking labral fans; posterior abdominal segments not wide and without a ring of hooks……..…...15

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15. Fleshy proturbences or long setae present on all body segments (Fig. 15a) ……**Ceratopogonidae (in part)**

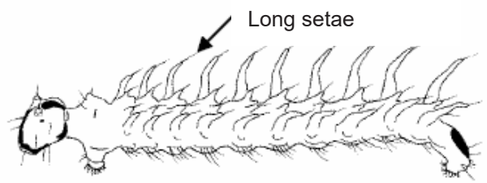

Fig. 15a

- Fleshy proturbences or long setae absent (Fig. 15b)……..….**Chironomidae**

Fig. 15b

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16. Long filament like extensions arranged laterally, present on last abdominal segment (Fig. 16)……..…..**Tanyderidae**

Fig. 16

- Last abdominal segment without long extensions; only one anal proleg present, at most ……..……..…….17

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17. Thin, sclerotized transverse bands that resemble straps present in all or some of the dorsal body segments (Fig. 17a)…….…… **Psychodidae**

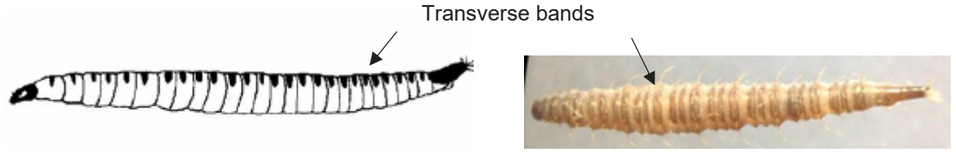

Fig. 17a

- Sclerotized transverse bands absent, longer than broad body segments; long and thin head (Fig. 17b)…….. **Ceratopogonidae (in part)**

Fig. 17b

Key for Families of Suborder Brachycera

1. Externally visible head capsule with sclerotization (Fig. 1) ……..…..…2

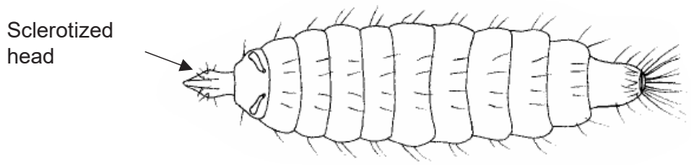

Fig. 1 (Dorsal view)

- Absence of externally visible head capsule ……..……..8

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2. Body flattened, surface uneven, sometimes circular tuft of hair present at the posterior end; often with peculiar eye prominences (Fig. 2) ……..**Stratiomyidae**

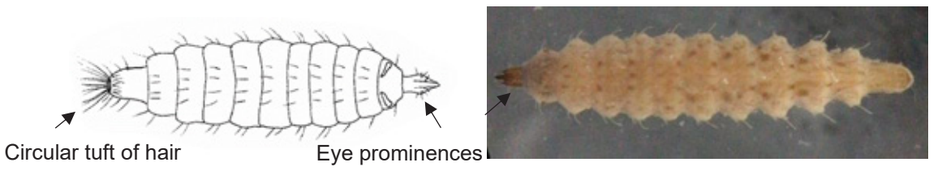

Fig. 2

- Body usually not flattened; peculiar eye prominences absent 3

---

3. Dorsally well-developed head capsule ……..…4

- Head capsule reduced to two thin metacephalic bars (Fig. 3)……...7

Fig. 3

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4. 3-4 pairs of fleshy creeping swellings or prolegs encircle 1-7 abdominal segments; posterior spiracles present (Fig. 4)……**Tabanidae**

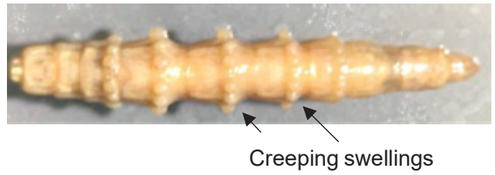

Fig. 4

- Posterior spiracles located in a tiny cavity or significantly reduced ……..……5

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5. Body cylindrical, prolegs and tubercles absent……..…..……..6

- The body has two prolegs on each abdominal segment ventrally, abdominal segments with thin lateral and dorsolateral tubercles; two divergent processes on the rear end (Fig. 5)……..……..**Athericidae**

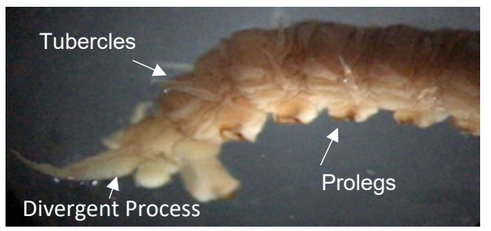

Fig. 5

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6. Protective layer smooth and shiny; body subdivision resembling beads (Fig. 6a); respiratory spiracles absent (apneustic respiratory system) .....**Pelecorhynchidae**

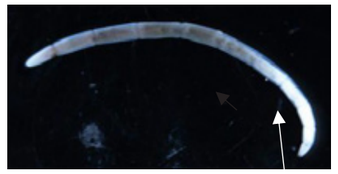


Fig. 6a

- 1-7 abdominal segments have creeping bumps on the ventral side (Fig. 6b), body subdivision is not bead like; respiratory system metapneustic (Fig. 6c) or amphipneustic (Fig. 5b of suborder Nematocera)……..…..**Rhagionidae**

Fig. 6b

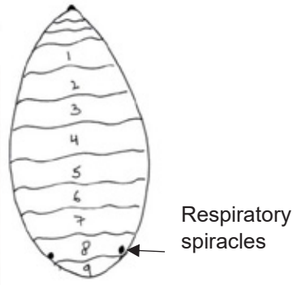


Fig. 6c

7. Abdominal segments with two prolegs having irregular edges (Fig. 7a); respiratory spiracles usually apneustic or metapneustic in arrangement (Fig. 6c)..... **Empididae**

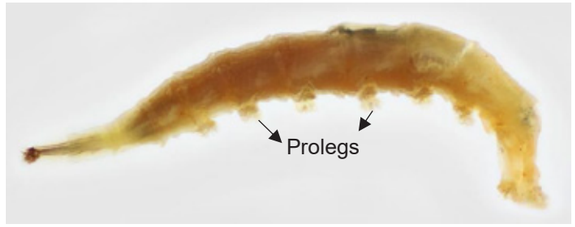


Fig. 7a

- Segments of the abdomen with raised, transverse, ventral folds (Fig. 7b); posterior spiracles located at the base of the terminal segment's top two of its four smooth main lobes (Fig. 7b); larva metapneustic (Fig. 6c) ..... **Dolichopodidae**

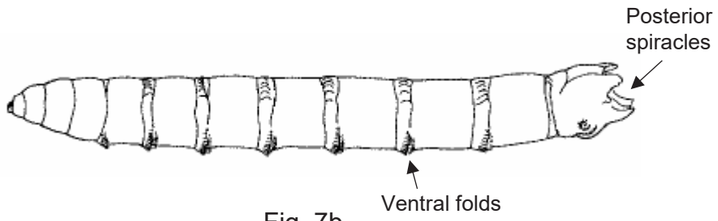
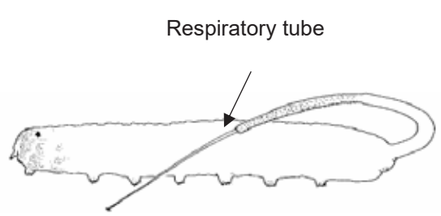


Fig. 7b

8. Clearly distinct posterior spiracular plates that are not present on a respiratory tube..... 9, 10

- Joint or very closely placed posterior spiracular plates, usually on the tip of a long respiratory tube (Fig. 8a)..... **Syrphidae**



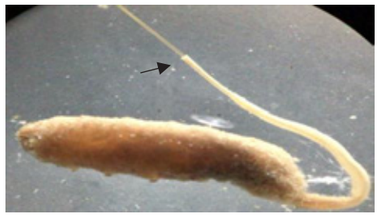


Fig. 8a

- Posterior spiracles divided by a slender cleft, are present at the tip of the respiratory tube (Fig. 8b) ……..……**Canacidae**

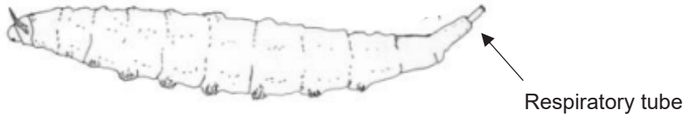


Fig. 8b

9. Terminal abdominal segment covered with spines/bristles; posterior spiracles on raised projections (Fig. 9a)..... **Sepsidae**

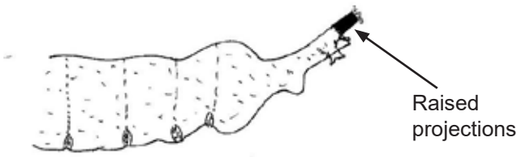


Fig. 9a

- Posterior spiracles on 2 clearly differentiated subcylindrical lobes, which are 2-3 times longer than the spiracular plate (Fig. 9b)…….....…**Sphaeroceridae**

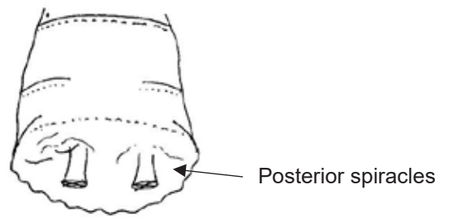


Fig. 9b

- Posterior spiracles on conical projections resemble knobs ……**Anthomyiidae**

10. Body flat and covered with spicules (Fig. 10)……..**Phoridae**

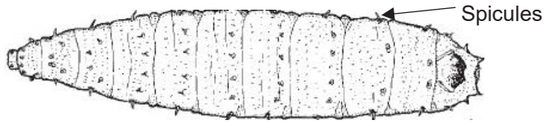


Fig. 10

- Body cylinder like not covered with spicules.....11

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11. Oval feature with branched fibres around the posterior spiracles; body sections frequently masked with small, thin setae (Fig. 11)..... **Sciomyzidae**

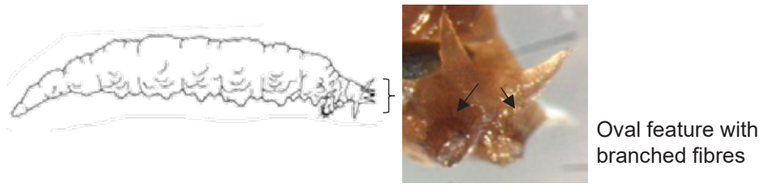

Fig. 11

- Posterior spiracles without a branched oval feature..... 12

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12. Posterior spiracles present in the lowest part of a depression, which is present on the terminal segment (Fig. 12a), sub vertically angled spiral slits (Fig.12 b)……**Sarcophagidae**

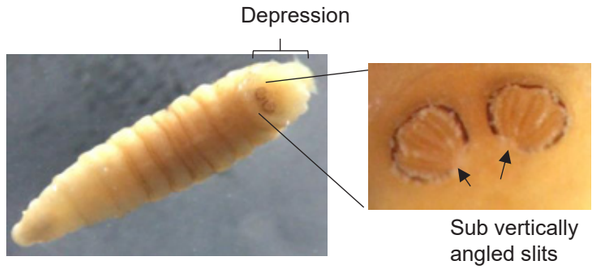

Fig. 12a

Fig. 12b

- Posterior spiracles well revealed, not confined in a depression, spiracular slits nearly horizontal..... 13

---

13. Abdomen rather reduced posteriorly……..…..…14

- Abdomen may have prolegs; the terminal end splits into two before its tip (forked end) and a relatively tapering posterior (Fig. 13)……..**Ephydridae**

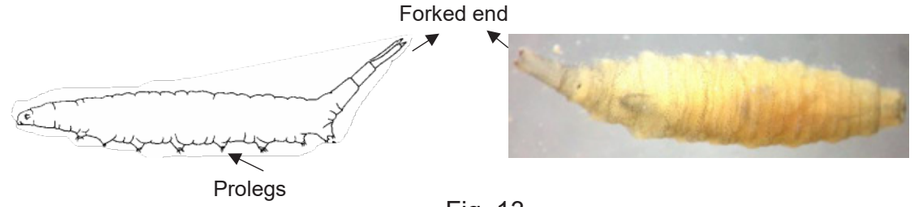

Fig. 13

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14. No lobes along the border of the posterior spiracular plate; posterior spiracles with many curves (Fig. 14a)……..……**Muscidae**

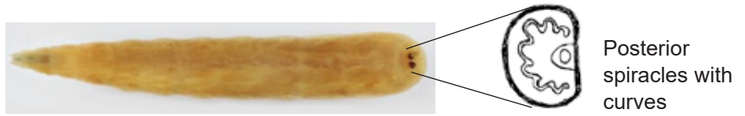


Fig. 14a

- Short lobes along the border of spiracular plate present in abundance (Fig. 14b); rear end inclined at an angle with regard to the body's plane …….. **Scathophagidae**

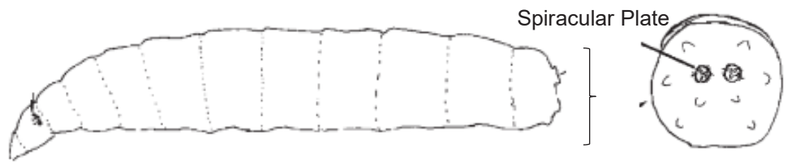
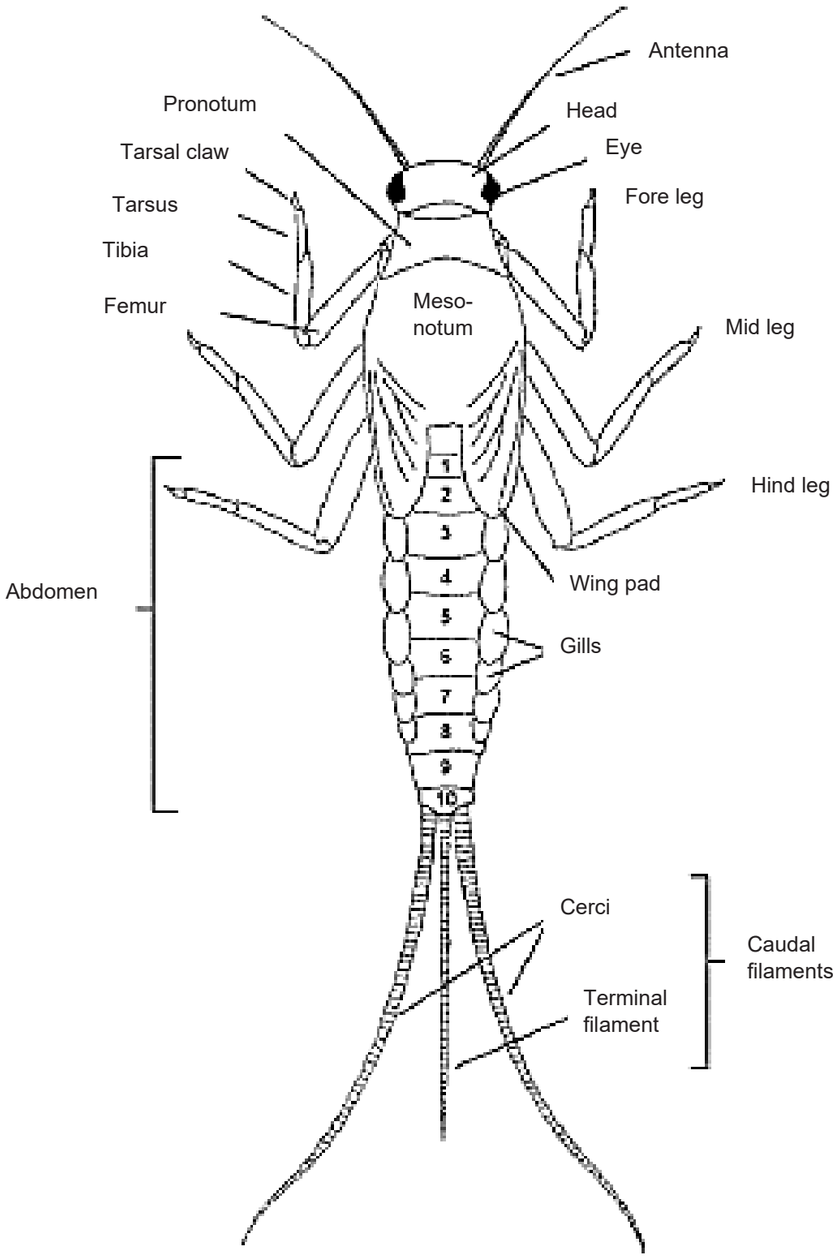


Fig. 14b

ORDER EPHEMEROPTERA

Family-Heptageniidae



Dorsal View

Morphological Features (Larva)

Image source: Bouchard, 2004.

Key Points

Family: Ephemeridae *(Representative Ephemeroptera)*

1. Common name- May fly
2. Origin of the name- Greek terms ‘ephemeros’ (lasting a day) and ‘pteron’ (wing).
3. Characteristics:

- Head hypognathous (the lower jaw longer than the upper) or prognathous (having a projecting lower jaw or chin)
- Mandibulated mouthparts present
- 10 abdominal segments with paired lateral/ dorsal gills
- Three (rarely two) caudal filaments present
- Eyes larger
- Fore and hind wing pads emerge from the meso- and metathorax
- Forelegs are generally shorter than Hindlegs
- Body length 3–30 mm

List of Families

1. **Prosopistomatidae**
2. **Potaminthidae**
3. **Ephemeridae**
4. **Polymitarcidae**
5. **Caenidae**
6. **Neoephemeridae**
7. **Ephemerellidae**
8. **Teloganodidae**
9. **Heptageniidae**
10. **Tricorythidae**
11. **Leptophlebidae**
12. **Baetidae**
13. **Ameletidae**
14. **Siphlonuridae**

Key for Families of Order Ephemeroptera

1. Body beetle-like; abdominal gills entirely concealed by a large thoracic shield (Fig. 1)…….……..…….. **Prosopistomatidae**

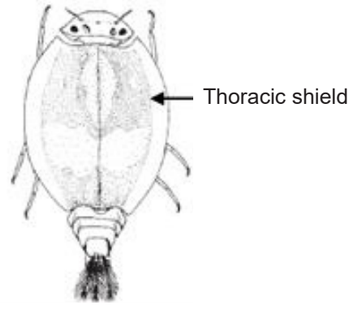


Fig.1

- Body form not as above; abdominal gills partially or completely exposed…….2

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2. Mandibles with large tusks (Fig. 2a)…..……..……3

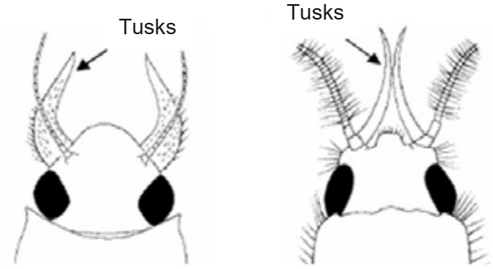

Fig. 2a

- Mandibles without tusks (Fig. 2b)…….……..…..……5

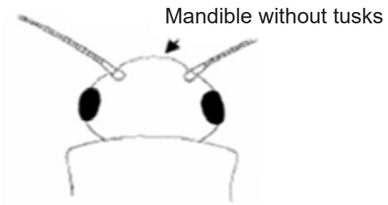

Fig. 2b

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3. Abdominal gills held laterally (Fig. 3a)……..**Potaminthidae**

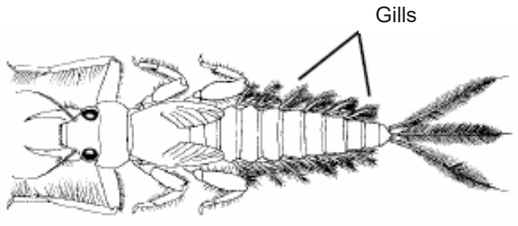


Fig. 3a

- Abdominal gills held dorsally over abdomen (Fig. 3b).....……..……4

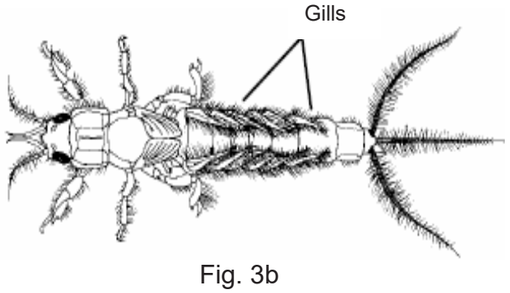


Fig. 3b

4. Mandibular tusks curving outward (dorsal view) and upward apically (lateral view) (Fig. 4 a)……..…….... **Ephemeridae**

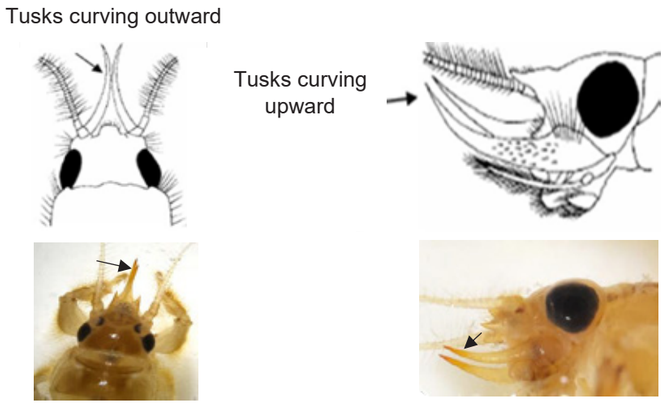


Fig. 4a

- Mandibular tusks curving inward and downward apically (lateral view) (Fig. 4 b).....**Polymitarcidae**

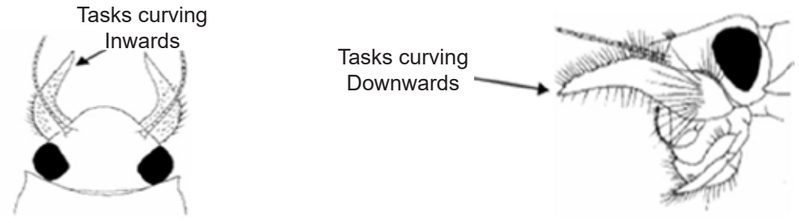


Fig. 4b

5. Operculate gills present on second abdominal segment which covers subsequent pairs of gills (Fig. 5a)..... 6

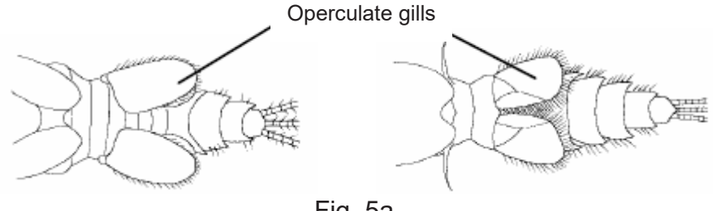


Fig. 5a

- Operculate gills absent on second abdominal segment which do not cover subsequent pairs of gills (Fig. 5b) 8

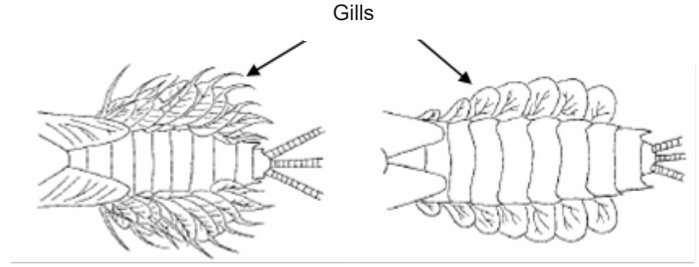


Fig. 5b

6. Operculate gills overlap along the midline (Fig. 6)…….....**Caenidae**

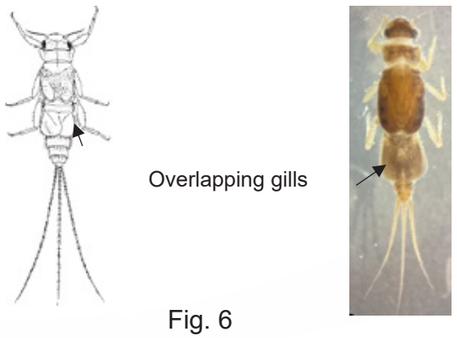


Fig. 6

- Gills not overlapping ……7

7. Gills triangular in shape, present from abdominal segments II–V or II–VII, gills do not align medially (Fig. 7a).....**Tricorythidae**

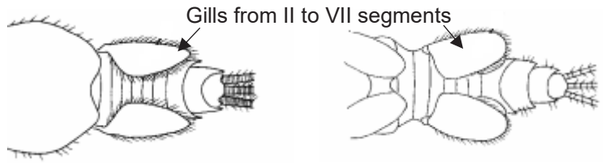


Fig. 7a

- Gills square in shape and aligning medially (Fig. 7b)……..……**Neoephemeridae**

Fig. 7b

8. Abdominal segments with 4 or 5 plate like gills, arranged dorsally (Fig. 9 a & b)…….9

-Abdominal segments with 7 plate like gills ……..……..……..……..…10

9. Gills absent on abdominal segment II, gills present on segment III–VII or IV–VII; three cerci (tails); paired dorsal tubercles present on abdomen (Fig. 9a)……..…**Ephemerellidae**

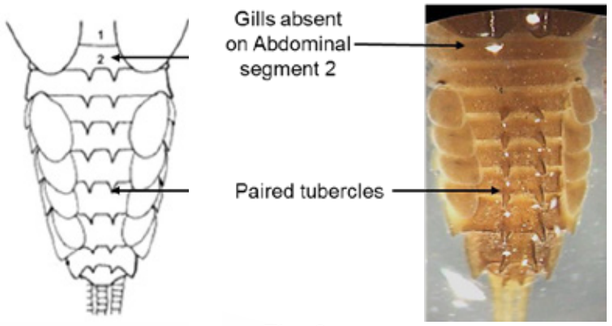


Fig. 9a

- Gills present on abdominal segment II, gills present on segment II–VI; two cerci (tails); dorsal tubercles present on center of the abdomen (Fig. 9b)……**Teloganodidae**

Fig. 9b

10. Body and head distinctly flat; eyes and antennae dorsal in position; leaf-like or plate-like gills with tuft of filaments, (Fig. 10a)…….. **Heptageniidae**

Fig. 10a

- Head not distinctly flattened; eyes and antennae lateral in position; gills forked, oval or heart shaped (Fig. 10b)……..…….……11

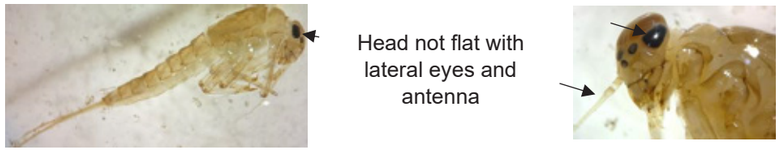


Fig. 10b

11. Abdominal gills forked, consisting of broad base and slender filaments (Fig. 11a).....**Leptophlebidae**

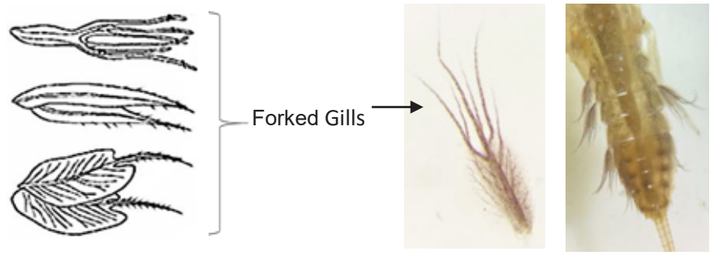


Fig. 11a

- Gills not as above, usually oval or heart shaped (Fig. 11b).....……12

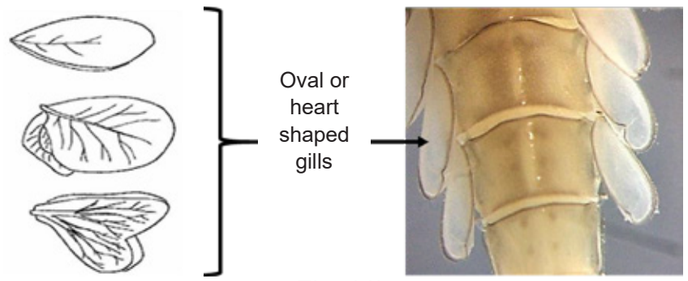


Fig. 11b

12. The antenna usually two or three times longer than the width of head; labrum has a deep median notch; abdominal segment IX without lateral spine; usually three tails (two cerci and one caudal filament but sometimes caudal filament absent or reduced) (Fig. 12a)…..……..……..……**Baetidae**

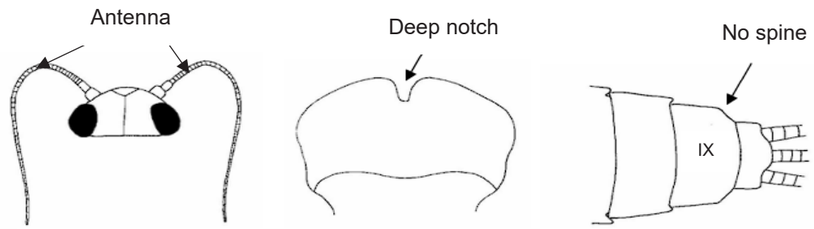


Fig. 12a

- Antenna shorter than the width of head; three cerci present; labrum without notch or with a shallow notch; abdominal segment 9 with lateral spines (Fig. 12b) ……13

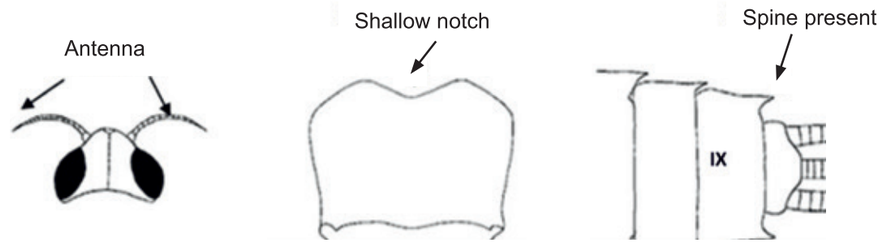
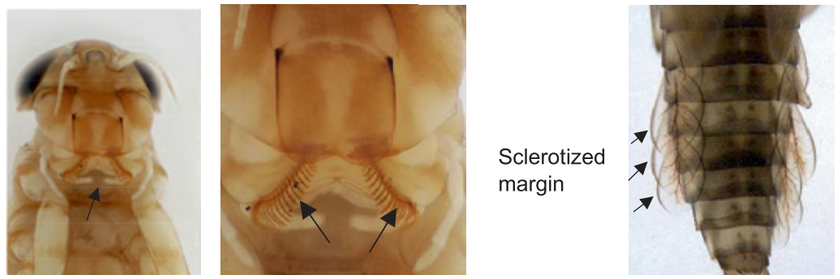


Fig. 12b

13. Maxilla (second pair of jaws) each with row of conspicuous pectinate (comb-like) spines; gills outer margin sclerotized (Fig. 13a)……..……..**Ameletidae**



Maxilla with fringed margin

Fig. 13a

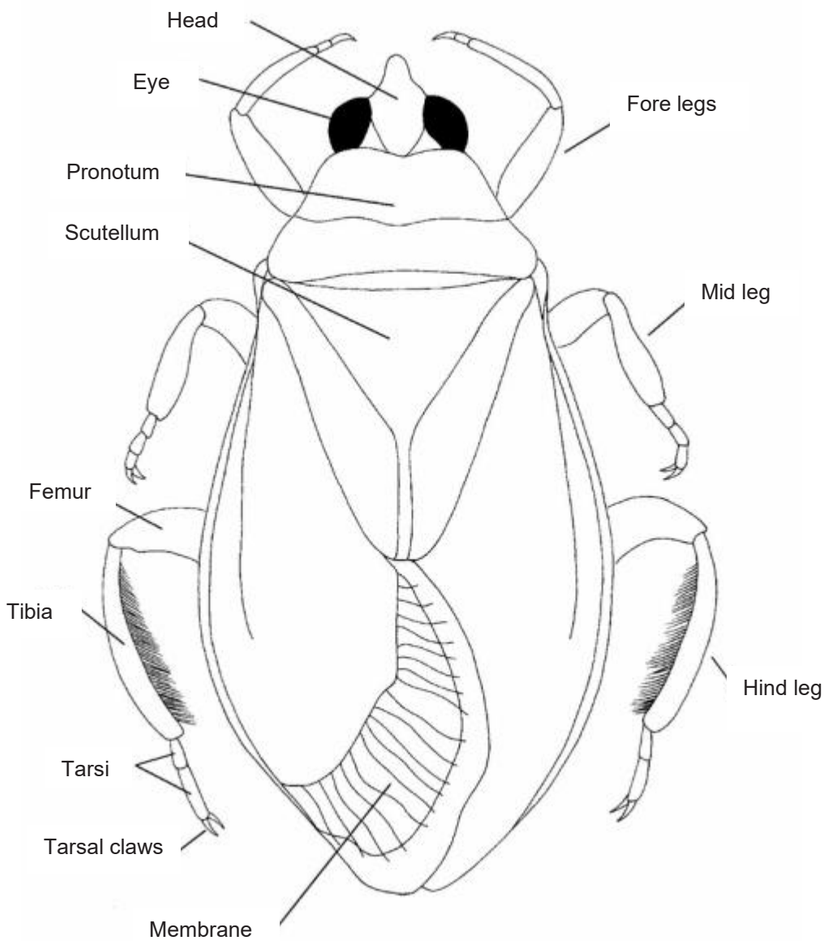
- Maxilla without a fringed bottom edge; gills on 1 and 2 segments either double lamellate or single lamella (Fig. 13b)……..……..……**Siphlonuridae**

Fig. 13b

Bateshwar, Uttar Pradesh

ORDER HEMIPTERA

Family- Nepidae



Dorsal View

Morphological Features (Adult)

Image source: Bouchard, 2004.

Key Points

Family: Notonectidae *(Representative Hemiptera)*

1. Common name- True bugs
2. Origin of the name- Greek- meaning half winged
3. Characteristics:

- They are little to medium-sized, oval-shaped, soft-bodied, and elongated.
- The hemelytron is a distinct feature that has membranous and partially thickened front wings.
- Cerci are always absent.
- Mouthparts are piercing and sucking type.
- Well-developed compound eyes.
- The shape and length of antennae, beak and legs and can be important for separating different families of this order.

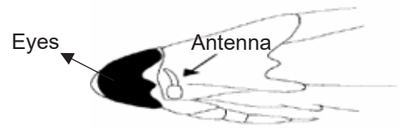
List of Families

1. **Corixidae**
2. **Micronectidae**
3. **Nepidae**
4. **Belostomatidae**
5. **Naucoridae**
6. **Aphelocheiridae**
7. **Pleidae**
8. **Helotrephidae**
9. **Notonectidae**
10. **Gelastocoridae**
11. **Ochteridae**
12. **Saldidae**
13. **Leptopodidae**
14. **Gerridae**
15. **Vellidae**
16. **Hydrometridae**
17. **Hebridae**
18. **Mesovellidae**

Key for Families of Order Hemiptera

1. Antennae inserted under the eyes and shorter than the head (Fig.1a) (lateral view) ……..……..…….2

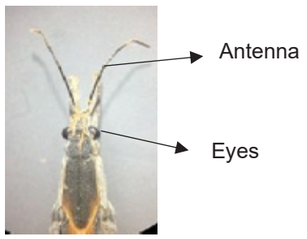
Dorsal View



Lateral View

Fig. 1a

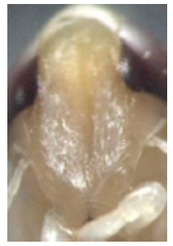
- Antennae inserted in front of the eyes and longer than the head (Fig.1b) ……..9



Dorsal View

Fig. 1b

2. Mouthparts blunt and triangular or beak-like, segmented (Fig. 2a); the tarsi of forelegs modified into a scoop-like structure (Fig. 2b); four segmented antennae; concealed scutellum…….....**Corixidae**



Triangular and segmented beak

Fig. 2a

Scooped and fringed tarsus

Fig. 2b

- Mouthparts blunt and triangular or beak-like, non-segmented; small size (<1mm-5mm); antennae divided into three segments; exposed scutellum (Fig. 2c) ……**Micronectidae**

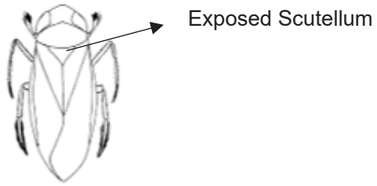


Fig. 2c

- Mouthparts elongate and cylindrical or cone-shaped, beak divided into segments; tarsi of forelegs not fringed and scooped shape (Fig. 2d) ……..……3

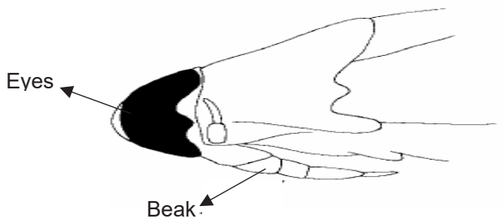


Fig. 2d

3. Presence of a long, thin, tubular apical respiratory appendage (Fig. 3)…….. **Nepidae**

Fig. 3

- Absence of apical respiratory appendage (if present, short and flat)……..4

4. Middle and hind thoracic legs fringed with swimming setae 5
- Middle and hind thoracic legs without swimming setae 8

5. Dorsoventrally flattened, ovate insects; profemora broad……..……..6
- Dorsoventrally not flattened, elongate or hemispherical insects .....……..7

6. Length usually greater than 18 mm; presence of short, flat, strap like apical respiratory appendages; eyes protrude from head margin; forewing membrane with veins (Fig.6a) ……..……. **Belostomatidae**

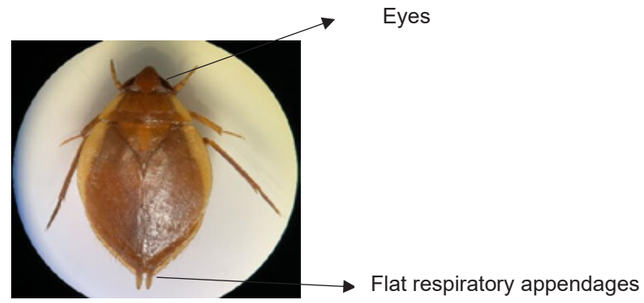


Fig. 6a

- Length usually greater than 16mm; absence of apical respiratory appendages; eyes not protruding; forewing membrane without veins; head much wider than long; rostrum cylindrical, short and thick (Fig. 6b) ..…….. **Naucoridae**

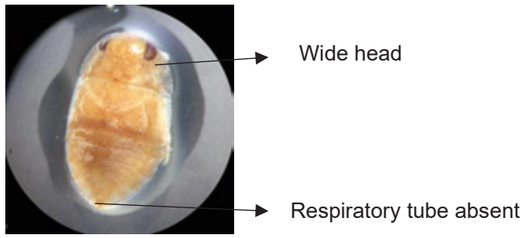


Fig. 6b

- Head usually longer than wide; rostrum long, slender (tip of the rostrum extends back to the base of the hind legs) (Fig.6c) ……..…….. **Aphelocheiridae**

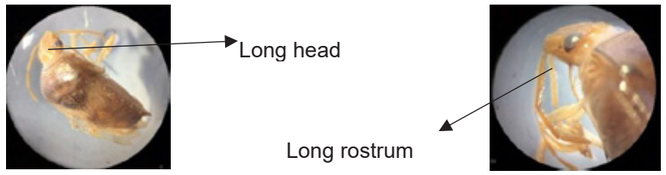


Fig. 6c

7. Body hemispherical (convex), robust, small (< 3mm); mid and hind legs of similar length; antenna 3 segmented; head and pronotum separate (Fig.7a).....**Pleidae**

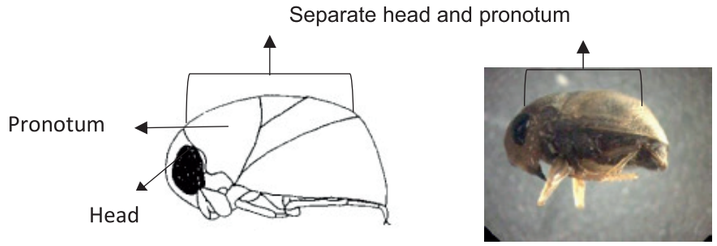


Fig. 7a

-Body hemispherical (convex); antenna 1 or 2 segments; head and pronotum fused, often indistinct (Fig. 7b) .....**Helotrephidae**

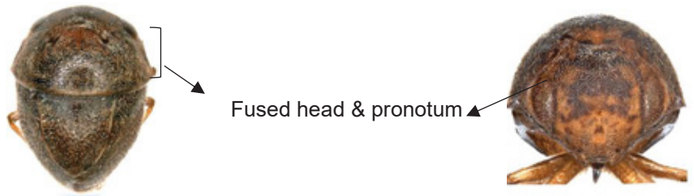


Fig. 7b

-Body elongate, length > 5mm; hind legs long and oar like fringed with hair (Fig. 7c) .....**Notonectidae**

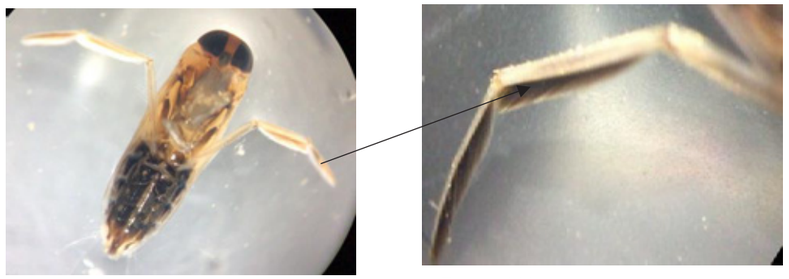


Fig. 7c

8. Broad profemora; antennae concealed from above (Fig. 8a) .....**Gelastocoridae**

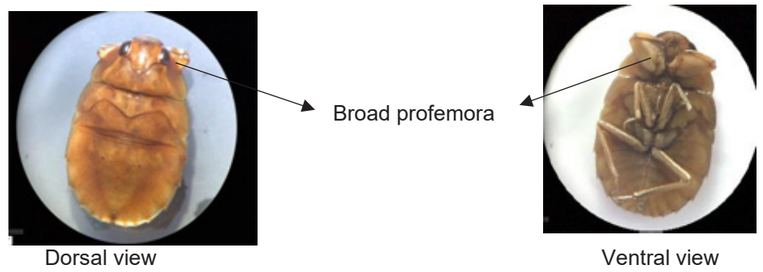


Fig. 8a

- Slender profemora, similar to other legs; antennae visible from above (Fig. 8b) .....**Ochteridae**

Fig. 8b

9. Membrane of hemelytra without veins or with dissimilar sized cells; small conical metacoxae; mid and hind legs unusually long.....10

   Membrane of hemelytra 4 or 5 equal sized cells; large transverse metacoxae; antennae shorter than body; rostrum long tapering (Fig. 9a) .....**Saldidae**

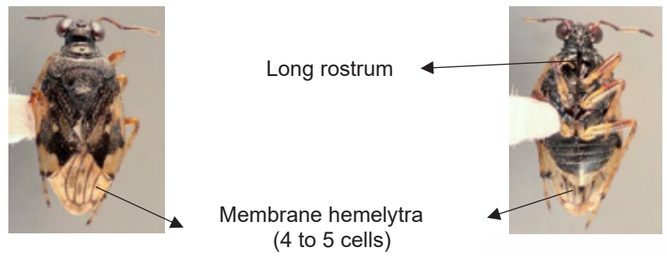


Fig. 9a

- Membrane of hemelytra 4 or 5 equal sized cells; large metacoxae; antennae longer than body; rostrum short reaching to apex of fore coxae; spines on fore femur (Fig. 9b) ..... **Leptopodidae**

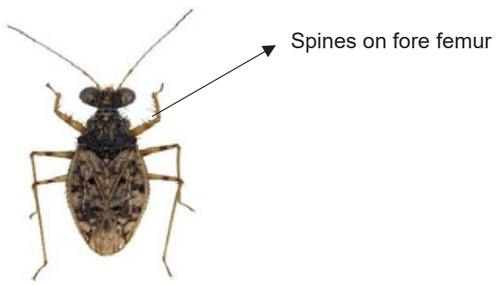


Fig. 9b

10. Claws of fore legs inserted before apex (Fig.10a) 11

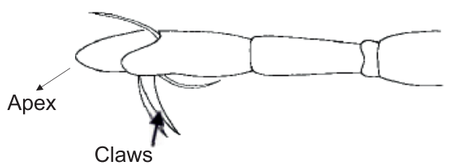


Fig.10a

- Claws of fore legs inserted at apex (Fig.10b) 12

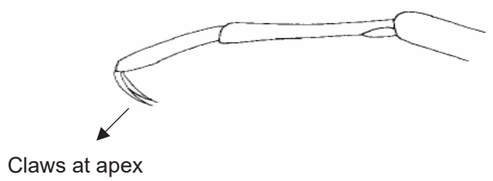


Fig. 10b

11. Metafemur is notably long, extending visibly beyond the tip of the abdomen (Fig.11a) .....**Gerridae**

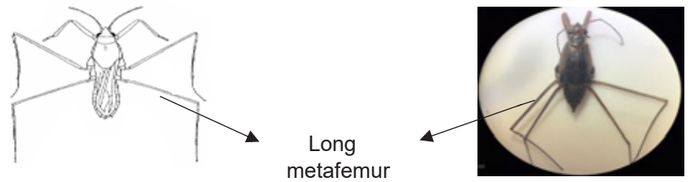


Fig.11a

-Metafemur is relatively short, only slightly extending or reaching beyond the tip of the abdomen (Fig.11b) .....**Veliidae**

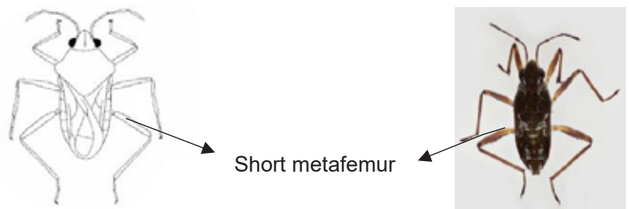


Fig.11b

12. Head as long as or longer than the thorax; body linear, slender, with eyes set about midway to base (Fig.12) .....**Hydrometridae**

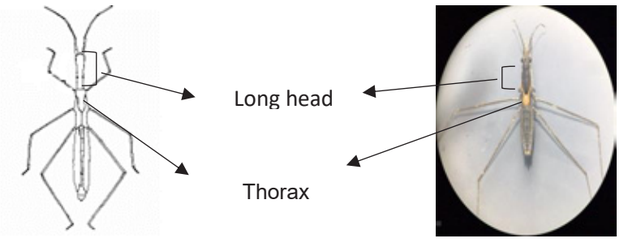


Fig. 12

- Head short and stout; eyes near posterior margin 13

13. Head grooved ventrally to receive rostrum; two tarsomeres (tarsi with two segments); hind leg without spines or bristles (Fig.13a)..... **Hebridae**

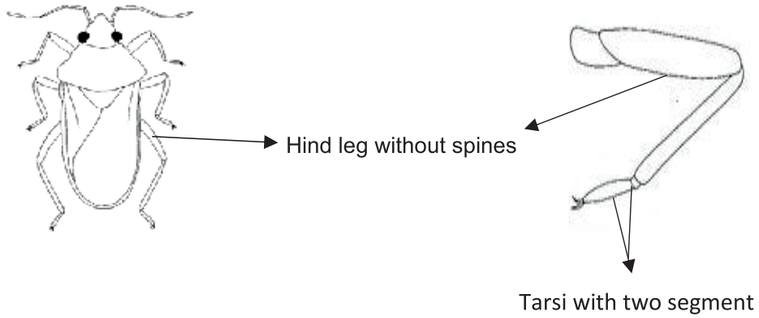


Fig. 13a

- Head not grooved ventrally; three tarsomeres (tarsi with three segments); hind leg with dark spines or bristles (Fig. 13b)…….…….…….. **Mesoveliidae**

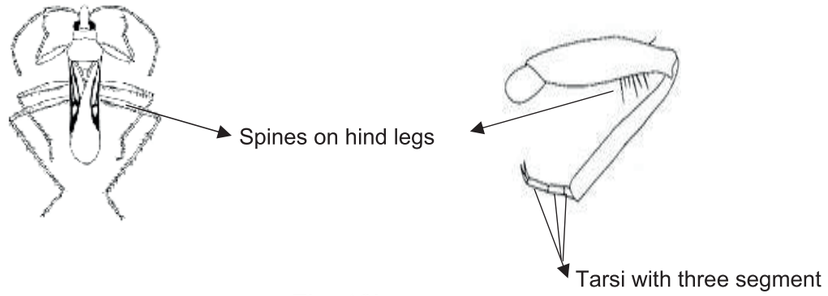
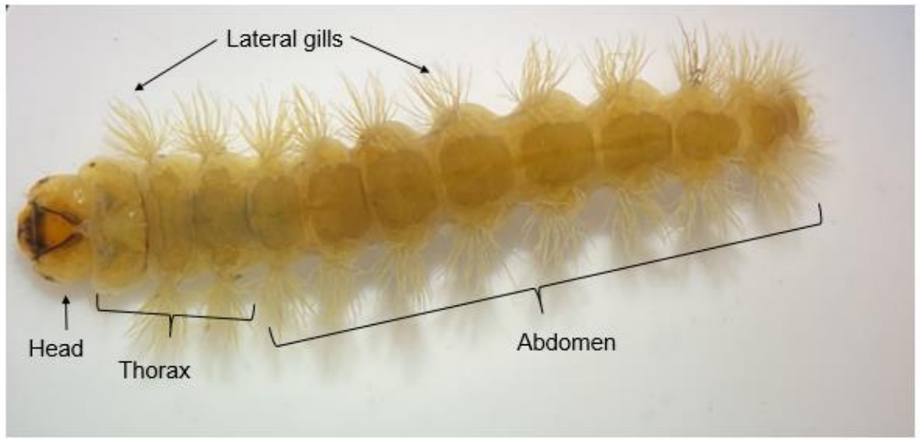


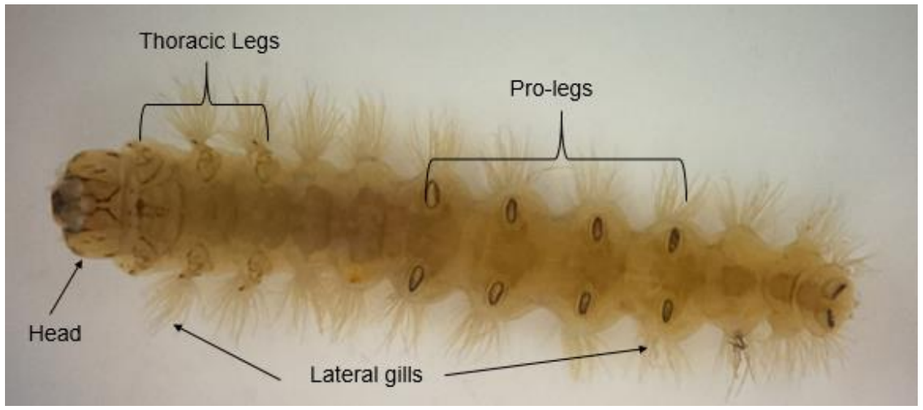
Fig. 13b

ORDER LEPIDOPTERA

Family- Crambidae



Dorsal View



Ventral View

Morphological Features (Larva)

Key Points

Family: Crambidae *(Representative Lepidoptera)*

1. Common Name- Moths
2. Origin of the name from Greek. Formed of two words: ‘lepis or lepid’ means ‘scale’ and ‘pteron’ means ‘wing’ together means “scale wing”.
3. Characteristics:
   - Predominantly terrestrial group; only a few species have aquatic larval stage.
   - Terrestrial larvae can be distinguished from the truly aquatic larvae by the presence of filament-like gills on body.
   - Pro-legs with crochets are present on some abdominal segments arranged in oval fashion.

List of Family

1. Crambidae

Key for Family of Order Lepidoptera

1. Head- prognathous (mouth parts projected forward) or hypognathous (mouthparts directed downwards); lateral gills (bush like or branched) on body segments; prothorax without paired sacs (Fig.1).....**Crambidae**

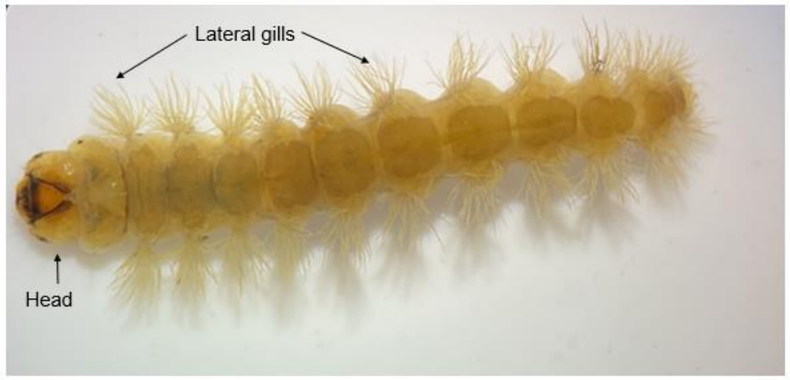
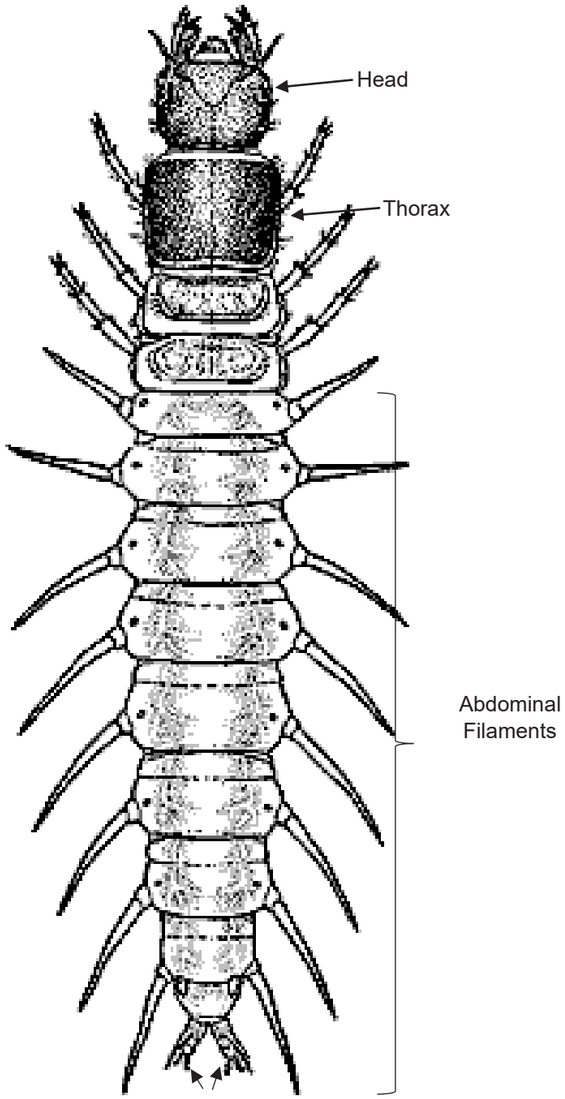


Fig. 1

ORDER MEGALOPTERA

Family: Corydalidae



Dorsal View

Morphological Features (Larva)

Image source: CSIRO, Insect and their Allies

Key Points

Family: Corydalidae *(Representative Megaloptera)*

1. Common name- dobsonflies, alderflies
2. Origin of the name- Greek-Megalo means ‘large’ and ptera ‘wings’
3. Characteristics:

- Wings are absent
- The maxilla and mandible are formed for catching and chewing, and the mouthparts are present for biting.
- Caudal filament present or absent
- Thorax with 3 pairs of legs
- Prolegs absent on abdominal segments
- Paired long and strong lateral processes on either 1-7 or 1-8 abdominal segments
- An extended terminal process or two hooks present at the end of abdomen
- Body is up to 50mm long

List of Families

1. **Sialidae**
2. **Corydalidae**

Key for Families of Order Megaloptera

1. Larvae with seven pairs of lateral abdominal filaments (gills); a long filament present at the terminal abdominal segment (Fig. 1a); prolegs absent.....…….....**Sialidae**

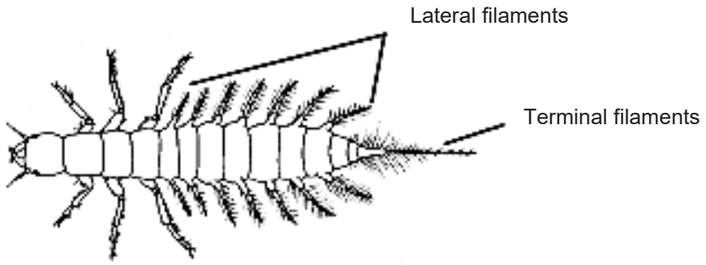


Fig. 1a

- Larvae with eight pairs of lateral abdominal filaments (gills); long filament absent at the end of abdomen, instead two hooked prolegs present (Fig. 1b) ……..…….....**Corydalidae**

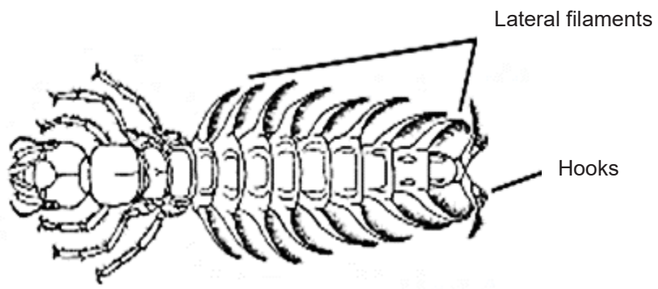
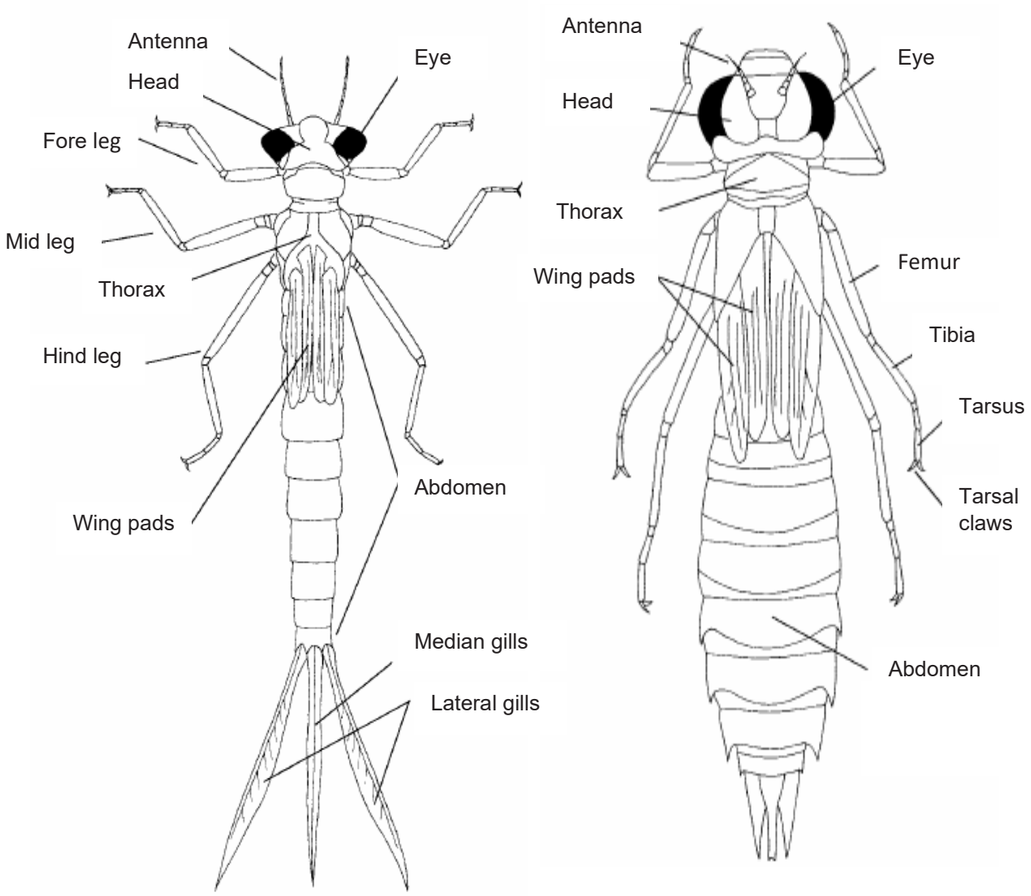


Fig.1b

ORDER ODONATA

Family- Euphaeidae



Dorsal View

Suborder

Zygoptera **Anisoptera**

Morphological Features (Larva)

Image source: Bouchard, 2004.

Key Points

Family: Gomphidae *(Representative Odonata)*

1. Common name- Damselflies (Zygoptera) and Dragonflies (Anisoptera)
2. Origin of the name- Greek- Odon meaning tooth
3. Characteristics:

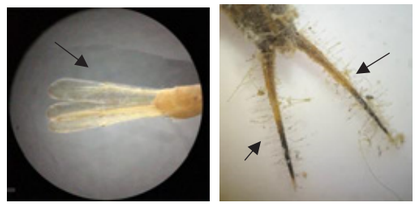
- Odonate larvae have a distinctive labium
- Labium forms a scoop like appendage that covers other mouth parts
- In both Dragonflies and Damselflies, the shape of labium is a characteristic feature for identifying different families
- Abdominal segments terminate into leaf like or stiff pointed appendages
- Aquatic larval stage (nymph) with posterior tracheal gills
- Antennal segments and their form is also an important feature

List of Families

1. **Epiophlebiidae**
2. **Chlorocyphidae**
3. **Euphaeidae**
4. **Calopterygidae**
5. **Lestidae**
6. **Synlestidae**
7. **Philogangidae**
8. **Platystictidae**
9. **Protoneuridae**
10. **Platycnemididae**
11. **Coenagrionidae**
12. **Gomphidae**
13. **Aeshnidae**
14. **Chlorogomphidae**
15. **Cordulegastridae**
16. **Macromiidae**
17. **Synthemistidae**
18. **Libellulidae**
19. **Corduliidae**

Key for Suborders of Order Odonata

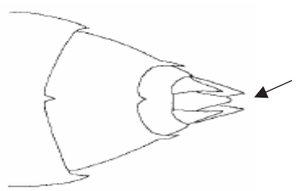
Thin larvae; thorax and abdomen narrower than head, abdomen; abdomen terminating in 2-3 caudal gills (Fig. 1)……..…**Zygoptera**

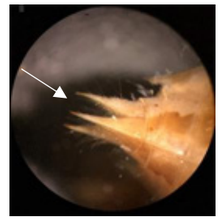


Caudal gills

Fig. 1

Thorax and abdomen usually broader than head; abdomen terminating in 5 pointed appendages (Fig. 2), three largest of which combine to form an "anal pyramid" or triangle process…….....**Anisoptera**





Pointed appendages

Fig. 2

Strong, elongated larvae without caudal gills; five segmented antennae; tubercles present all over the body ……..……..…..**Anisozygoptera**

(one family: **Epiophlebiidae**)

Key for Families of Suborder Zygoptera

1. Caudal gills forceps like, strongly reduced median caudal gill (Fig. 1a)…… **Chlorocyphidae**

Fig. 1a

- Caudal gills three in number may be flat, bag or blade type (Fig. 1b)…….....2

Fig. 1b

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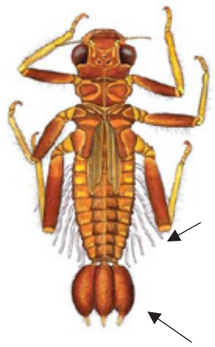
2. Abdominal segments 2-8 with lateral filamentous gills (Fig. 2a); sac like caudal gills (Fig. 2b) ……..……..……..…….....…..**Euphaeidae**



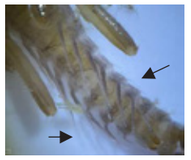


Fig. 2a

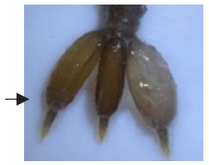


Fig. 2b

-Filamentous gills absent…… ……..…….....3

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3. Antennal segment 1 is longer than the combined length of the other segments (Fig. 3a); the caudal gills have a pronounced dorsal ridge and are blade-like, the median gills being shorter than the lateral caudal gills (Fig. 3b)……..……...**Calopterygidae**

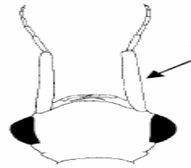

Fig. 3a

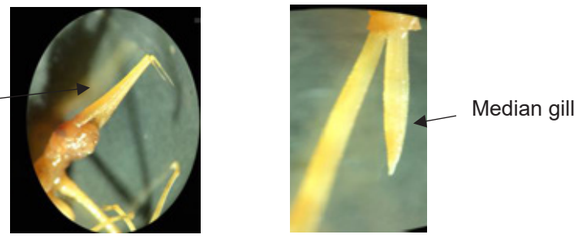

Fig. 3b

- Antennal segment 1 is significantly shorter than the succeeding segments (Fig. 3c); caudal gills are roughly the same length……..……4

Fig. 3c

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4. Prementum [basal lower portion of labium (lower lip)] greatly narrowed (spoon shaped) with large sharp teeth (Fig.4a) ……..**Lestidae**

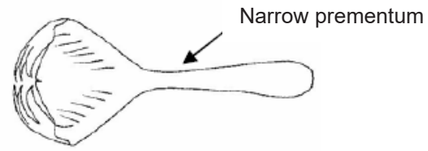
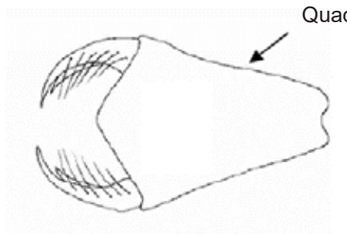


Fig. 4a

- Prementum quadrate in shape (Fig. 4b), mentum or palpal lobes without setae..……5



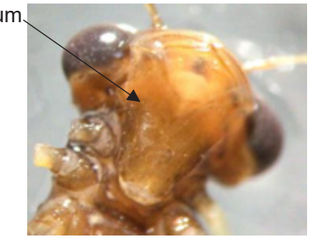


Fig. 4b

- Quadrate prementum, mentum or palpal lobes with setae ….……..……7

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5. Caudal gills with rounded apices resemble leaves (Fig. 5)……..**Synlestidae**

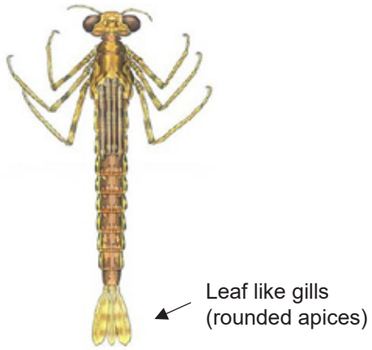

Fig. 5

- Sac type gills with pointed apices; thin legs bordered with setae……...6

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6. Large and pigmented larvae; lateral caudal gill (sac type) different in size from median (Fig. 6a)……**Philogangidae**

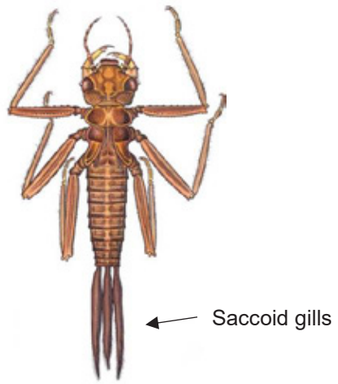

Fig. 6a

- Eyes of the larvae large; caudal gills are same in size and shape with long filamentous tips (Fig. 6b); labium with single flexible hook and one spine.....**Platystictidae**

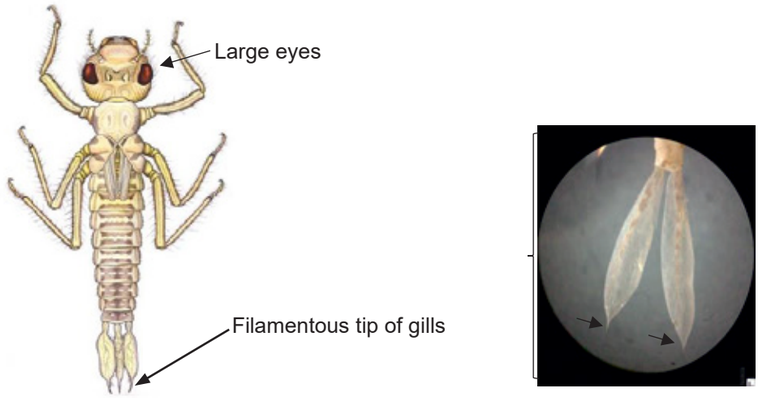

Fig. 6b

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7. Mentum with single premental seta situated on both sides of the midline (Fig. 7)……**Protoneuridae**

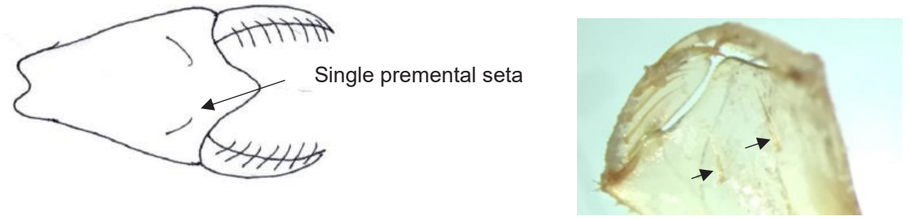

Fig. 7

- Mentum with more than one premental seta on both sides of the midline ……8

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8. Abdomen as long as the caudal gills (Fig. 8a); second segment of antenna shorter than the third..... **Platycnemididae**

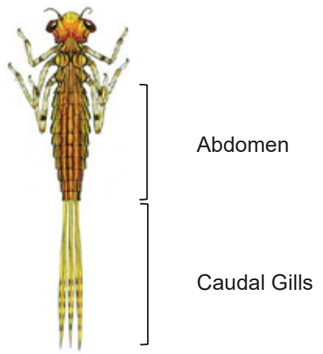


Fig. 8a

- Abdomen longer than the caudal gills (Fig. 8b); second segment of antenna longer than the third; 3-5 premental setae are generally present on both sides of the mentum's midline (Fig. 8c) ..... **Coenagrionidae**

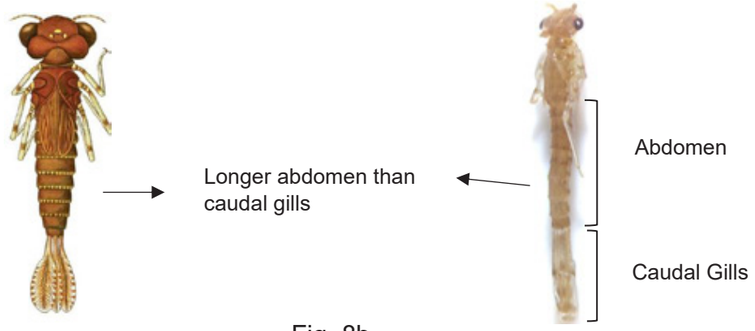


Fig. 8b

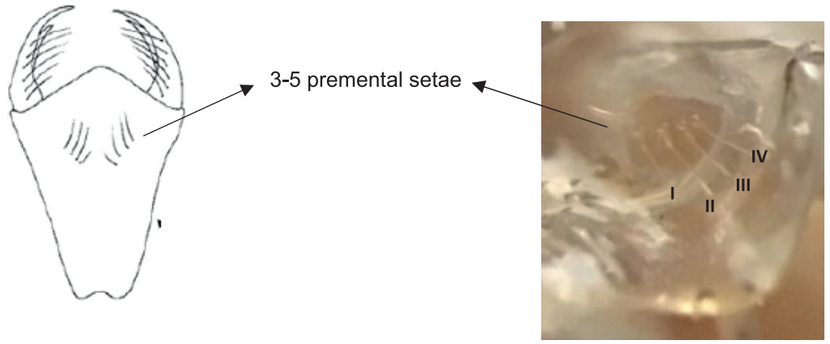


Fig. 8c

Key for Families of Suborder Anisoptera

1. Flat prementum and palpal lobes of the labium (lower lip), with no setae on the prementum and usually none on the palpal lobes (Fig. 1a). 2

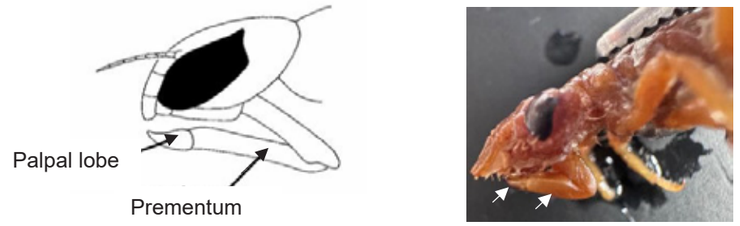


Fig. 1a (Lateral view)

- Scoop or spoon shaped prementum and palpal lobes of labium (Fig. 1b), setae usually occur on prementum and present on the palpal lobes.....3

Fig. 1b (Lateral view)

2. Four antennae segments, the third of which is enlarged (Fig. 2a); two segmented tarsi of first two pairs of legs; long abdomen .....**Gomphidae**

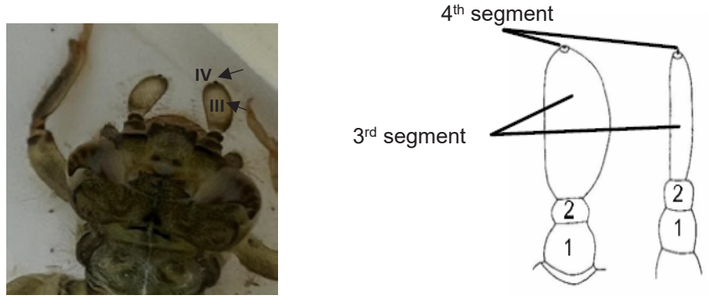
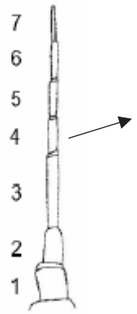


Fig. 2a

- Slender antennae with 6-7 segments (Fig. 2b); three segmented tarsi of all the legs (Fig. 2c).....**Aeshnidae**



6-7 segmented antenna

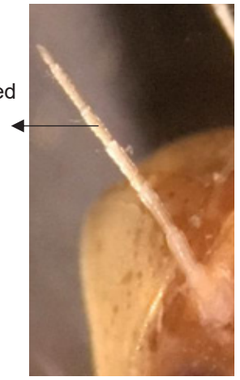


Fig. 2b

Tarsi with three segments

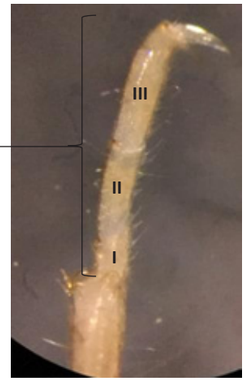


Fig. 2c

3. Long body with bunch of setae or bristles covering it; palpal lobes with big, uneven teeth (Fig. 3a)……4

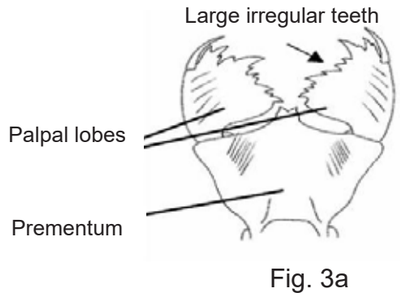
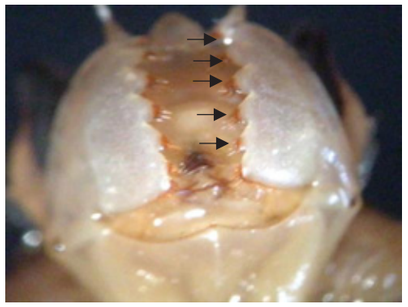


Fig. 3a

- Short robust body; palpal lobes having small, regular crenulations or almost straight teeth in distal margins (Fig. 3b)……5



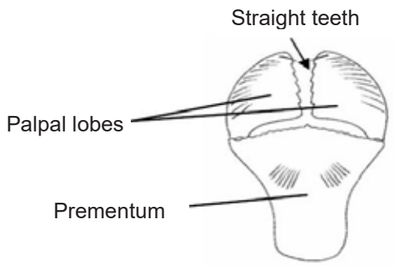
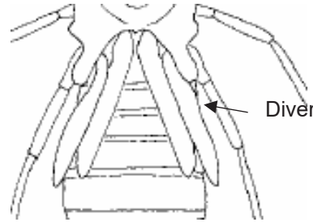


Fig. 3b

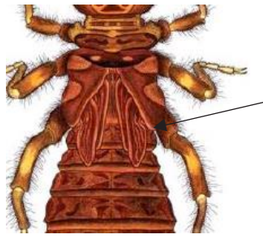
4. Divergent wing pads (Fig. 4a); body surface with contrasting pigmentation, especially on abdomen……**Chlorogomphidae**



Divergent wing pads

Fig. 4a

- Wing pads not divergent (Fig. 4b); body surface without pigmentation ..... **Cordulegastridae**



Wing pads not divergent

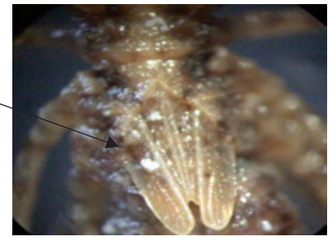
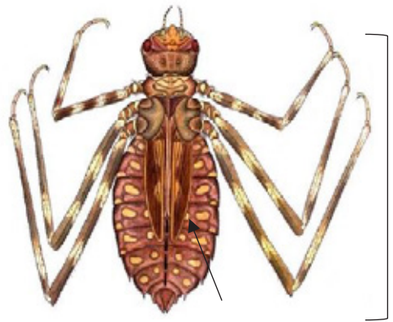


Fig. 4b

5. Legs extremely long resembling a ‘spider’ look (Fig.5a) (apex of each metafemur reaching to or beyond apex of abdominal segment 8); head with a horn like process between the antennal bases (Fig. 5b); wing pads parallel……**Macromiidae**



Spidery appearance due to long legs

Parallel wing pads

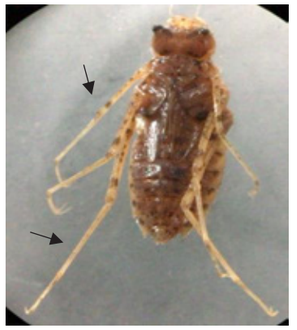


Fig. 5a

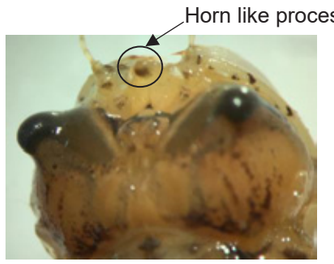


Fig. 5b (Dorsal view)

- Shorter legs; usually, the apex of the metafemora does not reach the tip of abdominal segment 8.; head without a notable frontal horn except for few cases; wing pads divergent ……..……..……..……..……**Synthemistidae**

- Legs relatively short; wing pads are parallel; abdomen not characterized by a round or depressed form; no noticeable horn between the bases of the antennae ……..……..…..6

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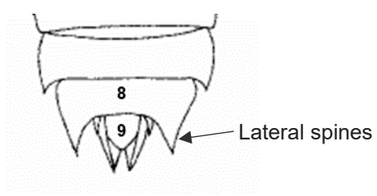
6. Small size; the lateral spines of abdominal segment 8 equals or exceeds the mid-dorsal length of segment 9 (Fig. 6a)…..……..…**Libellulidae**



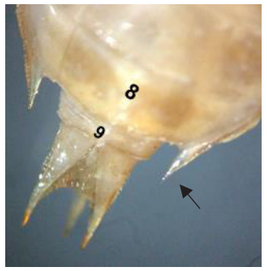


Fig. 6a

- Short and broad; the lateral spines of abdominal segment 8 shorter than the mid-dorsal length of segment 9 Fig. 6b) .....**Corduliidae**

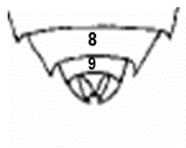
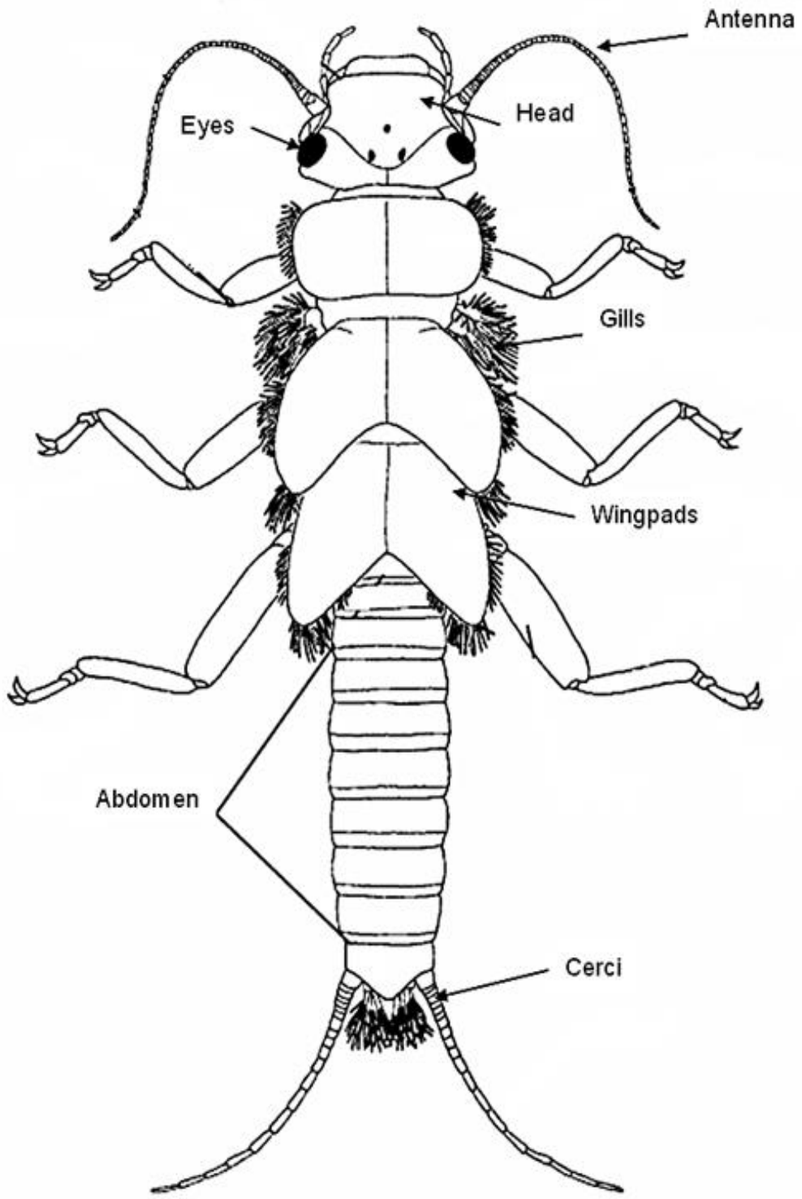


Fig. 6b

ORDER PLECOPTERA

Family-Perlodidae

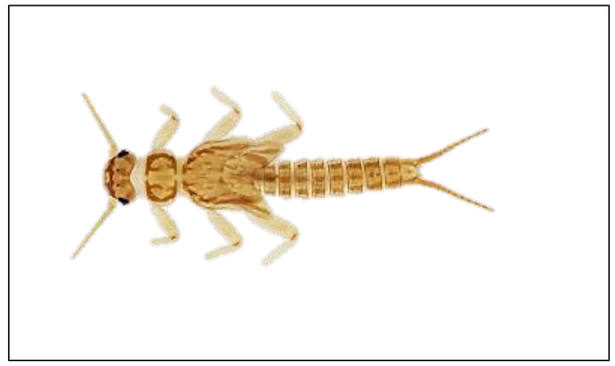


Dorsal View

Morphological Features (Larva)

Image source: Bouchard, 2004.

Key Points



Family: Perlodidae *(Representative Plecoptera)*

1. Common name- Stonefly

2. Origin of the name- Greek- “Pleco” meaning folded and “Ptera” meaning wing

3. Characteristics:

- The antenna is long, prominent and has segments
- Prognathic head attached on wide pronotum
- Mandibulated mouthparts adapted for chewing
- Mostly feed on leaf litter, decaying organic material or predators
- Wing pads present
- Branched gills are never found on dorsal or lateral sided of the abdomen.
- Branched gills may appear on the mouthparts or the neck or lateral sides of the thorax, or the underneath of the abdomen.
- Tarsi always 3 segmented with a pair of claws
- Legs long and widely separated
- Only two cerci present

List of Families

1. **Perlidae**
2. **Peltoperlidae**
3. **Perlodidae**
4. **Nemouridae**
5. **Taeniopterygidae**
6. **Chloroperlidae**
7. **Capniidae**
8. **Leuctridae**

Key for Families of Order Plecoptera

1. Gills present on sides of all thoracic segments (Fig. 1a) ……..……**Perlidae**

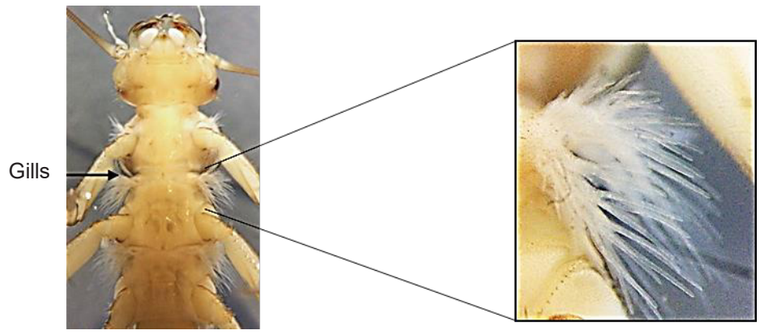


Fig. 1a

- Gills absent on sides of all thoracic segments (Fig. 1b)…..……..……...2

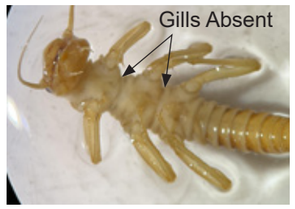


Fig. 1b

2. Body appearance roach-like; thoracic sterna plates overlapping; conical gills present behind coxae of middle and hindlegs (Fig. 2) ..... **Peltoperlidae**

Fig. 2

- Body appearance not roach-like, thoracic sterna do not overlap, conical gills absent……..……..……..……3

3. Wingpads strongly divergent from body axis (Fig. 3a)……..…4

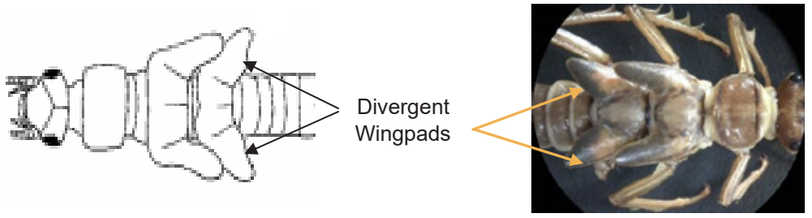


Fig. 3a

- Wingpads not strongly divergent (Fig. 3b).....…6

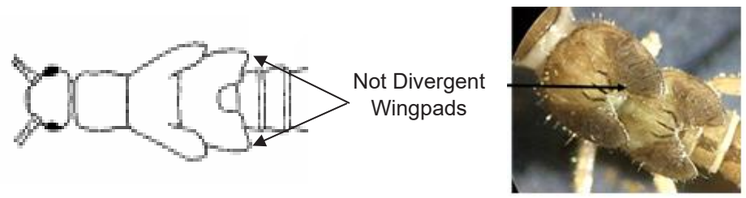
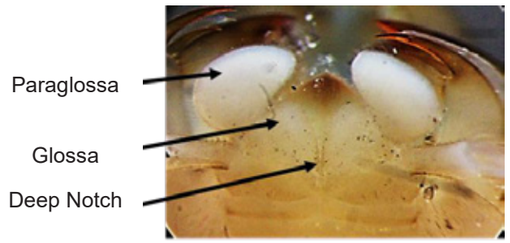


Fig. 3b

4. Labium (mouth part) with a deep notch and paraglossa extending beyond glossa (Fig. 4a)…….....**Perlodidae**



Ventral view

Fig. 4a

- Paraglossae not extending beyond glossa, labium with three small notches (Fig. 4b)…….....……..……...5

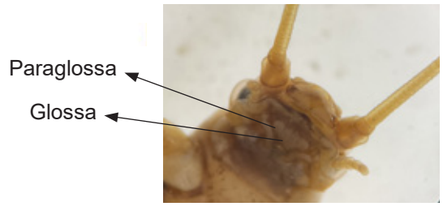


Fig. 4b

5. First tarsal segment (T1) longer than second (T2); coxal gills and triangular shape plate absent on ventral terminal of abdomen (Fig. 5a)…….....……....Nemouridae

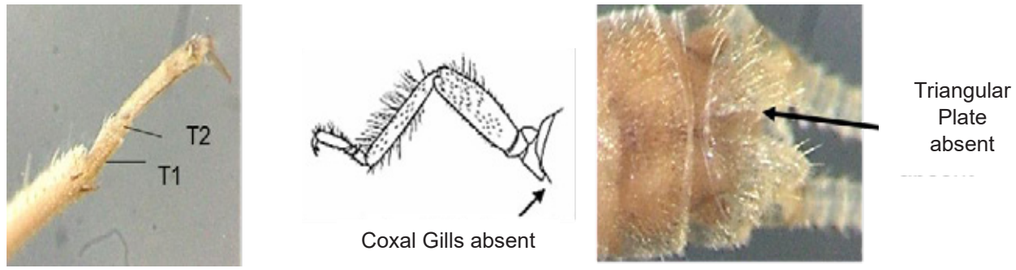


Fig. 5a

First tarsal segment (T1) as long as second (T2) (Fig. 5b); coxal gills and triangular shape plate present on ventral terminal of abdomen …….. **Taeniopterygidae**

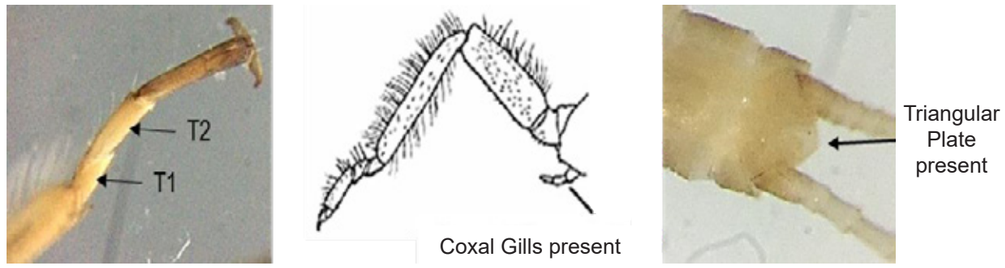


Fig. 5b

6. Cerci (tails) shorter (approximately 3/4th) than or as long as the abdomen (Fig.6a)…….…….**Chloroperlidae**

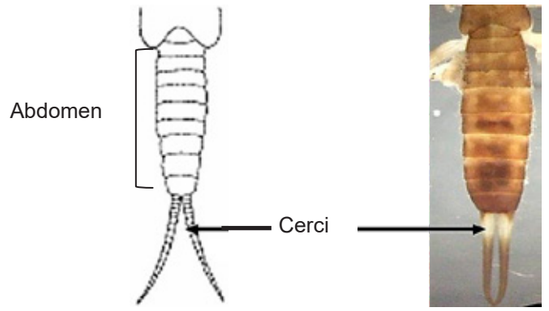


Fig. 6a

- Cerci as long or longer than abdomen (Fig. 6b)……..…..…..……..…7

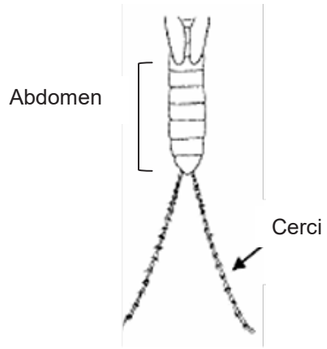


Fig. 6b

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7. Membranous fold present from abdominal segments 1-9; wing pads are located equally apart on mesothoracic and metathoracic segments (Fig. 7a) …… **Capniidae**

Fig. 7a

- Membranous fold absent from 7-9 abdominal segments; wing pads are located 2-3 times apart on mesothorax than metathorax (Fig. 7b)…… **Leuctridae**

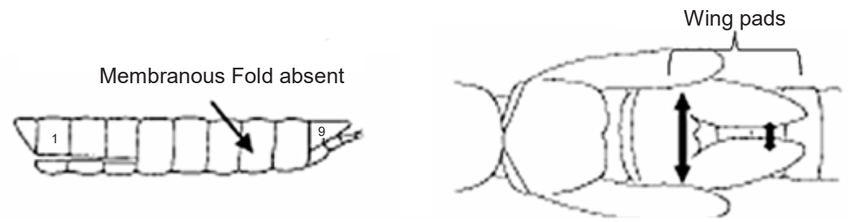
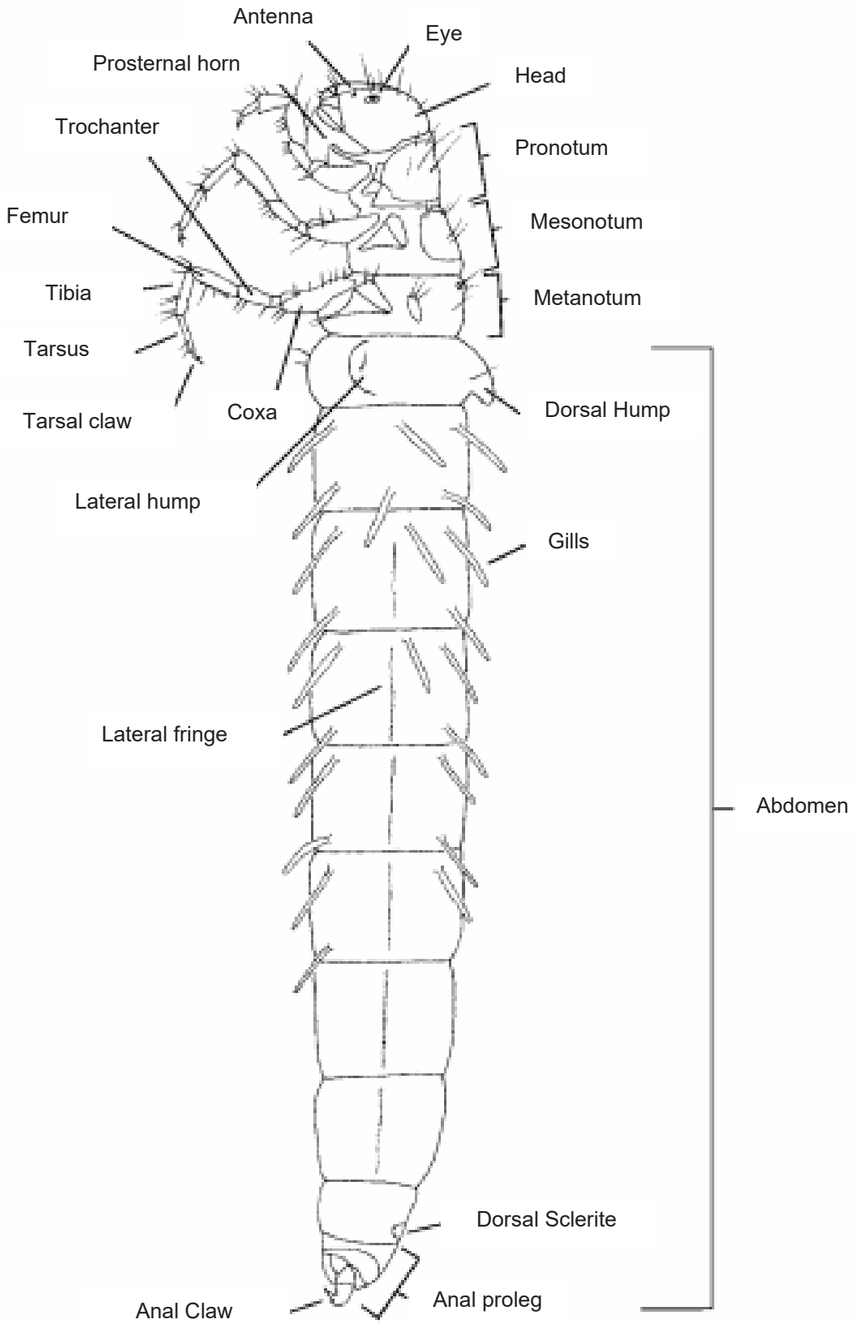


Fig. 7b

ORDER TRICHOPTERA

Family-Brachycentridae



Lateral View

Morphological Features (Larva)

Image source: Bouchard, 2004.

Key Points

Family: Hydropsychidae *(Representative Trichoptera)*

1. Common name- Caddisflies
2. Origin of the name- Greek- ‘trichos’ means hair and ‘ptera’ means wings
3. Characteristics:

- The head is dorsally divided by a Y-shaped ecdysial line
- Thorax with three pairs of legs and often sclerotized
- Nine abdominal segments present with or without branched gills
- Hooked prolegs present at the end of the abdomen
- Body length: 1.8-25.0 mm

List of Families

1. Helicopsychidae
2. Hydropsychidae
3. Hydroptilidae
4. Ecnomidae
5. Leptoceridae
6. Phryganeidae
7. Glossosomatidae
8. Hydrobiosidae
9. Rhyacophilidae
10. Philopotamidae
11. Stenopsychidae
12. Psychomyiidae
13. Xiphocentronidae
14. Dipseudopsidae
15. Polycentropodidae
16. Brachycentridae
17. Molannidae
18. Calamoceratidae
19. Lepidostomatidae
20. Phryganopsychidae
21. Goeridae
22. Uenoidae
23. Apataniidae
24. Limnephilidae
25. Sericostomatidae
26. Odontoceridae

Key for Families of Order Trichoptera

1. Anal claw comb-shaped (Fig. 1a)…….…… **Helicopsychidae**

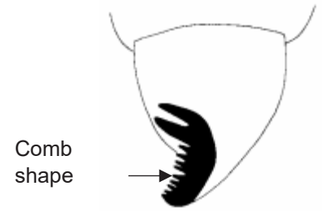


Fig. 1a

- Anal claw hook-shaped (Fig. 1b)……..……2

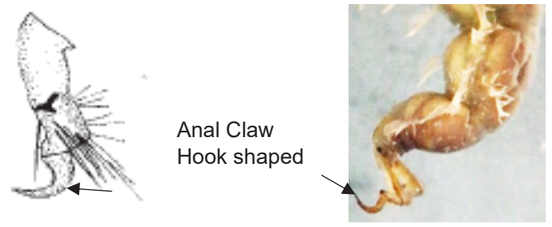
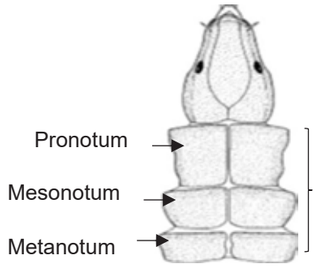


Fig. 1b

2. Each thoracic segment dorsally covered by sclerites, closely appressed or fused on mid dorsal line (Fig. 2a) ……..……..……...3



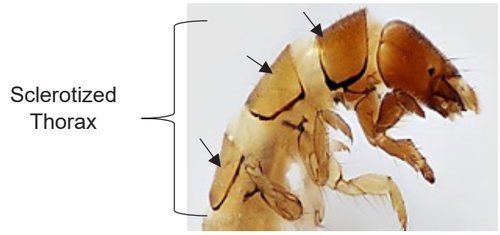


Fig. 2a

- Pronotum sclerotized and metanotum membranous; mesonotum either entirely membranous and, or smaller sclerites may be present (Fig. 2b)…….……....5

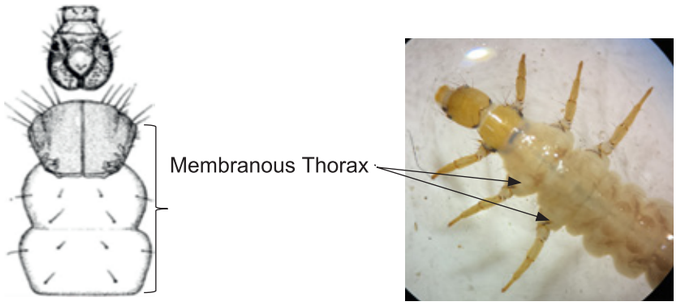


Fig. 2b

3. Abdomen with lateroventral rows of branched gills (Fig. 3)……...**Hydropsychidae**

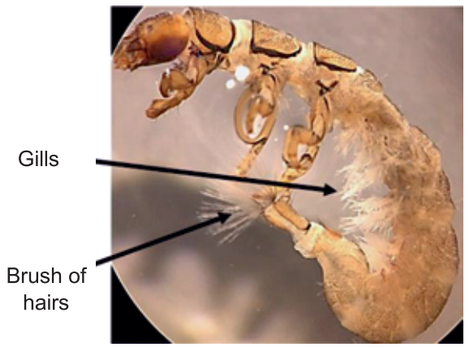


Fig. 3

- Abdomen lacking lateroventral gills……..……..……..…..…4

4. Very small larvae (1 - 4 mm); abdomen appears thickened (Lateral view) (Fig. 4a)……..…....**Hydroptilidae**

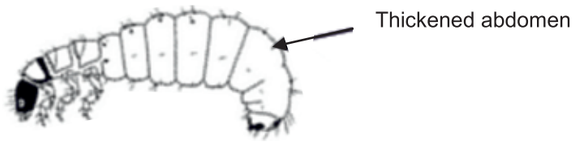


Fig. 4a

- Larvae of medium size (8-10 mm); elongated head and unthickened abdomen (lateral View) (Fig. 4b)…….. ……..……...**Ecnomidae**

Fig. 4b

5. Antennae very long and prominent, at least six times as long as its width (Fig. 5a); a pair of dark curved lines may present on posterior half of thorax ……..……...…**Leptoceridae**

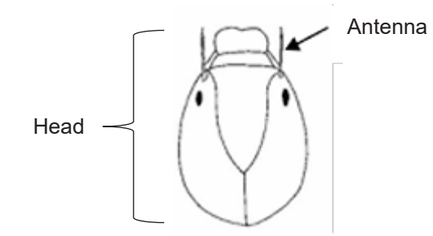


Fig. 5a

- Antennae of normal length, no more than three times as long as its width (Fig. 5b) ……..……..……..……..……6

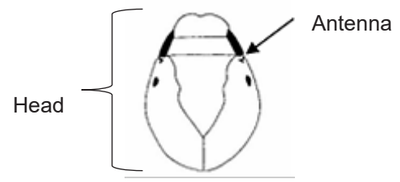


Fig. 5b

6. Mesonotum either membranous or with small scattered sclerites (Fig. 6a); pronotum without anterolateral projections……..……..... 7

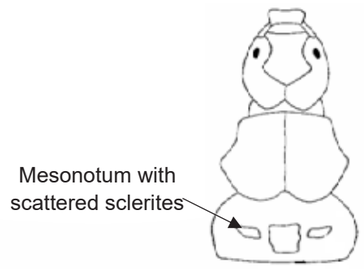


Fig. 6a

- Mesonotum largely covered by variously subdivided sclerotized plates and pronotum sometimes with prominent anterolateral projections or processes (Fig. 6b)……..…….....16

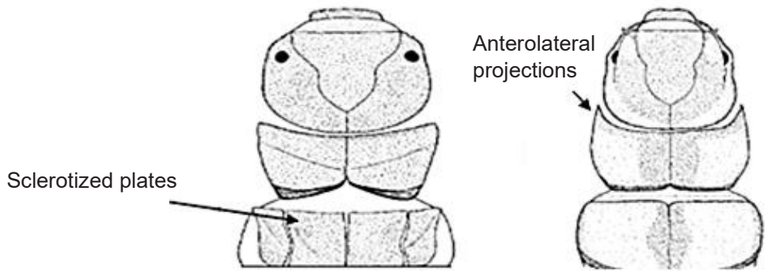


Fig. 6b

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7. Abdominal segment IX with sclerite on dorsum (Fig. 7a)…….……..…..8

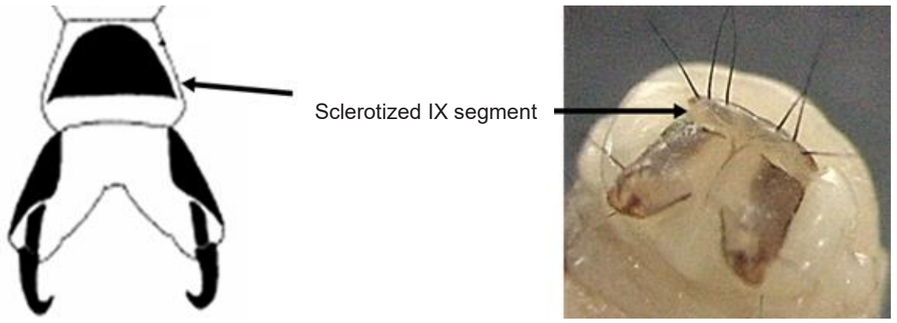

Fig. 7a

- Abdominal segment IX without sclerite on dorsum or entirely membranous (Fig. 7b)……....11

Fig. 7b

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8. Prosternal horn present (Fig. 8a)……..……..…..**Phryganeidae**

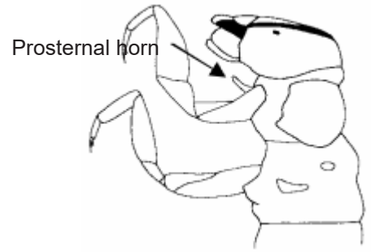

Fig. 8a

- Prosternal horn absent (Fig. 8b)..……..……..…..9

Fig. 8b

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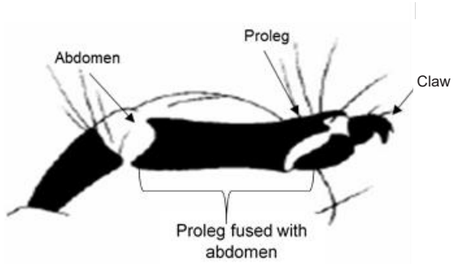
9. Anal proleg fused with abdominal segment IX (Fig. 9 a)……..……..…..……..**Glossosomatidae**



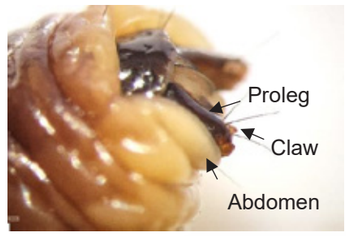


Fig. 9a

- Anal proleg free of abdominal segment IX (Fig. 9b)……...10

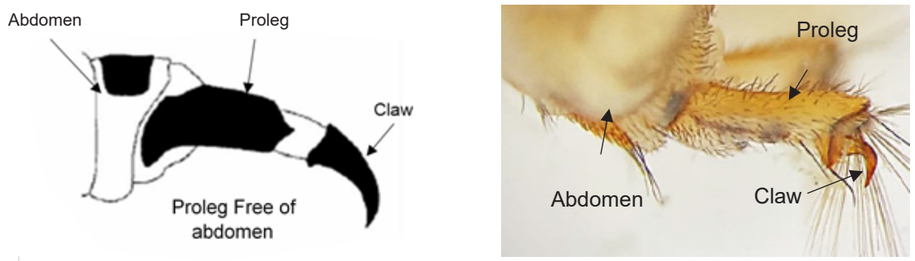


Fig. 9b

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10. Forelegs modified into grasping organs, each with oblong rod like coxa; short tibia and tarsus; claw setae like (Fig. 10a)…...……..…...**Hydrobiosidae**

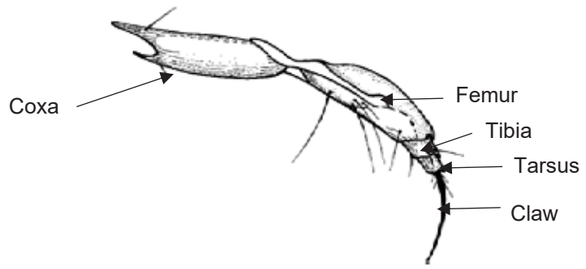

Fig. 10a

- Forelegs not as above, normal walking legs (Fig. 10b)……..……**Rhyacophilidae**

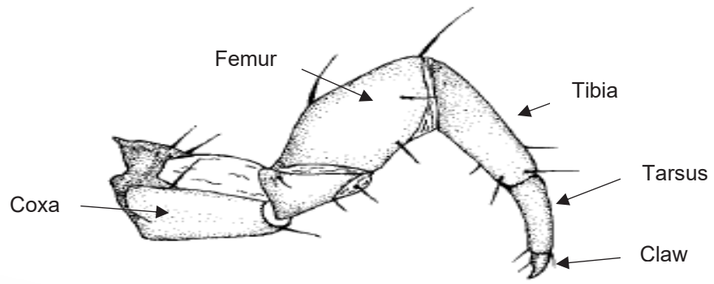

Fig. 10b

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11. Labrum (upper lip) T-shaped (Fig. 11a)……..…… **Philopotamidae**

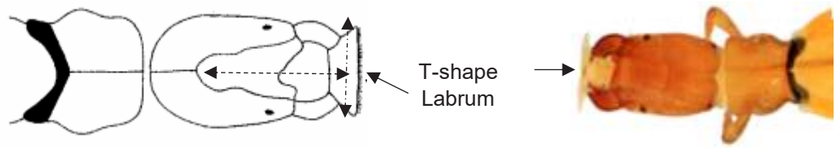

Fig. 11a

- Labrum sclerotized, rounded and articulated in normal way (Fig. 11b)..……...12

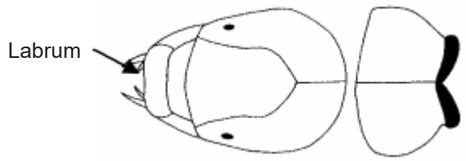

Fig. 11b

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12. Abdomen without lateral fringe, anal prolegs only as long as abdominal segment IX……...13

- Abdomen with lateral fringe on both sides (Fig. 12) and anal prolegs as long as abdominal segments VIII & IX combined……..……15

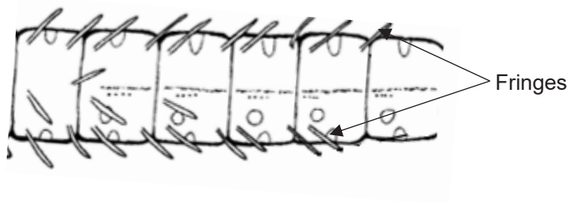

Fig. 12

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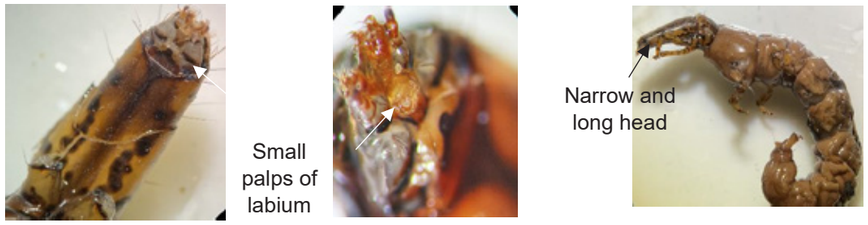
13. Head very long (more than 2 times of its width) and narrow; labium suboval with small palps (Fig. 13).....**Stenopsychidae**



Ventral side of Head

Fig. 13

- Head as long as wide; labium slender and labial palps absent.....14

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14. Trochantin (projections near shoulder of front leg) broad and hachet shape at apex (Fig. 14a).....**Psychomyiidae**

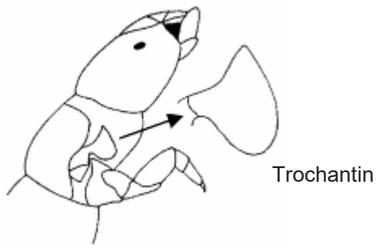

Fig. 14a

- Trochantin pointed/acute at apex (Fig. 14b).....**Xiphocentronidae**

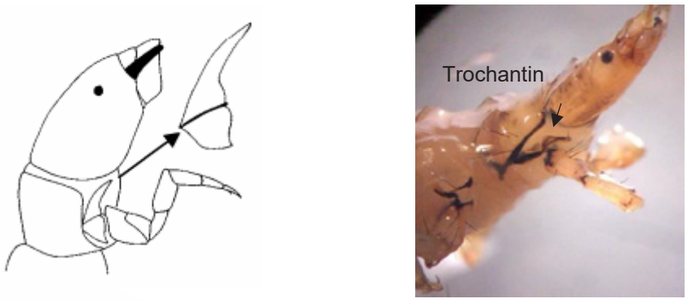

Fig. 14b

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15. Tarsi of all legs wider than tibiae (Fig. 15a).....**Dipseudopsidae**

Fig. 15a

-Tarsi narrower than tibiae, mostly cylindrical (Fig. 15b).....**Polycentropodidae**

Fig. 15b

---

16. Abdominal segment I without dorsal and lateral humps, and mesonotum with four plates in a row; pronotum is divided by a crease (Fig. 16a) .....**Brachycentridae**

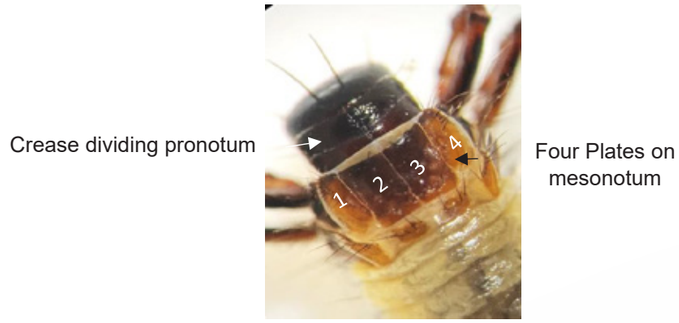

Fig. 16a

- Abdominal segment I always with a lateral hump on each side (Fig. 16b); sclerites not as above ……..…….....17

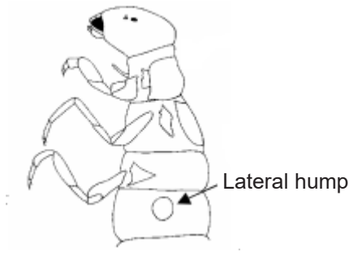

Fig. 16b

17. Tarsal claws on hind leg smaller than fore and mid leg claws (Fig. 17a)……..…….. **Molannidae**

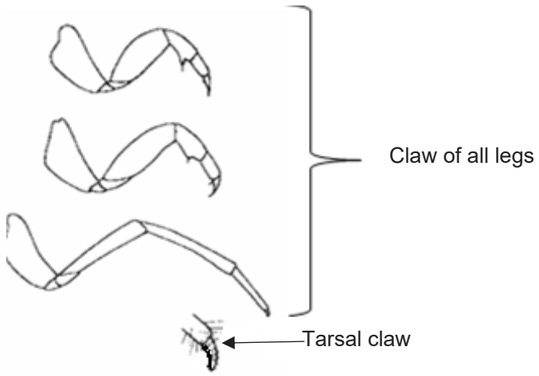

Fig. 17a

- Tarsal claw of hind legs similar to claws of other legs (Fig. 17b)……..……..18

Fig. 17b

18. The labrum (upper lip) has a transverse row of approximately 16-22 stout setae across the central part (Fig. 18a)……..…….. **Calamoceratidae**

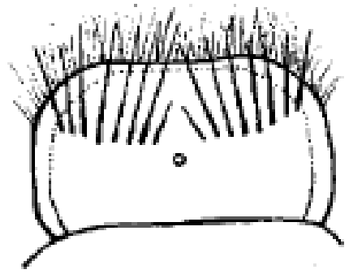

Fig. 18a

- Labrum with no more than 6 long setae across central part (Fig. 18b)……19

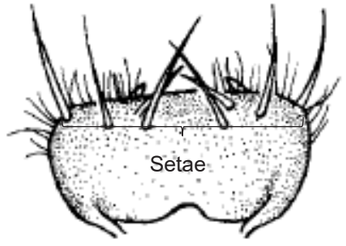

Fig. 18b

19. Median dorsal hump of abdominal segment I absent ……..……20

- Median dorsal hump of abdominal segment I present (Fig. 19)……..…21

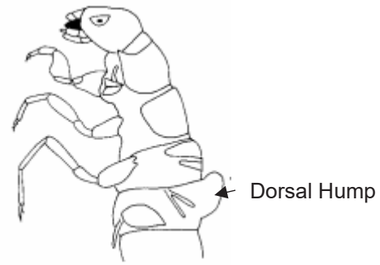

Fig. 19 (Lateral View)

20. Antenna close to eyes (Fig. 20a)……..……**Lepidostomatidae**

Fig. 20a

- Antenna close to anterior margin (next to) of head (Fig. 20b) ……..……..**Phryganopsychidae**

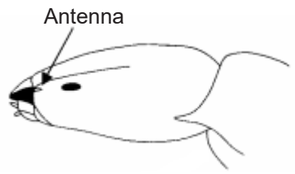

Fig. 20b

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21. Mesonotum extending forward on both sides either long and pointed or rounded and spiny (Fig. 21)..……..……**Goeridae**

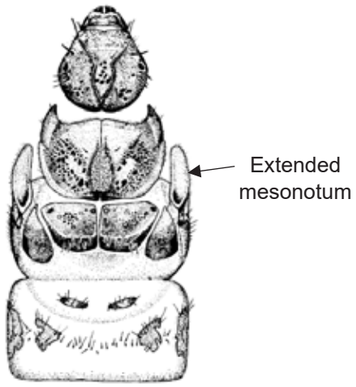

Fig. 21

- Mesonotum not extended……22

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22. Anterior edge of mesonotum notched at centreline; metanotal unsclerotized with only one or two setae (Fig. 22a)……..……**Uenoidae**

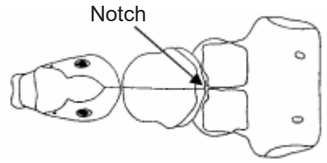

Fig. 22a

- Anterior edge of mesonotum not notched, straight or continuously curved; metanotal with a sclerotized plate, and/or with two setae (Fig. 22b)……..……..…23

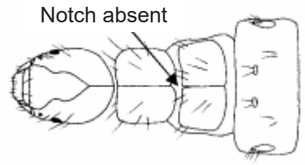

Fig. 22b

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23. Basal setae of each tarsal claw as long as claw; mandibles with scrapper blade, not toothed (Fig. 23a) ……..……..……**Apataniidae**

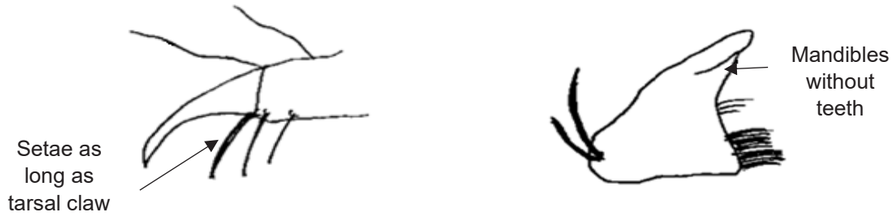

Fig. 23a

- Basal setae of tarsal claw smaller than claw; mandibles always toothed (Fig. 23 b)……..……..……24

Fig. 23b

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24. A pair of sclerites located on each side of the mesonotum separated by the midline (Fig. 24a)……..**Limnephilidae**

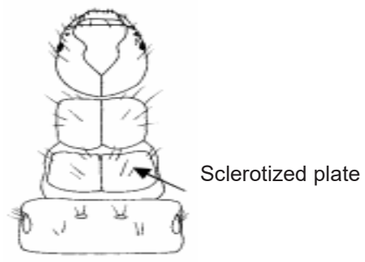

Fig. 24a

- Mesonotum divided into 2-3 sclerotized plates (Fig. 24b)……..25

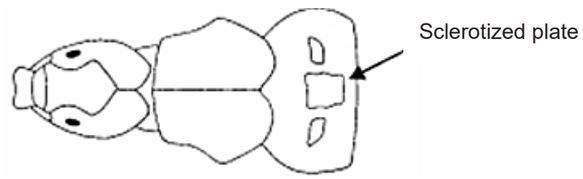

Fig. 24b

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25. Cluster of 30 (or greater) setae located at dorsum of each anal proleg and medial to the lateral sclerites; lateral sclerites small (Fig. 25a)……....**Sericostomatidae**

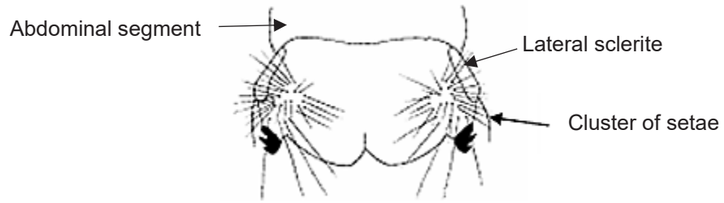


Fig. 25a

- 3-5 setae located atop the anal proleg and medial to the lateral sclerites, (some genera present with short spines); lateral sclerites large (Fig. 25b)……..……**Odontoceridae**

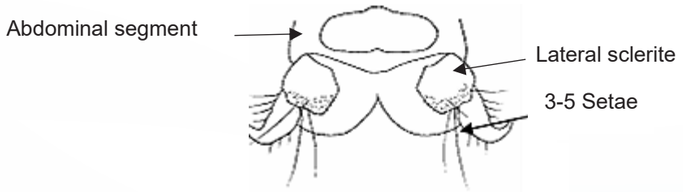
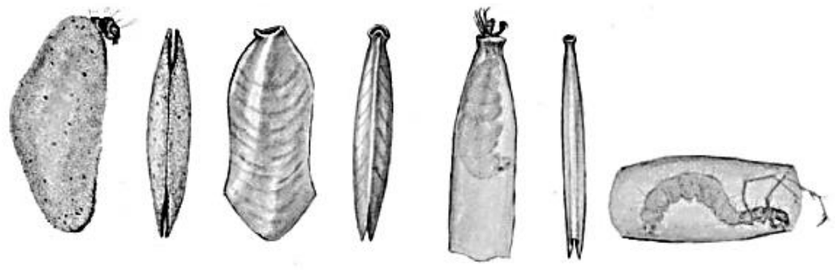
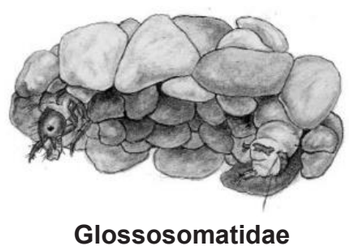


Fig. 25b

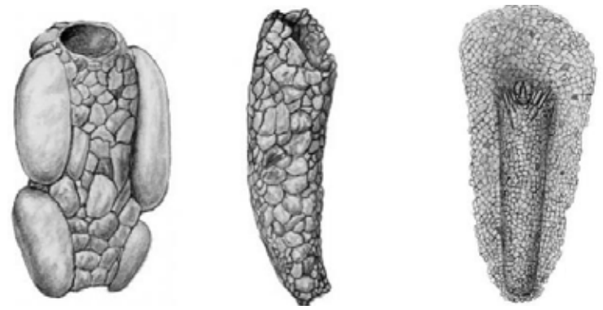
Case Making Larvae of Trichoptera



Hydroptilidae



Glossosomatidae



Goeridae

Limnephilidae

Phryganeidae

Lepidostomatidae

Brachycentridae

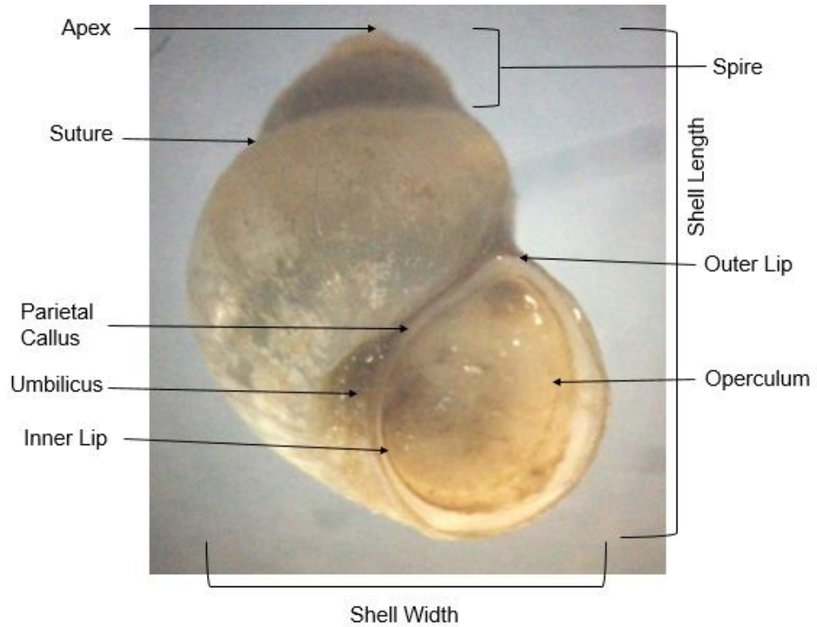
Leptoceridae

Yamunotri, Uttarakhand

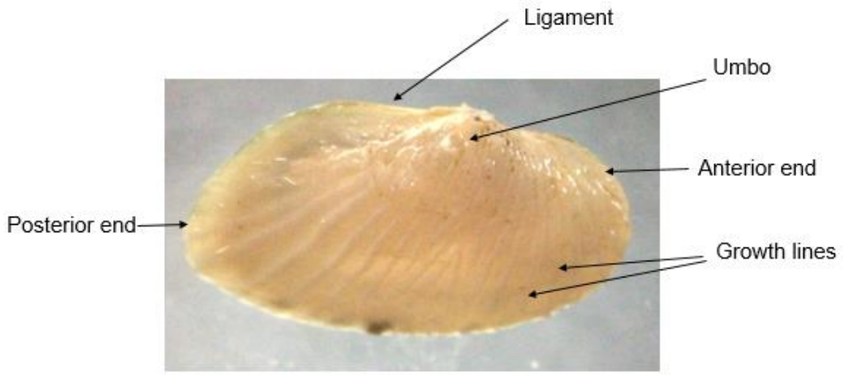
6

PHYLUM MOLLUSCA

Family-Unionidae



Class: Gastropoda



Class: Bivalvia

Morphological Features (Adult)

Key Points

Family: Assimineidae *(Representative Mollusca)*

1. Common Name: Shells
2. Latin: molluscus, means: mollis, soft.
3. **Characteristics:**
   - All freshwater molluscs possess a shell (snails) or two shells (bivalves).
   - The shell is a hard, calcareous structure that covers the soft parts of the animal's body, providing protection.
   - Snail shells are usually coiled to the right (clockwise), but left-handed (counter clockwise) shells are also known.
   - In bivalves, the shell consists of two valves held together at the dorsal margin by a ligament.

List of Families

1. **Neritidae**
2. **Septariidae**
3. **Ancylidae**
4. **Bullinidae**
5. **Planorbidae**
6. **Physidae**
7. **Lymnaeidae**
8. **Iravadiidae**
9. **Thiaridae**
10. **Pachychillidae**
11. **Paludomidae**
12. **Assimineidae**
13. **Liitorinidae**
14. **Pomatiopsidae**
15. **Valvatidae**
16. **Bithyniidae**
17. **Ampullariidae**
18. **Viviparidae**
19. **Stenothyridae**
20. **Arcidae**
21. **Pharidae**
22. **Solenidae**
23. **Mactridae**
24. **Sphaeridae**
25. **Cyrenidae**
26. **Unionidae**
27. **Etheriidae**

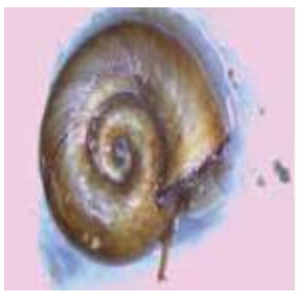
Shell Characteristics

Shell Size:

- Small- up to 10 mm
- Medium- 10-30 mm
- Large- more than 30 mm

Shell Shapes:

Limpet



Discoidal

Sinistral

Turreted (Circular tower)

Key for Classes of Phylum Mollusca

1. Single shell present which is coiled (Fig. 1) or uncoiled (Fig. 2)…..……..**Gastropoda**

Fig. 1

Fig. 2

2. Two shells (valves) present and connected by a ligament hinge (Fig. 3)……..**Bivalvia**

Fig. 3

Key for Families of Class Gastropoda

1. Shell cap-like (limpet-shaped) (Fig. 1a)……..... 2

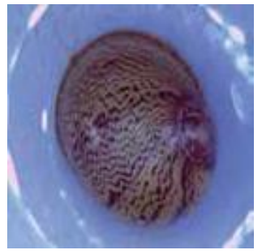


Fig. 1a

- Shell coiled (Fig. 1b)……..3

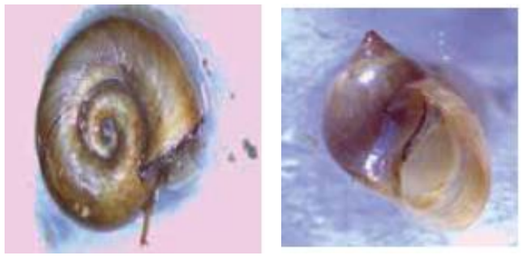


Fig. 1b

2. Thick shelled like porcelain or a marble, brownish color; black zig-zag pattern (Fig. 2a)……..... **Neritidae**

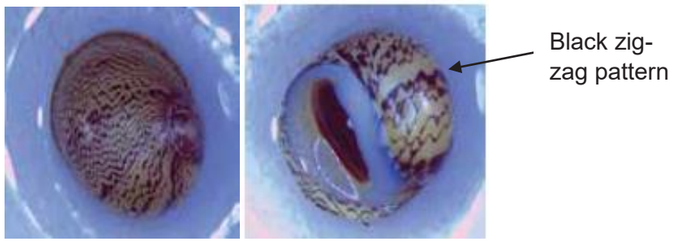


Fig. 2a

- Thin shelled spiral coil and operculum (Fig 2b)……..……**Septariidae**

Fig. 2b

- Limpet shape without spiral coil and operculum (Fig. 2c)…… **Ancylidae**

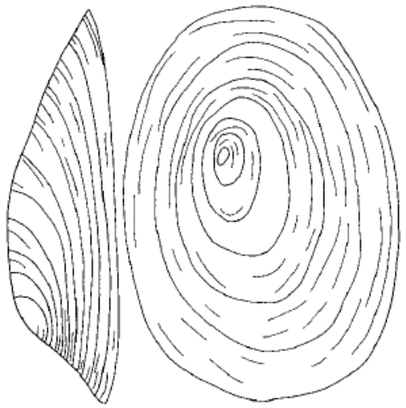


Fig. 2c

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3. Shell discoidal (disc shaped) (Fig. 3a)……..4

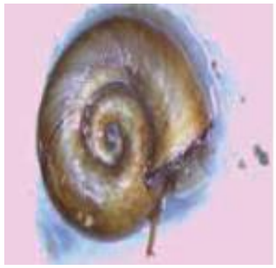

Fig. 3a

- Shell turreted (circular tower) shape (Fig. 3b)……..5

Fig. 3b

- Shell globose (Fig. 3c)……6

Fig. 3c

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4. Shell large; aperture ear shaped (Fig. 4a)……..**Bullinidae**

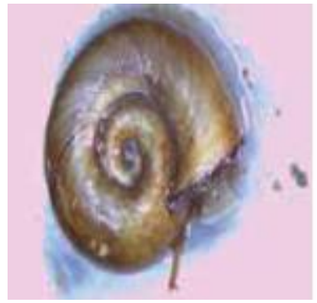

Fig. 4a

- Shell small; aperture small (Fig. 4b).....**Planorbidae**

Fig. 4b

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5. Shell coiled sinistral (coiled to the left) (Fig.5a).....**Physidae**

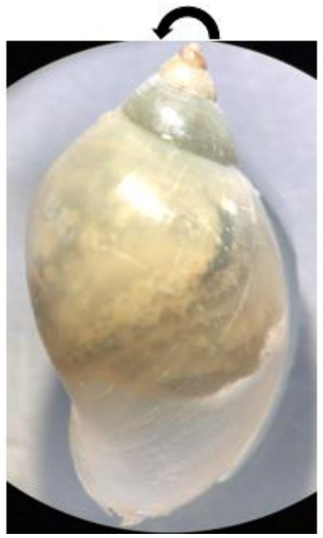

Fig. 5a

- Shell coiled dextral (coiled to the right) (Fig. 5b)..... **Lymnaeidae**

Fig. 5b

- Shell small; whorls with strong and prominent spiral ridges (Fig. 5c)…**Iravadiidae**

Fig. 5c

- Shell medium to large; with orange-brown or red-brown periostracum (thin organic coating) (Fig. 5d)……..…..**Thiaridae**

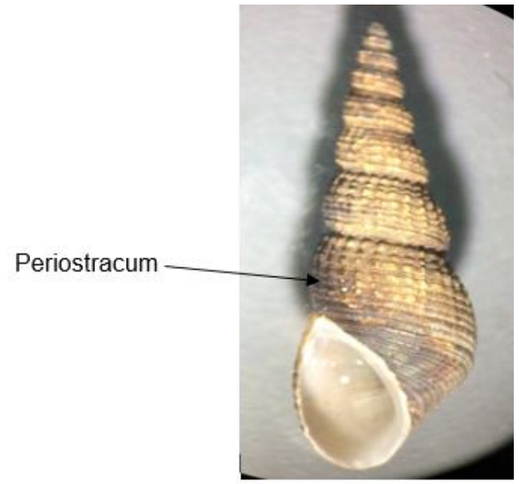

Fig. 5d

- Shell large, elongated; nodes on surface (Fig. 5e).....**Pachychillidae**[1]

Fig. 5e

- Shell large, dark-brown with one or two brown transverse bands……..**Paludomidae**

[1]Pluerocerida is renamed as Pachychillidae (IRMNG, 2023)

- Shell medium-sized, pointed tip; with dark red-brown spiral bands (Fig. 5f)……..…..… **Assimineidae**

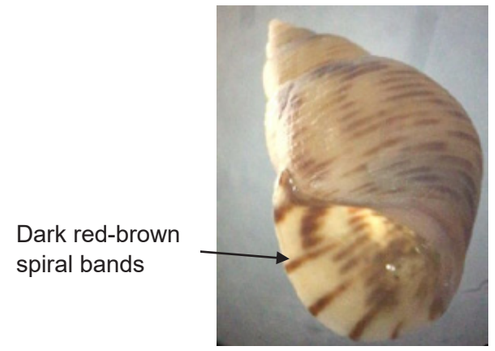

Fig. 5f

- Shell thick, whorls more or less rounded, sculpture smooth or spirally striate, (Fig. 5g)……..……..……..…**Littorinidae**

Fig. 5g

- Shell moderate or small (up to 10 mm), elongate with a number of whorls; operculum transparent and thin (Fig. 5h) .....**Pomatiopsidae**

Fig. 5h

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6. Operculum circular (Fig. 6a) …….....**Valvatidae**

Fig. 6a

- Shell small; opening is half to the total size (Fig. 6b)……..**Bithyniidae**

Fig. 6b

- Operculum oval and concentric…….....7

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7. Shell globose or oval; spire usually depressed, less than ½ the total shell length; aperture elongate (Fig. 7)..... **Ampullariidae**

Spire less than ½ the total shell length

Fig. 7

- Shell ovately conic; spire not depressed, whorls regularly increase, acuminate…8

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8. Last whorl with a wide opening (Fig. 8a).....**Viviparidae**

Last whorl with a wide opening

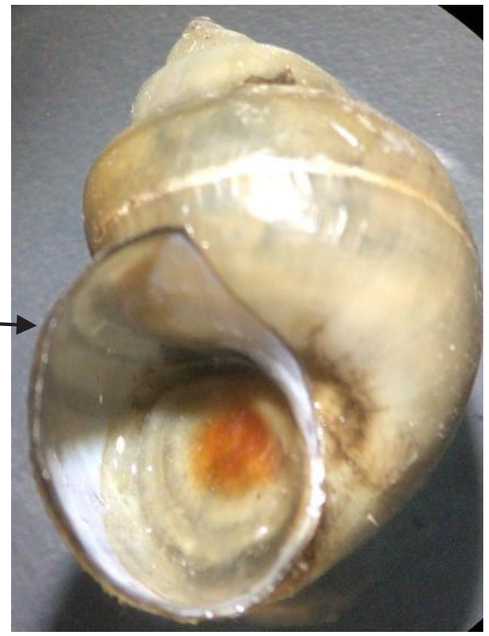

Fig. 8a

- Size small; operculum round; last whorl large with a narrow opening (Fig. 8b)…….…… **Stenothyridae**

Fig. 8b

Key for Families of Class Bivalvia

1. Shell thin and small……..……..2

- Shell thick and medium / large…....……....3

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2. Boat shape; parallel margin is straight linear (Fig. 2a)…….**Arcidae**

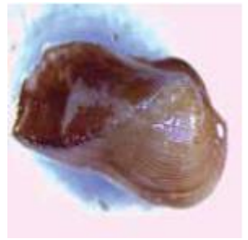


Fig. 2a

- Rectangular shape; equivalve; hinge narrow and weak (Fig. 2b)……..……..**Pharidae**[2]

Fig. 2b

[2] *Only one genus- Novaculina of Family Solecurtidae is fresh-water. Novaculina is placed under Family-Pharidae (MolluscaBase eds., 2024a)*

- Rectangular shape; very long; shell thin sometimes transparent; hinge with three cardinal teeth (anatomical feature) (Fig. 2c)……..…....**Solenidae**

Fig. 2c

- Shell small to large with anterior cardinal teeth form an inverted v-shape (anatomical feature) (Fig. 2d)..…….. **Mactridae**

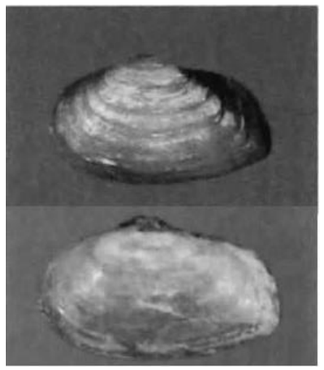


Fig. 2d

- Shell fragile; color gray to dark brown with numerous dark concentric growing lines or yellow to gray-blue without dark concentric growing lines (Fig. 2e)……..**Sphaeriidae**

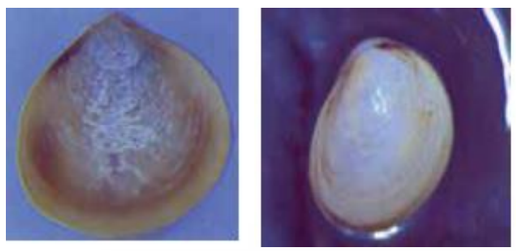


Fig. 2e

3. Shell sub-triangular; striae regular (Fig. 3a)……..…… **Cyrenidae**[3]

Fig. 3a

- Shell regular, equivalve and valve not attached to substratum (Fig. 3b)…….....**Unionidae**[4]

Fig. 3b

- Shell large; irregular, inequivalve and attached to substratum with one valve (Fig. 3c)…..…..……..……..…..**Etheriidae**

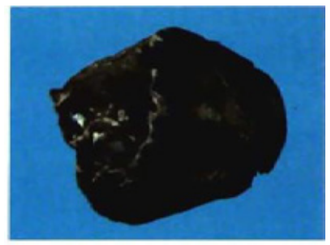


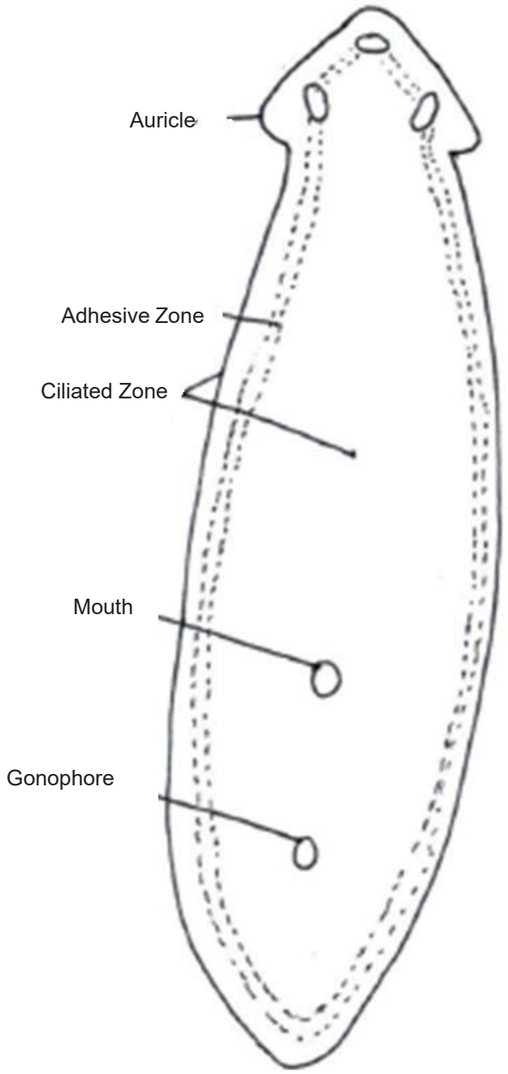
Fig. 3c

[3] *Corbiculidae is renamed as Cyrenidae (MolluscaBase eds., 2024b)*
[4] *Amblemidae is a sub-family of Unionidae (MolluscaBase eds., 2024c)*

7

PHYLUM PLATYHELMINTHES

Family-Duggesidae



Ventral View

Morphological Features (Adult)

Key Points

Family: Dugesiidae *(Representative Platyhelminthes)*

1. Common name- Flatworms (Planarians)
2. Characteristics**:**

- The planarian has a soft, flat, wedge-shaped body
- Identified by the arrangement or number of their ocelli or eye-spots, head morphology, coloration, embryology, nephridiopores arrangement and marginal adhesive zone.
- Absence of a coelom, anus, no distinct internal systems
- They are mainly found in terrestrial and aquatic (marine and fresh water) habitats. Based on Habitat, they are classified into three groups viz. Terricola (land planarians), Paludicola (freshwater planarians) and Maricola (marine planarians).
- Predators Temnocephalid flat worms consume tiny crustaceans, rotifers, insect larvae and nematodes
- Total length: up to 20 mm

List of Families

1. **Temnocephalidae**
2. **Scutariellidae**
3. **Dendrocoelidae**
4. **Dugesiidae**
5. **Planariidae**

Key for Orders of Platyhelminthes

1. 2 to 6 finger-like tentacles present anteriorly (Fig. 1)……**Temnocephalida**

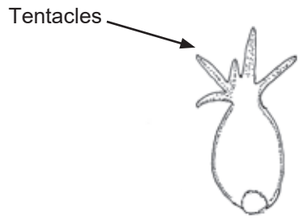


Fig. 1

- Without any tentacles (Fig. 2)……**Tricladida**

Fig. 2

Key for Families of Order Temnocephalida

1. 2 to 6 tentacles, sometimes 1 pair, tentacles conjoined basally; mouth opens downward (Fig. 1a)…….…….…. **Temnocephalidae**

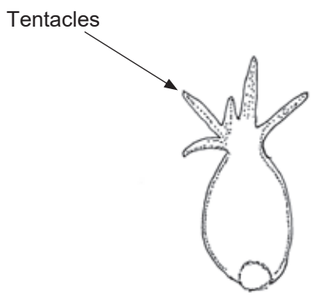


Fig. 1a

- 1 pair of tentacles (Fig. 1b); tentacles short, stumpy, on the fronto-lateral margins; mouth opening anteriorly between tentacles…….…. **Scutariellidae**

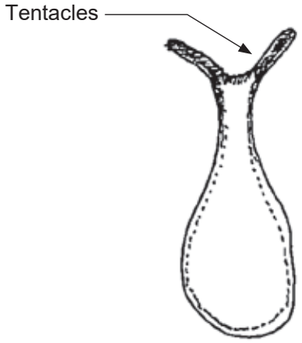


Fig. 1b

Key for Families of Order Tricladida

1. Usually unpigmented; two eyes (dorsal side) far away from each other; Waved body margin (Fig 1a); anterior adhesive organ well developed ……..…..…**Dendrocoelidae**

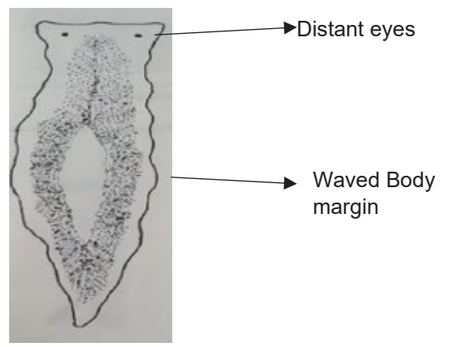


Fig. 1a

- Usually pigmented, Anterior adhesive organ absent .....……..……2

2. Head triangular (Fig 2a); one pairs of eyes (Dorsal side) with white auricle and eyefields, eyes close to each other and at same distance from the anterior margin of the head ……**Dugesiidae**

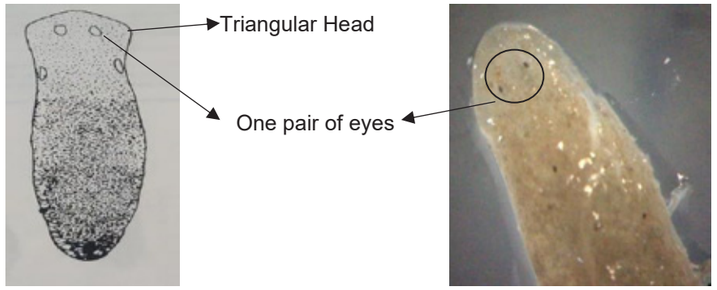


Fig. 2a

- Head rounded, eyes if present two or numerous on lateral margin of head (Fig. 2b), lacking white auricles or eyefields .....**Planariidae**

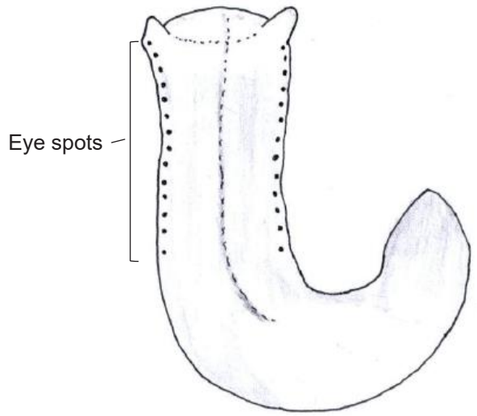


Fig. 2b

8

BIBLIOGRAPHY

References

- Akolkar, P., Ahmad, I., Ahmad, F., Goel, A., Sharma, J., 2017. Benthic Macro invertebrates of River Ganga. PR Division, Central Pollution Control Board, Ministry of Environment, Forest & Climate Change, Delhi, India.
- Bain, B. A. and Brinkhurst, R.O., Rogers, D., C., 2016. Phylum: Annelida, Subclass: Oligochaeta, In: Thorp and Covich's Freshwater Invertebrates, Keys to Nearctic Fauna, Thorp, J., H., Rogers, D., C (Eds.), Fourth edition, Volume II, pp 227-234.
- Balke, M., Jach, M.A., Hendrich L. 2004. Insecta: Coleoptera. In: Freshwater Invertebrates of the Malaysian Region, Yule, C., N., Sen, Y., H.. (Eds), Academy of Sciences Malaysia.pp 555-609.
- Baugh, S.C., 1960a. Studies on Indian Rhynchobdellid leeches. Parasitology, 50:217-310.
- Baugh, S.C., 1960b. Studies on Indian Rhynchobdellid leeches-II. Zool. Anz., 165:468-477.
- Bhatt, B.D., 1961. Freshwater leeches from Nainital district (U.P.). Proc. Nat.Acad. Sci. India,31(B): 311-314.
- Bocher, J., Kristensen, N., P., Pape, Thomas., Vilhelmsen, L., 2015. The Greenland Entomofauna, An identification manual of Insects, Spiders and their Allies, Brill, Leiden, Boston.
- Bouchard, R.W., Jr., 2004. Guide to aquatic macroinvertebrates of the Upper Midwest. Water Resources. Center, University of Minnesota, St. Paul, MN.
- Brinkhurst, R.O., 1986. Guide to the Freshwater Aquatic Microdrile Oligochaetes of North America.
- Brown, S. D., 2016. Thesis on Radiole Regeneration and Branchial Crown Structure of the Feather Duster Worm, Schizobranchia insignis.
- Bruce, N.L. 2004. Crustacea: Isopoda. In: Freshwater Invertebrates of the Malaysian Region, Yule, C., N., Sen, Y., H.. (Eds), Academy of Sciences Malaysia. pp.298-306.
- Chandra, K., Gopi, K. C., Rao, D. V., Valarmathi, K., Alfred J. R. B., 2017. Current status of Freshwater Faunal Diversity In India, Chapter 30, pp. 467-485.
- Chandra, M., 1991. The Leeches of India – A Handbook. Zoological Survey of India, Kolkata: 1-117.
- Choate, P.M., 2010. Identification Key to the Principal Families of Florida Hemiptera, Heteroptera, Identification - Insects of Florida.
- Dobson, M., 2013. Family-Level Keys to Freshwater Fly (Diptera) Larvae: A Brief Review and a Key to European Families Avoiding use of Mouthpart Characters, Freshwater Reviews 6, pp.1-32.
- Elias, R. and Rivero, M. S., 2009. Two new species of Cirratulidae (Annelida: Polychaeta) from Mar del Plata, Argentina (SW Atlantic) Laboratorio de Bioindicadores Bentónicos. Departamento de Ciencias Marinas, Universidad Nacional de Mar del Plata. Zoosymposia (2): 139-148.
- Elliott, J.M., Humpesch, U.H., Macan, T.T., 1988. Larvae of the British Ephemeroptera: a key with ecological notes. Scientific Publication, Freshwater Biological Association. 49:145.
- Epler, J.H., 2006. Identification Manual for the aquatic and Semi-Aquatic Heteroptera of Florida.
- Fauchald, K., 1977. The polychaete worms. Definitions and keys to the orders, families, and genera. Natural History Museum of Los Angeles County. Science Series 28: 1–188.
- Fauchald, K. and G.W. Rouse., 1997. Polychaete systematics: past and present. Zoological Scripta 26: 71–138.
- Fusari, L., M., Dantas, G., P., S., Pinho L., C., 2018. Order: Diptera, In: Thorp and Covich's Freshwater Invertebrates, Keys to Neotropical Hexapoda. Fourth Edition, Volume 3, pp. 607-623.
- Glasby, C.J. & T. Timm. 2008. Global diversity of polychaetes (Polychaeta; Annelida) in freshwater. Hydrobiologia 595: 107–115.
- Glasby, C.J., T. Timm, A.I. Muir & J. Gil. 2009. Catalogue of non-marine Polychaeta (Annelida) of the World. Zootaxa 2070: 1–52.
- Hernandez, M. A. T., 2010. Taxonomic update of the sabellids (polychaeta: sabellidae) from chile and taxa established by prof. Ernst ehlers, with a key to genera of sabellinae Anales Instituto Patagonia (Chile). 38(2):7-29.
- Higler, L.W.G.,1992. A check-list of Trichoptera recorded from India and larval key to the Families. Oriental Insects. Vol. 26, 67-106.
- IRMNG. 2023. Pleuroceridae P. Fischer, 1885 (1863). Accessed at: https://www.irmng.org/aphia.php?p=taxdetails&id=112019 on 2024-08-16

- Jaihao, R. and Phalaraksh, C., 2013. An illustrated key to stonefly larvae (Plecoptera, Insecta) at Huai Nam Dung National Park, Thailand. RJAS Vol. 3 No. 1. 25-38.
- Jarvis, S., Hesionidae (GRUBE, 1850) - A provisional guide to the identification of the British species (Marine Invertebrate Ecological Services).
- Jehamalar, E., Kailash, C., Zettel, H., 2018. New species and first record of Helotrephes from India, and a check-list of Indian Helotrephidae (Hemiptera: Heteroptera), Acta Entomologica, 58(1): 243–248.
- Jessup, B.K., Markowitz, A., Stribling, J.B., Freidman, E., LaBelle, K., Dziepak, N., 2003. Taxonomic keys to Macroinvertebrate families found in Maryland streams. Maryland Department of Natural Resources.
- Joffe, B., I., Cannon, L., R., G., Schockaert, E., R., 1998. On the phylogeny of families and genera within the Temnocephalida, Hydrobiologia, 383, pp 263–268.
- Joshi, R., Aquatic Lepidoptera. Zoological Survey of India, Kolkata.
- Julka, J.M., 1988. The fauna of India and the adjacent countries. Megadrile: Oligochaeta (Earth worms). Haplotaxida: Lumbricina: Megascolecoidea: Octochaetidae. Zoological Survey of India, Calcutta. pp. 400.
- Kment, P., Carapezza, A., Zdeněk J., 2020. Taxonomic catalogue of the family Ochteridae with description of Ochterus papaceki sp. nov. from Socotra Island and Tanzania (Hemiptera: Heteroptera). Acta Entomologica 60(1): 23–64.
- Knezović, L., Miliša, M., Kalafatić, M., Rajević, N., Planinić, A., 2015. A key to the freshwater triclads (Platyhelminthes, Tricladida) of Herzegovina watercourses, Periodicum Biologorum, UDC. 57:61 Vol. 117 (3), pp 425–433.
- Kupriyanova, E. K., Sun, Y., Ten Hove, H. A., Wong, E., Rouse, G. W., 2015. Serpulidae (Annelida) of Lizard Island, Great Barrier Reef, Australia. Zootaxa 4019 (1): 275-353.
- Lok, A., F., S., L., Orr A., G., 2009. The biology of *Euphaea Impar* Selys (Odonata: Euphaeidae) In Singapore, Nature in Singapore 2, pp. 135–140.
- Loo, M. G. K., Ophel-Keller, K., Cheshire, A.C., 2006. Report on Development of novel methodologies for cost effective assessment of the environmental impact of aquaculture. Aquafin CRC, Fisheries Research and Development Corporation and South Australian Research and Development Institute (Aquatic Sciences), Adelaide. 116 pp. SARDI Publication No. RD03/0036-4.
- Malakauskas, D.M., S.J. Willson, M.A. Wilzbach & N.A. Som. 2013 Flow variation and substrate type affect dislodgement of the freshwater polychaete, Manayunkia speciosa. Freshwater Science 32: 862–873.
- Mandal, C.K. and Kumar, H., 2018. Annelida: Oligochaeta. In, Faunal Diversity of Indian Himalaya: 139-144 (Published by the Director, Zool. Surv. India, Kolkata).
- Mandal, C.K., 2004. Checklist of the Hirudinea (Leech) of India. Rec. Zool. Surv.India,102(1-2):41-46.
- Mandal, C.K., Poulami, P., Hasan, N., Bandyopadhyay, P.K., 2018. One new Terrestrial Leech Haemadipsa kaushiki from West Bengal, India International Journal of Advanced Research in Basic Engineering Sciences and Technology (IJARBEST). Vol.4 Issue 1, 12- 18.
- Milligan, M. R., 1997. Identification Manual for the aquatic Oligochaeta of Florida. Vol. I. Freshwater oligochaetes.
- MolluscaBase eds. (2024a). MolluscaBase. Novaculina gangetica theobaldi Hanley & Theobald, 1874. Accessed through: World Register of Marine Species at: https://www.marinespecies.org/aphia.php?p=taxdetails&id=876643 on 2024-08-13.
- MolluscaBase eds. (2024b). MolluscaBase. Corbicula alesiensis (Fontannes, 1884). Accessed through: World Register of Marine Species at: https://www.marinespecies.org/aphia.php?p=taxdetails&id=1603329 on 2024-08-13.
- MolluscaBase eds. (2024c). MolluscaBase. Unionidae Rafinesque, 1820. Accessed at: https://www.molluscabase.org/aphia.php?p=taxdetails&id=160333 on 2024-08-13.
- Morse, J.C., 2004. Insecta; Trichoptera, In: Freshwater Invertebrates of the Malaysian Region, Yule, C., N., Sen, Y., H. (Eds), Academy of Sciences Malaysia. pp. 501-544.

- Needham, K.M., 1996. An identification guide to the nymphal mayflies (Order Ephemeroptera) of British Columbia. Resource Inventory Committee, BC Ministry of Environment, Lands, and Parks, Victoria. 77 pp.
- Nesemann, H. and Sharma, G., 2012. Description of a new species of the leech family Salifidae (Odontobdella krishna sp. nov.) from the river Ganga at Patna, Bihar (India). Rec. Zool. Surv. India,111(3): 1-7.
- Nesemann, H., Shah, R., D., T., Shah, D., N., 2011. Key to the larval stages of common odonatan of Hindu Kush Himalaya, with short notes on habitats and ecology, Journal of Threatened Taxa (JoTT Communication), 3(9), pp. 2045-2060.
- Nesemann, H., Sharma, S., Sharma, G., Khanal, S.N., Pradhan, B., Shah, D.N., Tachamo, R.D., 2007. Aquatic Invertebrates of the Ganga River System-Mollusca, Annelida and Crustacea (in part), Vol.-I, first ed. Chandi Press, Kathmandu, Nepal.
- Ng., P.K.L. 2004. Crustacea: Decapoda, Brachyura. In: Freshwater Invertebrates of the Malaysian Region, Yule, C., N., Sen, Y., H.. (Eds), Academy of Sciences Malaysia. pp.311-336.
- Noreña, C., Damborenea, C., Brusa, F., 2016. Phylum: Platyhelminthes, In: Thorp and Covich's Freshwater Invertebrates, Keys to Nearctic Fauna, Thorp, J., H., Rogers, D., C (Eds.), Fourth edition, Volume II, pp 97-98.
- Orr, A., G., Butler, S., G., Hämäläinen, M., Kemp, R., G., 2004. Insecta: Odonata, In: Freshwater Invertebrates of the Malaysian Region, Yule, C., N., Sen, Y., H. (Eds), Academy of Sciences Malaysia, pp. 409-442.
- Parapar, J., Moreira, J., Barnich, R., 2019. A new species of Ampharete (Annelida: Ampharetidae) from the West Shetland shelf (NE Atlantic Ocean), with two updated keys to the species of the genus in North Atlantic waters. European Journal of Taxonomy. 531.
- Pescador, M. L., and Rasmussen, A. K., 1995. Identification manual for the caddisfly (Trichoptera) larvae of Florida by Entomology, Center for Water Quality Florida A&M University.
- Pinder, A. M. and Ohtaka, A. 2018. Annelida: Clitellata, Oligochaeta. Yule, C.M., and Sen, Y.H., 2004; Freshwater invertebrates of the Malaysian Region, pp.162-174.
- Pinder, A., 2009. Tools for identifying selected Australian aquatic oligochaetes (Clitellata: Annelida).
- Ramakrsihna, Dey, A., 2007. Hand book on Indian Fresh water Molluscs. Director Zoological Survey of India. Kolkata. Government of India.
- Rao, N.V.S., 1989. Handbook Fresh water Molluscs of India, Director Zoological Survey of India, Calcutta, Government of India.
- Rogers, D., C., 2016. Thorp and Covich's Freshwater Invertebrates, Keys to Nearctic Fauna, Thorp, J., H., Rogers, D., C (Eds.), Fourth edition, Volume II, Chapter 16, pp 432-433.
- Saetung, T., Makbun, N., Sartori, M., Boonsoong, B., 2020. The subfamily Platycnemidinae (Zygoptera: Platycnemididae) in Thailand, with description of the final stadium larva of *Copera chantaburii* Asahina, 1984, International Journal of Odonatology, 23 (3) pp. 219–237.
- Schmelz, R.M., Erséus, C., Martin, P., Haaren, T. V., Timm T.,2021. A proposed order-level classification in Oligochaeta (Annelida, Clitellata), Zootaxa 5040 (4): 589–597.
- Sewell, K. B., 2013. Key to the genera and checklist of species of Australian temnocephalans (Temnocephalida), Museum Victoria Science Reports, 17 pp 1–13.
- Sluys, R., 1989. Phylogenetic relationships of the triclads (Platyhelminthes, Seriata, Tricladida), Bijdragen tot de Dierkunde, 59(1), pp 3-25.
- Sluys, R., Kawakatsu, M., Riutort, M., Baguñà, J., 2009. A new higher classification of planarian flatworms (Platyhelminthes, Tricladida), Journal of Natural History, 43(29-30), pp 1763-1777.
- Subramanian, K., A., and Sivaramakrishnan, K., G., 2007. Aquatic Insects of India-A Field Guide. Ashoka Trust for Ecology and Environment (ATREE), Bangalore, India.
- Sundermann, A., Lohse, S., Beck, L. A., Haase, P., 2007. Key to the larval stages of aquatic true flies (Diptera), based on the operational taxa list for running waters in Germany, Ann. Limnol. - Int. J. Lim., 43 (1), pp. 61-74.
- Thyssen, P., J., 2010. Keys for Identification of Immature Insects, In: Current Concepts in Forensic Entomology, Amendt, J., Campobasso C.P., Grassberger, M.pp. 25-41.

- Timm, T., 2017. Aquatic microdrile Oligochaeta (Annelida, Clitellata): New nominal taxa and combinations since 1984., Zootaxa. 4282 (3): 401–452.
- Türkmen, G. and Kazanci, N., 2013. The key to the Ephemeroptera (Insecta) larvae in running waters of the Eastern Black Sea Basin (Turkey) with the new records. Review of Hydrobiology. 6,1: 31-55.
- Wallace, I., 2003. The Beginner's Guide to Caddis (Order Trichoptera). Bulletin of the Amateur Entomologists' Society, Volume, 62.
- WoRMS 2024. Naididae Ehrenberg, 1831. Accessed at: https://www.marinespecies.org/aphia.php?p=taxdetails&id=2039 on 2024-082.
- Wowor D., Cai, Yixiong, Ng, P.K.L. 2004. Crustacea: Decapoda, Caridea. In: Freshwater Invertebrates of the Malaysian Region, Yule, C., N., Sen, Y., H. (Eds), Academy of Sciences Malaysia. pp.337-357.
- Yang, C. M., Kovac, D., Cheng L., 2004. Insecta: Hemiptera Freshwater Invertebrates of the Malaysian Region, Yule, C., N., Sen, Y., H. (Eds), Academy of Sciences Malaysia. pp.457-490.
- Zettel, H., 1998. Introduction to the Helotrephidae (Nepomorpha) in Thailand and adjacent countries, Amemboa. 2: 15–19.
- Zwart, D. and Trivedi, R., C., 1995. Manual on integrated water quality evaluation Appendix 6, Taxonomical Key for biological water quality determination, Pp- 10-11.

Weblink

- https://www.biosch.hku.hk/ecology/staffhp/dd/macroinvertebrates/Ephemeroptera/ephemeroptera.html
- https://www.researchgate.net/publication/269109295_Calamocera_larvae
- https://midge.cfans.umn.edu/vsmivp/trichoptera/limnephilidae
- https://www.nhm.ac.uk/take-part/identify-nature/guide-identifying-common-freshwater-invertebrate-groups.html
- https://www.macroinvertebrates.org/taxa-characters/diptera-larva
- Key to Aquatic Macroinvertebrates in Utah – Diptera, extension Utah state University, https://extension.usu.edu/waterquality/macrokey/no-shell/diptera/ (Accessed on 25th April, 2023)
- Odonata, Introduction to the Odonata, Dragonflies and Damselflies, https://ucmp.berkeley.edu/arthropoda/uniramia/odonatoida.html (Accessed on 23rd December, 2022)
- Odonata, Macroinvertebrtaes.org, https://www.macroinvertebrates.org/taxa-characters/odonata-larva/gomphidae/ophiogomphus/dorsal (Accessed on 25th April, 2023)
- Platyhelminthes (Flat worms), Bugguide, https://www.mdfrc.org.au/bugguide/display.asp?type=2&class=26&Subclass=&Order=&Family=&genus=&species=&couplet=0&fromcouplet=14 (Accessed on 8th May, 2023)
- Temnocephalida, Lucid central keys, https://keys.lucidcentral.org/keys/lwrrdc/public/Aquatics/abflat/html/temnoc.htm (Accessed on 8th May, 2023)
- https://keys.lucidcentral.org/keys/lwrrdc/public/Aquatics/
- https://thebestphylumproject.weebly.com/polychaetes.html
- https://www.bumblebee.org/invertebrates/ANNELIDAPolychaeta.htm

Illustrations and Photographs Credit

1. Line drawings/sketches are from "**Guide to aquatic macroinvertebrates of the Upper Midwest. Water Resources. Center, University of Minnesota, St. Paul, MN 2004**": **Order Coleoptera (Adults):** Figs. 1a, 1b; **Order Coleoptera (Larvae):** Figs. 3a, 3c, 5, 6b**; Order Diptera** Figs. 1, 2, **Suborder Nematocera**: Figs: 1a, 1b, 5a, 8, 10b, 11, 13, 15a, 15b, 17a, 17b; **Suborder Brachycera**: Figs 1, 2, 4, 7b, 8a,11, 13; **Order Ephemeroptera**: Figs 2a, 2b, 3a, 3b, 4a, 4b, 5a, 5b, 6, 7a, 9a, 10a, 11a, 11b, 12a, 12b,13b; **Order Hemiptera:** Figs. 1a, 2c,2d,7a,10a,10b,11a,11b,12,13a ,13b**; Order Megaloptera**: Figs. 1a, 1b; **Order Odonata**: Fig. 2, **Suborder Zygoptera**: Figs. 3a, 3c, 4a,4b, 8c; **Suborder Anisoptera**: Figs. 1a, 1b, 2a, 2b, 3a, 3b, 4a, 6a, 6b; **Order Trichoptera**: Figs. 1a,1b, 2a, 2b, 3, 4a, 5a, 5b, 6a, 7a, 7b, 8a, 8b, 9a, 9b, 11a, 11b, 14a,14b, 16b, 17a,17b, 18a,18b,19, 20a, 20b, 22a, 22b, 26, 27,28, 29,30,31, 32, 33, 34, 35.

2. Coloured/ B&W photographs are from below mentioned sources:

   i. **Zoological Survey of India, Kolkata**: **Order Ephemeroptera**: Dr. Kubendran, Scientist 'D', provided Fig. 9b; **Class Bivalvia**: Dr. S.K. Sajan, PDF provided Figs. 2c, 2d, 3c; **Subphylum Crustacea:** Infraorders Decapoda: Dr. K. Valarmathi, Scientist 'E' provided key points image, Figs. 1, 2, Infraorder Brachyura: Figs. 2a, 2b, 4a, 4b, 5a, 5b**; Order Isopoda:** Figs. 1, 2, 3, 4, 5, 6a 6b; **Order Amphipoda:** Figs. 1, 2a, 2b**.**

   ii. **Entomology Division, IARI, Pusa, Delhi**: **Order Ephemeroptera**; Figs. 13a

   iii. **Websites**: https://www.macroinvertebrates.org/: **Key for Identification of Orders-** Figs. 4b, 5b, 7a, 7b, 10a, 13a, 16a; **Class Polychaeta: 7a; Order Coleoptera (Adults):** Fig. 12, 19b; **Order Coleoptera (larvae):** Figs. 2a, 3b, 6a**; Order Diptera:** Key points img: Blephariceridae; Suborder Nematocera: Figs. 3b, 4a, Suborder Brachycera Figs 3, 7a, 14a;**Order Ephemeroptera:** Figs 13a, 13b; **Order Hemiptera:** Fig 11b**; Order Lepidoptera; Order Odonata:** Key points of Order Odonata Img: Gomphidae**; Order Plecoptera:** Figs. 2, 3a, 3b, 5a, 5b, 6a, 6b, 7a, 7b; **Order Trichoptera:** Family- Hydropsychidae, Figs. 15a, 15b; https://thebestphylumproject.weebly.com/polychaetes.html**: Order Polychaeta:** Fig. 1a, https://www.bumblebee.org/invertebrates/ANNELIDAPolychaeta.html: Fig. 2; **Order Hemiptera**: Fig. 9b, https://species.m.wikimedia.org/wiki/File:Leptopus_marmoratus.jpg.

   iv. **Book:** "Freshwater Invertebrates of the Malaysian Region", Yule, C., N., Sen, Y., H. (Eds), Academy of Sciences Malaysia: (2004): **Subclass oligochaete**: Figs. 3a,3b ,4a,4b; **Order Coleoptera (Adults):** Fig. 7b, 15, 17a, 17b, 19c, **Order Diptera: Suborder Brachycera**: Figs. 8b, 10, 14b; **Order Trichoptera**: Figs. 6b, 10a, 10b, 12, 21, 23a, 23b, 24a, 24b, 25a, 25b; **Order Ephemeroptera**: Figs. 1 and 6; "Aquatic invertebrates of the Ganga River System", Dr. Hasko F. Nesemann, 1993-2000, Pg.198: **Sub-class Hirudinea :** Plate 52 (7) & Plate 50(9) : order of subclass Fig 1a and 1b.

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   vi. **Research publications/reports/thesis as listed below:**

   - **Order Polychaeta:** Fig. 1b, Brown, Shannon D. thesis entitled. "Radiole Regeneration and Branchial Crown Structure of the Feather Duster Worm, Schizobranchia insignis." (2016); Figs. 3a, 4, 5a, 5b, Loo, M. G. K., Ophel-Keller, K. and Cheshire, A.C. (Eds.) (2006). Final Report on "Development of novel methodologies for cost effective assessment of the environmental impact of aquaculture" by Aquafin CRC; Fig. 5c, Rodolfo Elías & María Silvia Rivero. 2009. Two new species of Cirratulidae (Annelida: Polychaeta) from Mar del Plata, Argentina (SW Atlantic). Zoosymposia. 2:139-148; Fig. 6, Parapar, J., Moreira, J., & Barnich, R. 2019. A new species of Ampharete (Annelida: Ampharetidae) from the West Shetland shelf (NE Atlantic Ocean), with two updated keys to the species of the genus in North Atlantic waters. Europeon Journal of Taxonomy. 531:1-16; Fig. 7a, Elena K. Kupriyanova, Yanan Sun, Harry A. Ten Hove, Eunice Wong & Greg W. Rouse.2015. Serpulidae (Annelida) of Lizard Island, Great Barrier Reef, Australia Zootaxa.4019 (1: 275-353); Fig. 7b, Maria Na Tovar-Hernandez. 2010. Taxonomic updates of the Sabellids (Polychaeta: Sabellidae) from Chile and taxa established by Prof. Ernst Ehlers, with a key to genera of Sabellinae. Anales Instituto Patagonia (Chile). 38(2):7-297.

   - **Order Hemiptera:** Fig. 7b, Jehamalar, E., Kailash, C., & Zettel, H., 2018. New species and first record of Helotrephes from India, and a check-list of Indian Helotrephidae (Hemiptera: Heteroptera), Acta Entomologica, 58(1): 243–248; Fig. 8b, Kment, P., Carapezza, A., Zdeněk J.,2020. Taxonomic catalogue of the family Ochteridae with description of Ochterus papaceki sp. nov. from Socotra Island and Tanzania (Hemiptera: Heteroptera) Acta Entomologica 60(1): 23–64; **Order Odonata (Suborder Zygoptera)** Figs. 2, 5, 6a, 6b, 8a, 8b; **Suborder Anisoptera** Figs. 4b, 5a, Nesemann, H., Shah, R., D., T., Shah, D., N., 2011. Key to the larval stages of common odonatan of Hindu Kush Himalaya, with short notes on habitats and ecology: Journal of Threatened Taxa (JoTT) communication;

   - **Phylum Mollusca:** Figs. 1, 2; **Class Gastropoda:** Figs. 1a, 1b, 2a, 2b, 3a, 4a; **Class Bivalvia:** Figs. 2a, 2e, Akolkar, P., Ahmad, I., Ahmad, F., Goel, A., Sharma, J., 2017. Benthic Macro invertebrates of River Ganga. PR Division, Central Pollution Control Board, Ministry of Environment, Forest & Climate Change, Delhi, India; **Class Gastropoda**: Fig. 3b, 5c, 5e, 5g, 5h, 6a, 7. Hand book on Indian Fresh water Molluscs. Zoological Survey of India. Kolkata. Government of India.

   - **Phylum Platyhelminthes**: Fig. 2, **Order Tricladida**: Figs. 1a, 2a, Zwart, D., Trivedi, R., C., 1995. Manual on integrated water quality evaluation Appendix 6, Taxonomical Key for biological water quality determination.

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