BENTHIC MACRO INVERTEBRATES OF RIVER GANGA

CENTRAL POLLUTION CONTROL BOARD

Ministry of Environment, Forest & Climate Change
'Parivesh Bhawan' C.B.D.Cum-Office Complex,
East Arjun Nagar, Shahdara, Delhi-110032

May 2017

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Preface

The objective of this document is to enable beginners to identify aquatic invertebrate macro fauna up to the phylum, class, order, family and generic level which is required for biological water quality evaluation of River Ganga. In this some emphasis is put on behavioral characteristics and habitat preferences which are often more useful for field workers than taxonomical and morphological characteristics. This is especially important since the identification of the animals is to take place at the sampling site under field conditions. The document includes description of method of sampling and bio-assessment, taxonomic identification characters, habitat, distribution in their biological water quality, water temperature of their habitats along with their size in terms of length, width and height for the benthic macro-invertebrates collected from various locations identified on entire stretch of River Ganga in the states of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal. A glossary of scientific terms has been provided to understand the exact description of identification characteristics. Standard field protocol to be used for bio-monitoring of River Ganga is also provided. References include documentation of bio-monitoring of surface water carried out so far in India. The contribution of Uttarakhand Environment Protection and Pollution Control Board, Uttar Pradesh Pollution Control Board, Bihar Pollution Control Board, Jharkhand State Pollution Control Board and West Bengal Pollution Control Board in association with CPCB Zonal Offices of Lucknow and Kolkata, is appreciated.

Bio-monitoring of River Ganga

SEGMENT I (Gangotri to Haridwar)

Water Uses – Drinking, Religious bathing, Hydro power generation

Latitude - 30.9800^{0}N – 29.9560^{0}N

Longitude – 78.9300^{0}E – 78.1700^{0}E

Altitude (msl) 3042 – 294.7

Average Saprobic score 7.29

Average Diversity score -0.589

Biological Water quality Class 'A'

Biological Water Quality – Clean

Indicator Colour -Blue

Contributors

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Bio-monitoring of River Ganga
SEGMENT II (Haridwar to Narora)

Water Uses – Bathing, Irrigation, Propagation of wild life and Fisheries

Latitude – 29.9560 ^{0} N – 28^0 11'59"N

Longitude – 78.1700 ^{0} E – 78^0 22'47"E

Altitude (msl) 294.7 – 174

Average Saprobic score 4.99

Average Diversity score -0.66

Biological Water quality Class 'C'

Biological Water Quality – Moderate Pollution

Indicator Colour -Green

Message

Monitoring of environmental components is an important prerequisite for pollution control activities. Over the years, environmental scientists, all over the world, are exploring the possibility of using bio-monitoring techniques to determine the cumulative effect of a list of unending pollutants on the overall health of the aquatic ecosystem. These pollutants act quite differently in mixture than individually and therefore affect the ecosystem in a synergistic manner which cannot be detected by chemical analysis alone. Biological system can integrate all environmental variables over a long period of time in terms of effects which can be easily measured and quantified by identification of affected communities of indicator species in aquatic ecosystem. To achieve such targets, knowledge of identification of key species is most important to warn for sudden change in water quality and to measure any change in structural and functional integrity of aquatic ecosystem in response to pollution. Rational formulation of any pollution control programme for a water body needs to define water quality objective (targets) in a sound scientific manner. These objectives are used to identify the areas which are in need of restoration, extent of pollution control needed, prioritization of pollution control programmes, and effectiveness of pollution control efforts. Bio-monitoring of water quality is very much useful for achieving these objectives. Central Pollution Control Board has taken such initiatives to identify and compile the key species of River Ganga for improving its water quality.

Bio-monitoring of River Ganga

SEGMENT III A (Narora to Kanpur)

Water Uses – Bathing, Irrigation, Industrial

Latitude – 28 ^{0} 11'59" N – 26.4607 ^{0} N

Longitude – 78 ^{0} 22'47" E – 80.3334 ^{0} E

Altitude (msl) 174 – 126

Average Saprobic score 5.0

Average Diversity score -0.38

Biological Water quality Class 'D'

Biological Water Quality – Heavy Pollution

Indicator Colour -Orange

Message

One of the long term objective for pollution control authorities is that all the natural water bodies should remain free from harmful effects, to man and aquatic life, caused by polluted discharges. For the regulation of effluent discharges, one should estimate the actual damage an effluent is causing to the aquatic environment. Bio-monitoring of water quality can play a vital role in effective control strategy for complex effluents. Being effective, cheaper and easy to perform, bio-monitoring methodology can help the decision makers in:

- Identifying environmental problems;
- Establishing priorities for pollution control efforts;
- Setting discharge limits for effluents;
- Identifying and implementing appropriate control measures; and
- Monitoring compliance with regulatory limits.

In developed countries AQUALARM have been used to restore animal and plant life, from the sudden deterioration in water quality. Bio-monitoring is an important tool which can help in determination of the impacts on aquatic ecosystem due to various reasons including: non - availability of water in non-monsoon periods, low oxygen conditions and eutrophication, high Fecal Coliform numbers, presence of heavy metals and pesticides, elimination of sensitive species and damage due to autochthonous and allochthonous pollution. Initiatives of Central Pollution Control Board on validation of bio-monitoring methodology on various other rivers in India over last two decades, has ultimately resulted in to formulation of action plan for improvement in water quality of River Ganga.

Bio-monitoring of River Ganga

SEGMENT III B (Kanpur to Allahabad)

Water Uses – Religious bathing, irrigation

Latitude – 26.4607^0 N – 25.4500^0 N

Longitude – 80.3334^{0}E – 81.8500^0 E

Altitude (msl) 126 - 98

Average Saprobic score – 5.12

Average Diversity score – 0.66

Biological Water quality Class – C

Biological Water Quality – Moderate Pollution

Indicator Colour – Green

Message

Generally, the water quality management is related to identified beneficial uses of water. If a water body is put to multiple use, then the use which demands the highest quality of water is called the designated-best-use. Measurement of chemical and physical and bacteriological characteristics have been used so far either to detect pollution or to control it. Biological effects often occur at concentrations below analytical capabilities. Many of the pollutants are present in such low concentrations that instrument sensitivity is too poor to determine the micro quantity of pollutants. Biological monitoring of water quality could be useful for assessing the overall health of water bodies if some problems of rivers in India, could be solved. These problems are related to great annual variation in flow due to heavy monsoon in limited period, unstable river bed causing regular flushing of biotic communities, sudden flushing of rivers, in wake of agricultural development, the rivers are being trapped at several places and in dry weather not allowed to flow in the downstream which breaks the continuity of the river and destroy lot of habitats, sudden flushing of deposited pollutants in the vicinity of major pollution outfall causing great damage to the ecosystem, human activities, including cattle wading and water melon farming, brick industries etc damage the habitat of the flood plain of rivers. Bio-monitoring is a highly specified methodology and needs to be performed during biologically mature period of a year to get fruitful results. The entire biological system established during non-monsoon period is flushed because of the floods, After the monsoon receded, the biological system starts reestablishment. After gradual succession, “mature “ecosystem” establishes which is the appropriate time for bio-monitoring. To understand the life cycle pattern, taxonomical identification of biological community is essential. The contents of this book not only elaborate the characters but also its distribution in various habitats and will be useful to compare the benthic fauna of River Ganga, in the years to come.

Bio-monitoring of River Ganga
SEGMENT III C (Allahabad to Varanasi)

Water Uses – Religious bathing
Latitude – 25.4500^0 N – 25.2820^0 N
Longitude – 81.8500^{0}E – 82.9563^0 E
Altitude (msl) 98 - 81

Average Saprobic score – 4.8
Average Diversity score – 0.75
Biological Water quality Class – 'C'
Biological Water Quality – Moderate Pollution
Indicator Colour - Green

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FOREWORD

The aquatic ecosystems consist of several components and almost all these components are affected directly or indirectly by pollution. For evaluation of water quality, some of these components can be used as bio-monitoring parameters. The planktonic organisms in a river system cannot be used as indicator of water quality. They are generally not native of the place of their growth due to their passive movement in flowing waters. The Central Pollution Control Board (CPCB) has tried several methods for evaluation of biomonitoring during the development and testing of bio-monitoring methodology under the Indo-Dutch project way back in 1988-1994, and finally established that the inclusion of bio-monitoring parameters apart from physico-chemical parameters, for water quality monitoring network, will enhance the quality of evaluation in a cost effective manner. Among all the biotic components of river, the benthic macro-invertebrates have been considered and adopted as the most suitable biological parameter in terms of evaluation of saprobic score and diversity for water quality assessment. The precision in the methodology depends entirely on the taxonomy for identification of Benthic macro-invertebrates. To begin with, attempts have been made to collect and identify benthic fauna of macro invertebrates of River Ganga for its water quality assessment. This will help the users to find out the health of River Ganga.

(Arun Kumar Mehta)

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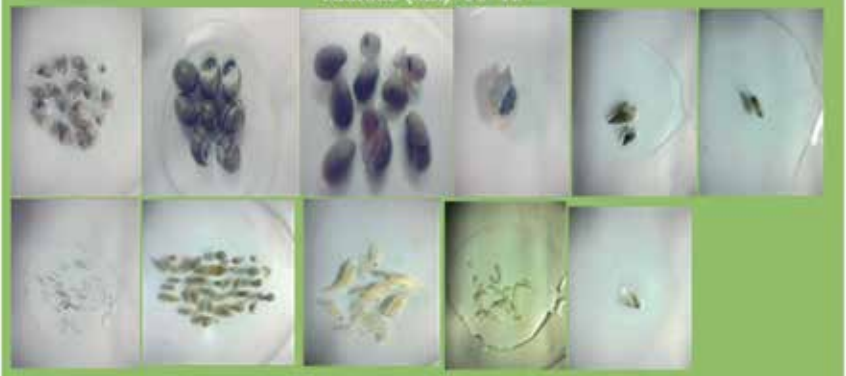
Bio-monitoring of River Ganga
SEGMENT IV (Varanasi to Garden Reach, Howrah)

Water Uses – Religious bathing
Latitude – 25.2820^0 N – 22.5900^0 N
Longitude – 82.9563^{0}E – 88.3100^0 E
Altitude (msl) 81- 12



Average Saprobic score – 5.37
Average Diversity score – 0.35
Biological Water quality Class – 'C'
Biological Water Quality – Moderate Pollution
Indicator Colour – Green

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1 INTRODUCTION TO BIO-MONITORING

Water quality management system based on physical and chemical parameters is not sufficient to assess the quality status in terms of the "health of a water body". Over the years, it has been realized that the inclusion of biological parameter will enhance the quality evaluation in cost-effective manner. Among all the biotic components, benthic macro-invertebrate communities have been considered as the most suitable biological parameter to assess the health of surface water bodies. In Germany, bio-monitoring has been practicing for almost 100 years, for effective water quality assessment. The maps drawn based on bio-monitoring have proved as a powerful tool; for preparation of action plan for control of pollution and for improvement of water quality of rivers. Biological monitoring provides an effective, easy to understand, less time consuming and cost-effective method to determine cumulative impact of pollution in surface waters in India. Use of benthic macro-invertebrates for bio-monitoring is based upon community effects and the most frequent response of a community which is expressed in terms of Saprobic score and Diversity score for determination of biological water quality using Biological Water Quality Criteria. Bio-mapping of River Ganga will help in evaluation of the performance of action plan to control industrial and domestic pollution contributed to River Ganga. The benthic macro-invertebrates have been collected from river stretch of Uttarakhand, Uttar Pradesh, Bihar, Jharkhand and West Bengal during the year 2014, 2015 and 2016.

1.1 Bio-Monitoring of River Ganga

The Ganga basin accounts for a little more than one fourth (26.3 %) of the country's total geographical area and is the biggest river basin in India, covering the entire states of Uttarakhand, Uttar Pradesh, Bihar Jharkhand, Delhi, parts of Punjab, Haryana, Himachal Pradesh, Rajasthan, Madhya Pradesh and West Bengal. The main river stream originates in the northern most part of Uttarakhand, flows through Uttar Pradesh, Bihar Jharkhand and West Bengal and finally drains into the Bay of Bengal. River Ganga is the longest river (2,525 km) and has largest river basin (861,404 km^2) in India. Rising from the icy caves of Gangotri glacier at the height of 4255 above mean sea level, River Ganga starts its long journey in Himalayan segment to join River Alaknanda and becomes River Ganga near Devprayag. The Bhagirathi and the Alaknanda originate from the opposite sides of the Chaukhamba peak (7,138 m). After flowing in the opposite directions they bend towards Devparayag, forming a garlanded shape. According to Hindu mythology, River Bhagirathi is the actual Ganga, through the name of

Ganga, is assumed only after the river Bhagirathi meets river Alaknanda at Devprayag. The Alaknanda and the Bhagirathi after joining at Devparayag, is conclusively called the Ganga and it finally descends into the plains at Haridwar. The main stretch of River Ganga runs from Rishikesh, Haridwar to Allahabad through over Nagal, Bijnor, Garhmukteshwar, Hasanpur, Anupshahar, Narora, Sahaswan, Kasgang, Ptiali, Kampil, Kaimgang, Fatehgarh, Kannauj, Bithur, Brahmavart, Kanpur and finally Allahabad. At Allahabad, it joins with a major tributary River Yamuna and thereafter passing through Varanasi in Uttar Pradesh, Bihar, Jharkhand and at Ganga Sagar in West Bengal, it joins Bay of Bengal. River Ganga has got very important place in Indian culture and tradition. It is lifeline of majority of population in cities, towns and villages located all along its bank. Deterioration in water quality of River Ganga, over the past several years, has gradually rendered the river water quality unsuitable for various beneficial purposes such as drinking bathing, propagation of wild life and fisheries etc. For maintaining the water quality of River Ganga, the pollution levels have been detected by monitoring limited number of physical and chemical parameters which could only determine the change in chemical characteristics of river water. The objective of the Water Act, 1974 is to maintain and restore the wholesomeness of river water in terms of ecological sustainability. In recent years, bio-monitoring has proved as a powerful tool for preparation of action plan for control of river pollution and to assess the improvement in water quality. Among all the biotic components of river, benthic macro-invertebrate fauna are extremely sensitive to change in water quality. Their population is among the first to show decline as a result of habitat degradation. River Ganga from its upstream to downstream reaches passes through a variety of habitats such as, riffle, slack, run, depositing, eroding, and turbulent and pool conditions due to a number of factors such as; altitude, river bed substratum, confluence of tributaries, depth, flow velocity etc. Thus, the entire stretch of River Ganga can be viewed in to three different ecological segments **(Table 1)**.

Table 1: Ecological Characterization of River Ganga

Ecological variables	Characterization of Ecological segments		
	Himalayan segment	Middle segment	Lower segment
River stretch	Gangotri to Dev Prayag	Kaudiyala to Haridwar	Bijnor to Howrah
Designated best use	Drinking water source without conventional treatment but after disinfection.	Outdoor bathing (Organized)	Propagation of Wild Life and Fisheries and Irrigation
Latitude	30.9800^{0}N -30.1463^{0}N	30.1070^{0}N-29.9560^{0}N	28.8000^{0}N-22.5900^{0}N
Longitude	78.9300^{0}E-78.5983^{0}E	78.2990^{0}E-78.1700^{0}E	78.1000^{0}E-88,3108^{0}E
Altitude (MSL)	3042-830	372-294.7	223-12

2 METHODOLOGY OF SAMPLING AND ANALYSIS OF BENTHIC MACRO-INVERTEBRATES

The purpose of this methodology is to lay down uniform and reliable method for sampling and analysis of benthic macro-invertebrates for bio-monitoring of fresh water bodies. This method of bio-monitoring is based on saprobic and diversity score analysis for benthic macro-invertebrates of fresh water bodies. Benthic macro-invertebrates are considered as most suitable biological parameter for water quality evaluation. This prescribes the methods of sampling and analysis of benthic macro-invertebrates of fresh water bodies. This method is applicable for bio-monitoring of all fresh water bodies for water quality evaluation.

Sampling Methods

Different methods of sampling for biota may be adapted depending upon nature of water bodies:

- Methods that extract and separate the organisms from their habitat (which at the same time will be disturbed).
- Methods that remove an undisturbed part of the habitat from which the organisms are then extracted.
- Various artificial experimental designs like; artificial substratum from which the biota are collected.

Rough Estimation of Substratum Composition (%)

An arbitrary assumption is made on river bed substratum type by selecting roughly one kilometer river stretch having almost uniform ecological conditions at sampling location on possibly both the river banks. The substratum of water body may be composed of boulders with size of >256 mm, cobbles 255-64 mm, pebbles 63 – 16 mm, gravel 15 – 2 mm, sand 0.0625 mm, silt 0.002 mm and clay <0.002 mm. Detritus and macrophytic vegetation on the bank is also included as a substratum for benthic macroinvertebrates. Artificial substratum may be used in water bodies such as canals etc.

Sampling Devices

Benthic macro-invertebrate fauna in water bodies are normally collected by adopting a variety of techniques for bio-monitoring. For determination of saprobity indicated by benthic fauna, it is sufficient to sample qualitatively. But, for the diversity evaluation of benthic biological community, it requires a more or less quantitative methodology. To obtain such evaluations, wide

ranges of sampling devices are used depending upon the nature of substratum of a water body.

Hand Nets and D-Nets are used in water bodies with swift and moderate current velocity and water depth of less than 1 m. The biological samples may be collected from boulders, large stones, gravel, sand, mud and compacted substrates, directly into hand net. For collection of benthic animals, the net is placed firmly on to the stream substratum against the water flow. Standing before the net, the stream bed is kicked up by foot and the animals collected into the net. The exercise is repeated at different sites at same location.

Shovel Sampler - Shovels of smaller to bigger sizes are locally available. Such samplers are normally used for water bodies, having gravel, sand, mud and compacted substrate type of substratum and in water depth of less than 1 m.

Surber Sampler - Surber sampler is specially designed for quantitative survey of benthic animals. They are used in shallow water bodies of less than 1 m depth with swift and moderate current velocity and having boulders, large stones or gravel type of substratum.

Eckman Grab - This sampler is usually used for water bodies with more than 1-3 m depth with very slow and static current velocity. Grab sampler can be used for gravel, sand and mud type of substratum in a water body.

Excavator - Use of excavator for sampling in deep water and higly polluted water bodies and also in water bodies with no proper approach/slope on the shore.

Artificial Substratum - Use of artificial substratum for bio-monitoring of water bodies provide a quantitative approach to bio-monitoring. It provides establishment and collection of animals along the river, lakes, canals or water bodies, where it is difficult to collect benthic animals in very deep waters with strong currents. It helps in establishing biological communities in an area where;

- varied flow conditions are prevailing
- there is non-availability of proper substratum
- the substratum is unstable like sandy bed
- constant alterations in substrate condition of water body due to human interferences like cattle wading, mass bathing etc.
- it can be used for bio-monitoring during monsoon period when the rivers and canals are in floods.
- the effects of shock load of pollutants leading to an abrupt change in water quality.

Hand Picking - The animals which are attached to the small stones and rocks in shallow water body of less than 0.5 m depth of water with swift and moderate current velocity, can be picked up by hand with the help of forceps and needle. In mountainous streams and shallow rivers, these animals also construct attached cases, tubes or nets where they live. Their free living forms also inhabit under or over the stones, rocks, organic debris and other substrate during all or part of their life cycle.

Water Plants - The macro-invertebrates can also be collected from the water plants attached to any substratum in a shallow water body with swift and moderate current velocity. The plants are uprooted and washed directly in white tray or in the net to collect animals.

Sorting of Animals

The methods of sampling described above are adequate to collect aquatic macro invertebrates in most habitats. The collected sample needs to be sieved for separating the animals from the substratum. Materials collected by any of the sampling device should be placed on a sieve and then washed. Usually, US Standard sieve No. 30, with a pore size of 0.6 mm is used to retain the organisms. Mud or very fine sand will pass through the sieve leaving the organisms behind. However, the substrate of coarse sand, rock or organic detritus will not pass through the sieve. In such cases, the material is placed in a bucket or tub to which water is added, the mixture is stirred and the excess water is poured through the sieve. Light organisms will pass on to the sieve while heavy forms of benthic fauna remain in bucket or tub.

Organisms can be picked up from the sieve with the forceps and then be placed in an identification tray or collection bottle containing water. Another way to remove the organisms from the sieve is to concentrate them at one edge of the sieve by gently swirling the sieve in a little quantity of water and the sieve is tilted over a wide-mouth bottle, gently back-flushing water through the mesh. The organisms are flushed into the bottle.

Sampling Frequency

For allowing spatial and temporal comparison of the biota, all biological samples of a water body at different locations must be taken in the same season to minimize seasonal variations resulting from life cycle changes and annual hydrological variations. There is marked variation in biotic composition due to intermittent release of water from dams and barrages. Hence, the period followed by such releases should be avoided, if possible. The sampling should be done on monthly basis, covering biologically active period of the year (October-May), excluding monsoon and post monsoon periods for bio-monitoring on natural substratum. The sampling frequency

may be continued throughout the year at locations, where bio-monitoring is carried out through artificial substratum.

Sampling Area

Normally, organisms are not randomly distributed on river bed. Different habitats support different densities of specific organisms. Therefore, it is desirable to cover large river bank area (at least 1 km.) at each sampling location. Monitoring through artificial substratum, if used as at proper location, overcomes the difficulties of sampling a large area on river bed, and represents the bio-diversity of entire habitat of sampling location on water body.

Number of Samples

Sufficient number of samples should be taken from each sampling station on a natural substratum of water body whereas; only one sample of artificial substratum is enough for water quality evaluation. A maximum of 250 of specimen may be collected from each location in order to obtain reliable and meaningful information on saprobic and diversity score.

Preservation

Preferably, the identification of species present, together with evaluation of saprobity and diversity score, is carried out at the sampling site. During unfavorable conditions and for verification purposes, the animals can be preserved with formalin or alcohol in wide mouth polyethylene bottle of 500 ml capacity. For bio-accumulation study, the animals should be preserved in ice.

Note: *Formalin is a toxic compound. Avoid contact with bare skin specially the eyes and prevent inhalation of the fumes.*

Analytical Procedure for Saprobic Score

Saprobic score is calculated by making an evaluation for presence or absence of representative species of the selected taxonomic families of organisms, identified as indicative organism for degree of saprobity in the system. The modified BMWP score chart as presented in the field protocol (Annexure I) may be used. The samples, which are collected and sorted as per the aforementioned procedures are used to evaluate the saprobic score as follow;

- Record all the species which can be identified at site from the composite sample of various habitats. This can be accomplished by using a number of petri-dishes initially for sorting the animals according to their taxonomical order or

class, followed by segregation to their families and eventually a detailed comparison of individuals within common family. The detailed information can be stored in the pre-printed field protocol.

- The animals are released back into the river at the end of evaluation. For verification and study purpose, the unidentified animals may be carried to the laboratory.
- The encountered species provides a score according to the values indicated in the protocol and also their abundancy is specified.
- The scores for all the species encountered are averaged to provide final BMWP saprobic score.

Analytical Procedure for Diversity Score

Bottom fauna vary greatly according to their sensitivity to various types of environmental conditions. Unpolluted water support large numbers of species of bottom fauna. The introduction of pollution reduces the number of species by eliminating those species/individuals sensitive to the pollutant, until the survival of those organisms that can thrive in adverse conditions. The survivors increase their number because of lack of competition among species, till the amount of food and space is available. This results in reduction of diversity in benthic community. The bottom macro-invertebrates collected at sampling station for evaluating saprobity is used for evaluation of diversity score as follows:

- The diversity score is calculated by segregating the macro-invertebrates from the sediment and they have to be immobilized by adding few drops of 90% alcohol.
- The macro-invertebrates are randomly distributed in a flat white enamel or plastic tray with square lines on the bottom. The square lines help the investigator undertaking sequential comparison of each organism.
- When less than 250 organisms are collected either from natural or artificial substratum, the sequential comparison for diversity score evaluation is performed on the entire collection. Following steps are followed, if the collection contain more than 250 organisms:
  - (a) Determine the number of runs for the first 15 specimen of macro-invertebrates.
  - (b) Calculate the diversity with number of runs/15 specimen.

(c) Plot graph of diversity score against the number of organisms examined (blank graph annexed in field protocol).

(d) Analyze the next 15 specimens.

(e) Determine the total number of runs for 30 specimens examined and plot the graph.

(f) Repeat this procedure with an increment of 15 specimens until the curve becomes asymptotic. Further continuation of the procedure will produce an insignificant change in diversity score value. At this point, enough specimens have been examined for water quality evaluation.

(g) Occasionally, the diversity of benthic animals may be low due to excessively abundant animals among the presence of rare, scarce and commonly abundant animals. Under such circumstances, score all the rare, scarce and common animals in the beginning when scoring diversity. Thus, the final scoring of such sample is ascertained at maximum diversity.

(h) Normally, high diversity of benthic animals always supports good quality of water. However, diversity alone cannot indicate the overall health of water body. High and low diversity could be of animals tolerant, or sensitive to pollution. Thus, for biological water quality evaluation, the diversity score of benthic animals is always compared with the saprobic score.

Calculation

$$\text{Saprobic Score (BMWP)} = \frac{\text{Grand total multiplied score}}{\text{Grand total of families encountered}}$$

$$\text{Diversity Score} = \frac{\text{Number of runs (sum of all 1's)}}{\text{Number of organisms (sum of all 0 and 1's)}}$$

Biological Water Quality Criteria (BWQC) for Evaluation of Water Bodies

Central Pollution Control Board (CPCB) has derived a Biological Water Quality Criteria (BWQC) for evaluation of water bodies. This criteria has been developed from the combination of different ranges of saprobic score

with the diversity score of the benthic macro-invertebrate families with respect to water quality. The system has been developed after making a calibration study on the saprobity and diversity score data of benthic macro-invertebrate families, collection from various water bodies used for the bio-monitoring through artificial as well as natural substratum. The system can be made applicable for evaluation of all the natural water bodies also. To make reliability of the results, the BMWP score and the diversity score of natural and artificial substratum in water bodies having same water quality can be compared though BWQC.

One of the advantages of using BWQC for water quality evaluation is that it can be done by simple scoring of indicator species or their presence and absence can easily indicate the water quality without involving any statistical analysis. The biological responses in an aquatic ecosystem are not independent parameter. They are exposed and influenced by multiple environmental factors. Therefore, the statistical analysis of biological data sometimes leads to incorrect and erroneous conclusions, as far as the morphological and physiological response of a biological system is concerned.

The entire range of the saprobity score from 1 to 10 in combination with the range of diversity score from 0 to 1 has been classified into five different classes of water quality to indicate changes in water quality with different grades of pollution level. Abnormal combination of saprobity with diversity range indicates sudden change in environmental conditions, physical disturbances in natural or artificial substratum and abrupt change in water quality due to pollution **(Table 2)**.

Table 2: Criteria for Biological Water Quality Evaluation

Range of Saprobic Score (BMWP)	Range of Diversity Score	Water Quality	Water Quality Class	Indicator Colour
7 and more	0.2 – 1	Clean	A	Blue
6 – 7	0.5 – 1	Slight Pollution	B	Light Blue
3 – 6	0.3 – 0.9	Moderate Pollution	C	Green
2 – 5	0.4 & less	Heavy Pollution	D	Orange
0 – 2	0 – 0.2	Severe Pollution	E	Red

The range of diversity for the benthic animals having highest saprobic value, in class 'A' waters, is very wide because their preference to the water quality is limited only in clean waters. Any adverse environmental conditions to minimum level will eliminate the most sensitive organisms. On the contrary,

the range of diversity for the animals having very low saprobic value in class ‘C’ waters is very narrow where only the abundance of pollutant tolerant animals can thrive and their number increases with a very high load of pollution in a water body. Other bottom fauna that can tolerate moderate pollution loads generally occur in the intermediate zone of class ‘C’ water body. With this concept, the saprobity and diversity of the benthic macro-invertebrate families have been classified into 5 different classes such as A, B, C, D & E. Different degrees of water quality deterioration are thus indicated in general terms like clean, slight pollution, moderate pollution, heavy pollution and severe pollution. To translate this information on a river map, the water quality classes can also be distinguished by means of colour comparison such as Blue, Light Blue, Green, Orange and Red.

3 CLASSIFICATION OF FRESH WATER BENTHIC MACRO-INVERTEBRATES OF RIVER GANGA

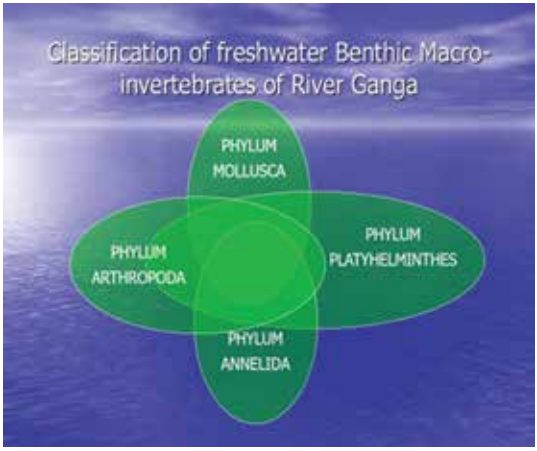

Figure 1 : Classification of Benthic Macro - Invertebrates

BENTHIC : Bottom inhabiting

MACRO : Macroscopic, can be seen through naked eye.

INVERTEBRATES : Aquatic animals without vertebral column.

3.1 Phylum Mollusca

- Macro invertebrates usually with a hard calcareous shell and lacking extremities.

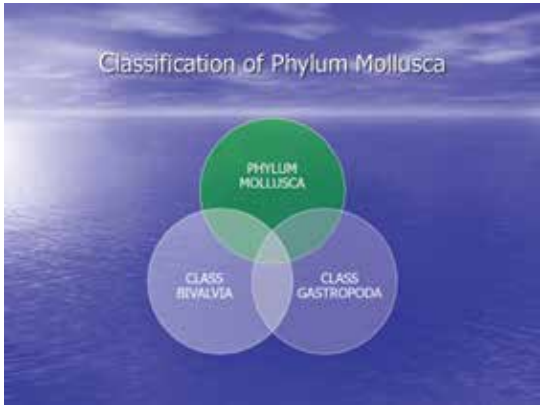

Figure 2 : Classification of Phylum Mollusca

3.1.1 Class Bivalvia

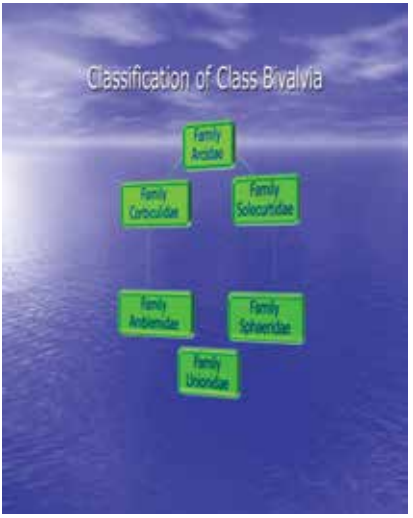

Figure 3 : Classification of Class Bivalvia

3.1.1 Class Bivalvia

- With two valves or shell halves joined by a hinge.

3.1.1.1 Family Corbiculidae

- Shell thick and large may be small or shell thin and sub-triangular.
- Periostracum brownish, striae regular/periostracum dark orange or brown or light shiny yellow.
- The shell surface may appear to be smooth, with striae microscopic In some outline more ovate.
- Adults may be ≥12 mm length or ≤12 mm length, lives in fine sand substrate, pollution-sensitive species of lotics and prefer sand and mud substrate.
- Occurs in various types of rivers, streams and lakes.
- Prefer fine gravel, sand or mud substrate.

3.1.1.1.1 Corbicula assamensis (Plate 1, Figure 1, 2)

Characters:

- Shell thick and small.
- Periostracum light shining yellow and brown.
- Striae regular.

Distribution: *Corbicula assamensis* was collected from River Ganga at Barawali railway and road bridge in Bijnor district, barrage at Narora, Kachlaghat bridge at Badaun, near bridge at Bithur, barrage at upstream Kanpur, bridge near Fatehpur, bridge SH-74 upstream Varanasi, Vindhyachal Ghat at upstream of Mirzapur and downstream of Mirzapur in Uttar Pradesh. Its presence was also observed in River RamGanga upstream and downstream of Moradabad, River Yamuna at NH-27, River Tons near Panasa and River Gomti at Rajwari. The animal was collected during the period of December 2014 to May 2015.

Habitat: *Corbicula assamensis* preferred a water temperature ranging from 10.5°C - 26°C and mainly substratum composition of 2 – 50% sand, 3 - 30 % silt, 5 – 80% clay, 5-55% detritus and 5 -80% macrophytic vegetation. The size of the collected individuals were found to be in the range of Length from 5.9 – 22.9 mm, width from 4.8 – 18.8 mm and height of 2.9 – 13.00 mm. Biological Water Quality Assesment has indicated that this animal prefers moderately polluted biological water quality in River Ganga.

3.1.1.1.2 Corbicula striatella (Plate 1, Figure 3)

Characters:

- Shell thick and large.
- Periostracum brownish.
- Striae regular.

Distribution: *Corbicula striatella* was collected from River Ganga at Narora in Aligarh, Kachlaghat bridge at Badaun, Bithur, Barrage at upstreamKanpur, bridge near Fatehpur, bridge on Allahabad bypass, bridge upstream of Varanasi city and Vindhyachal Ghat situated at upstream of Mirzapur and Tarighat downstream of Ghazipur. Its presence was also recorded in River Yamuna near Rajapur, River Tons near Panasa and River RamGanga downstream of Moradabad in Uttar Pradesh. *C. striatella* was collected during the months December 2014 to May 2015.

Habitat: Water temperature of *C. striatella* habitats ranged between 11°C – 26 °C. The substratum composition at the locations on water bodies where this animal was found, consisted of 2 – 70% of sand, 3-25% of silt, 5-80% of clay, 5-55% detritus and 5-60% of macrophytic vegetation. The size of the collected individuals were found to be in the range of length from 5.0 – 13.0 mm, width from 4.2 - 11.0 mm and height in the range of 2.3 – 6.9 mm. The Biological Water Quality of the habitats of *C. striatella* was found to be moderately polluted.

3.1.1.1.3 Corbicula bensoni (Plate 1, Figure 4)

Characters:

- Shell thin and sub-triangular.
- Periostracum dark orange-brown.
- The shell surface appears to be smooth.
- Striae microscopic.

Distribution: The abundance of *Corbicula bensoni* was restricted to stretch of River Ganga at Kachla Ghat in Badaun, Bithur in Kanpur, at bridge upstream of Varanasi near bridge, major bathing ghat 1 in Varanasi city and at Tarighat downstream of Ghazipur in Uttar Pradesh. The presence of this Bivalve was also observed in West Bengal near Farakka Barrage and at a location downstream of Nabadwip in Nadiya district. The animal was collected from different locations during the time period of December 2014 to May 2015.

Habitat: Water temperature of River Ganga, at the locations where *C. bensoni* was collected, recorded from 17°C - 35°C. It was collected from 5% boulder present at bathing ghat 1 in Varanasi. At other locations the substratum composition of River Ganga was found to be 5 - 40 % of sand, 5 - 30% of silt, 5 - 80% of clay, 5 - 10% detritus, 35 - 60% of Macrophytic vegetation. The size of animal collected from the bio-monitoring sites ranged from a length of 5.0 – 17.5 mm, width of 3.8 – 14.0 mm and height from 2.0 – 9.8 mm. This animal preferred the habitat having biological water quality ranging from slight pollution to moderate pollution.

3.1.1.2 Family Amblemidae

- Shell rounded or elongated, thick shelled and heavy with very strong hinge plate bearing prominent and furcated pseudocardinal teeth and slightly curved lateral teeth.
- They are often divided into a variable number of smaller accessary teeth in each valve.
- The hinge plate is slightly or significantly bent.
- The umbones are directed dorsally.
- Periostracum red-brownish, often yellow, brown, brown. Found in sand, gravels, mud and silt of running low land waters and may be between natural rocks also.

3.1.1.2.1 Parreysia corrugata laevirostris juvenile (Plate 1, Figure 5, 6)

Characters:

- Adult length 49.5-64.2 mm, height 30.8 -41.2, width 21.0 - 28.3 mm.

- Shell oval, thick shelled and heavy with strong hinge plates bearing furcated pseudocardinal teeth and straight lateral teeth.
- They are less prominent than *P. favidens*.
- The hinge plate is not typically bent, like in *P. favidens*.
- Umbones less prominent.
- They are more directed dorsally.

Distribution: This bivalve has very low abundance in River Ganga and its presence was seen only at two locaitons at bridge near Fatehpur and Tarighat downstream of Ghazipur in Uttar Pradesh. The animal was collected in February – March 2015.

Habitat: *P. corrugata laevirostris* was found to be surviving in habitats with water temperature in the range of 16°C to 25°C with substratum at the above mentioned locations was found to be composed of 5 - 20% of sand, 10 – 25% of silt, 10 – 70% of clay, 0.5% detritus and macrophytic vegetation in the range of 10-40% of the local substratum. The size of animals ranged from a length of 6.0 – 14.0 mm, width 4.0 – 10.0 mm and height of 2.7 – 5.5 mm. These animals preferred the location with biological water quality of moderate pollution.

3.1.1.2.2 Parreysia virudula (Plate 1, Figure 7, 8)

Characters:

- Shell similar to *P. favidens* but much shorter.
- Umbones shifted more into the center,
- Periostracum dark with strong greenish brown colour.

Distribution: *Parreysia virudula* species was observed in River Ganga at bridge near village Mahewa Kalan Kachart at Dengurpur, downstream Allahabad in Uttar Pradesh during the month of February, 2015.

Habitat: *P. virudula* was found surviving in the water temperature at the time of collection on the site at 19°C. The substratum composition of the collection site was observed containing 5% sand and silt, 75% clay, 5% of detritus was also observed with 10% composition of Macrophytic vegetation. The animal size was found to be ranging from a length of 27.7 – 51.9 mm, width of 19.8 – 34.2 mm and height of 12.5 – 21.7 mm. The biological water quality on the site was found to be moderately polluted.

3.1.1.2.3 Parreysia favidens favidens juvenile (Plate 1, Figure 9)

Characters

- Shell rounded, thick shelled and heavy with very strong hinge plate bearing prominent and furcated pseudocardinal teeth and slightly curved lateral teeth.

- They are often divided into a variable number of smaller accessory teeth in each valve.
- The hinge plate is slightly bent.
- The umbones are directed dorsally.
- Periostracum red- brownish.

Distribution: The juveniles of this species were found in River Ganga stretch between bridge at Ramnagar Road near Varanasi to Tarighat downstream of Ghazipur in Uttar Pradesh. The animals were collected during the months of March to May in the year 2015.

Habitat: *P. favidens* favidens juvenile was found at locations having water temperature on the site of collection ranging from 22°C - 25°C and substratum composition containing 15 – 20% of sand, 25 – 30% of silt, 10% clay, detritus in the range of 5-45% and macrophytic vegetation around 40%. The size of animals was found to be ranging from a length of 4.9 – 27.5 mm, width of 3.0 – 21.8 mm and height in the range of 2.0 – 13.9 mm. The biological water quality preference of these animals was found to be moderately polluted at the observed locations.

3.1.1.2.4 Parreysia favidens favidens (Plate 1, Figure 10)

Characters:

- Shell rounded.
- Thick shelled and heavy with very strong hinge plate bearing prominent and furcated pseudocardinal teeth and slightly curved lateral teeth.
- They are often divided into a variable number of smaller accessory teeth in each valve.
- The hinge plate is slightly bent.
- The umbones are directed dorsally.
- Periostrachum red-brownish and greenish.
- Habitat is sand, gravels, mud and silt of running lowland waters.

Distribution: *Parreysia favidens favidens* adult animals were found at bridge near Danapur in Patna, Bihar and Katwa in West Bengal and another location in Bihar near confluence of River Ganga with a Nalla 3b at Patna. The sampling was done on the above mentioned sites in the month from March to May 2015.

Habitat: *P. favidens favidens* was found in the water temperature ranging from 22°C - 25°C and substratum composition of 15 – 20% sand, 25 – 30%

silt, 10% clay, 5 – 45 % detritus and 40% of macrophytic vegetation. The size of the adult animals ranged from a length of 26.0 – 45.4 mm, width of 20.0 – 30.0 mm and height ranging from 11.0 – 24.0 mm. The biological water quality preferred by the species was found to be moderately polluted at all locations.

3.1.1.2.5 Parreysia triembolus (Plate 1, Figure 11, 12, 13)

Characters:

- Very heavy and thick-shelled.
- Umbones prominent and shifted anterior, posterior part angular.
- Cardinal and lateral teeth accompanied by additional strong accessory teeth.
- Periostracum orange to blue.
- Habitat is slowly running lowland-streams.

Distribution: *P. triembolus* bivalves were observed once in River Gomti at Rajwari in Uttar Pradesh in the month of March 2015.

Habitat: This animal was found in a water temperature of 26°C with a substratum composition of its habitat having 20% sand, 25% silt, 10% clay, 5% detritus and 40% Macrophytic vegetation. The observed animal had a body length of 52.0 mm, width at 38.0 mm and height recorded as 24.3 mm. The biological water quality at the site was classified as moderately polluted.

3.1.1.2.6 Radiatula pachysoma (Plate 1. Figure 14)

Characters:

- Shell elongated triangulate with wedge-shaped posterior end.
- Umbones prominently inflated.
- Lateral teeth rather long and straight.
- Periostracum deep greenish brown.

Distribution: This bivalve was observed once in River Ganga at Bithur near Kanpur in Uttar Pradesh. The animal was observed at the sampling location in the month of January 2015.

Habitat: At the particular location the animals Were found to prefer the habitat with water temperature at 19°C in the river bed composed of roughly 5% sand and silt, 80% clay and 10% of detritus material. The biological water quality at the site in Bithur was classified as modertaly polluted. Length of the observed animal was recorded as 46.0 mm, width at 23.2 mm and observed height was 16.9 mm.

3.1.1.2.7 Radiatula occata juvenile (Plate 1, Figure 15)

Characters:

- Shell short oval, very much compressed.
- Umbones not inflated and almost fattened.
- Anterior portion very short, rounded and dorsal margin here sharply bent into ventral direction.
- Lateral teeth rather short and straight.
- Peristracum is yellowish brown, even in adults lighter than in other members of this genus.

Distribution: The juvenile individuals of *Radiatula occata* were observed at various locations of River Ganga such as at Brijghat at Garhmukteshwar, bridge at Anupsahar, kachlaghat at Badaun, and Bithur near Kanpur in Uttar Pradesh. The juvenile animals were observed on the above mentioned locations during December 2014 to January 2015 duration.

Habitat: The recorded water temperature at the locations at the time of monitoring was between 17°C – 19°C with the substratum supporting the animals consisting of 5 - 90% of sand, 4 - 10% of detritus and 35% of macrophytic vegetation on the river bed. The size of the observed individuals of this bivalve ranged from a length of 4 – 16.5 mm, width of 2.0 to 9.0 mm and height of 1.4 mm to 5.0 mm. The analysis for biological water quality at the sites where these animals were observed was found to be moderately polluted water in River Ganga.

3.1.1.2.8 Radiatula occata (Plate 1, Figure 16, 17)

Characters:

- Shell short oval.
- Shell very much compressed.
- Umbones not inflated and almost flattened, anterior portion very short, rounded and dorsal margin here sharply bent into ventral direction.
- Lateral teeth rather short and straight.
- Periostracum is yellowish brown.

Distribution: The adult *Radiatua ocatta* animals were found in River Ganga only at one location in Narora in Uttar Pradesh during the month of December 2014.

Habitat: Water temperature recorded in the habitat was 18°C having river bed substratum of 5% sand and silt, 10% clay, 10% detritus and mostly 70% macrophytic vegetation abundancy in a moderately polluted biological water

quality. The observed animal had a body length of 30.00 mm, width of 18.00 mm and a height of 10.8 mm.

3.1.1.2.9 Radiatula caerulea juvenile (Plate 1, Figure 18)

Characters:

- Shell elongated and solid.
- Umbones well developed.
- Lateral teeth long and straight, dorsal and ventral margin almost parallel.
- Periostracum dark greenish brown in adults.
- It colonizes gravel, sand and mud substrate of lowland streams.
- Also abundant in running waters originated from mid mountains up to elevations of 250 meters above mean sea level.

Distribution: Common in large ponds with high nutrient and well oxygenated water. Juvenile of *Radiatula caerulea* were observed in River Ganga at downstream of Nabadwip in West Bengal in the month of May 2015.

Habitat: The juvenile animals were found in the habitat having water temperature of 34°C with river bed substrate composed of 10% sand, 15% silt, 25% clay, 5% detritus and highest percentage with 45% of macrophytic vegetation. The size of the observed animals varied from a length of 8.5 – 14.0 mm, width of 4.0 mm – 7.0 mm and height of 2.0 – 3.9 mm. They could survive in moderately polluted biological water at the site of River Ganga.

3.1.1.2.10 Radiatula olivaria juvenile (Plate 1, Figure 19)

Characters:

- Shell ovate, fragile and highly variable in form and size.
- Periostracum light yellowish to ochre.
- Male and females can be easily distinguished by their shells.
- Ventral margin more convex in females.
- Habitat is instable sand substrate of lotic habitat.
- It prefers stretches with mineral sediment and tolerates only a fine detritus cover.

Distribution: The juveniles of *Radiatula olivaria* were collected from River Ganga from near Farakka barrage in West Bengal in the month of May, 2015.

Habitat: It appears to be the most pollution – sensitive species. The animals were found in the habitat with substratum composition of 15% sand, 20% silt,

15% clay, 5% detritus and 45% macrophytic vegetation at the water temperature of 35°C at the location of sampling. The biological water quality at the point was found to be slightly polluted. The size of the animals varied in length of 8.5 mm to 14.0 mm, width of 4.0 to 7.0 mm and height of 2.0 to 3.9 mm.

3.1.1.3 Family Unionidae

1. Shell valves at least 1.5 times as long as broad.
2. Adult specimen is large, more than 30mm long. In closed conditions, the opening edge of the shell is not fully fused.

3.1.1.3.1 Lamellidens sp. juvenile (Plate 1, Figure 20)

Characters:

- Shell solid and thick
- Periostracum brown or dark brownish to blackish.
- Hinge plate with strong teeth, lateral linear.
- Ventral margin is slightly curved or convex.

Distribution: This species of bivalve was collected from River Ganga at bridge near Fatehpur, Allahabad bypass, at bathing ghat-1 at Varanasi in Uttar Pradesh as well as at downstream of FSTPS (Farakka Super Thermal Power Station) at Farakka in West Bengal. The time duration of collection varied at different locations of River Ganga from the month of February to May, 2015.

Habitat: The water temperature at the habitats of *Lamellidens* was found at around 30°C supporting a substratum composition of 15% sand and silt, 20% clay, 5% detritus and 45% of the substratum was composed of macrophytic vegetation and the species was found in the biological water quality ranging from clean to moderately polluted.

3.1.1.3.2 Lamellidens phenchooganjensis (Plate 1, Figure 21, 22)

Characters:

- Shell very elongated, thin.
- Hinge reduced.
- Pseudocardinal teeth are fused.
- Periostracum is dark brown or black.

Distribution: This species of *Lamellidens* was observed in River Ganga at Bithur and downstream of Ghazipur at Tarighat in Uttar Pradesh and also at near bridge at Buxar in the bordering Bihar stretch of the River Ganga. It was also found in River Ghaghra at Manjhi before confluence point with Ganga in Bihar state. The animal specimen were collected during the months of January to April, 2015.

Habitat: The water temperature ranged between 19°C to 26°C at the time of collection of *Lamellidens phenchooganjensis* with a varied percentage of substratum type at different locations. The substratum composition ranged from 5 - 20% of sand, 5 - 25% silt, 10 - 80% clay, 5-10% detritus and 35 – 40% of macrophytic vegetation with moderately polluted biological water quality. The size of observed individuals varied in length from 52 – 74 mm, width from 25 – 35 mm and height from 17.5 to 25.0 mm.

3.1.1.3.3 Lamellidens phenchooganjensis juvenile (Plate 1, Figure 23)

Characters:

- Shell very elongated, thin.
- Hinge reduced.
- Pseudocardinal teeth are fused.
- Periostracum is dark brown or black.

Distribution: Juveniles of *Lamellidens phenchooganjensis* were recovered from River Ganga near Danapur at Patna in Bihar in the month of April, 2015.

Habitat: They were found to withstand a water temperature of 28°C and were found preferring a river bed substratum composed of 15% sand, 25% silt, 15% clay, 5% detritus and 40% of Macrophytic vegetation in moderately polluted biological water quality. Their body size varied from a length of 23.9 – 31.0 mm, width of 13.5 – 18.0 mm and a height between 7.8 to 10.0 mm.

3.1.1.3.4 Lamellidens lamellatus (Plate 1, Figure 24, 25)

Characters:

- Shell moderately thin and solid.
- Umbones always inflated.
- Periostracum brownish.

Distribution: This species of *Lamellidens* was observed in River Ganga near bridge at Anupsahar in Uttar Pradesh in the month of December, 2014.

Habitat: The animal was found to be living in water temperature of 19°C with river bed substratum at the location having 90 % sand, 4% silt, 2% clay and only 4% detritus in a biological water quality at location classified as moderately polluted. The size of the bivalve was recorded as length of 64.8 m, width 34.0 mm and height of 19.2 mm.

3.1.1.3.5 Lamellidens rhadineus (Plate 1, Figure 26)

Characters:

- Thick-shelled.

- Well-developed hinge.
- Ventral margin curved and anterior part tapered.

Distribution: This species was observed in River Ganga near bridge at Anupsahar and Bridge on SH-98 at Varanasi in Uttar Pradesh during the months from December, 2014 and March, 2015.

Habitat: The water temperature preferred by the animal was found strictly at 19°C with varied substratum ranging from 10 – 90% of sand, 4 – 30% silt, 2 – 10% clay, 4 – 5% detritus and 45% of macrophytic vegetation present in moderately polluted biological water quality. The size of animals observed ranged from 27.0 to 42.0 mm in length, width of 17.0 to 22.0 mm and a height of 10.0 to 14.0 mm.

3.1.1.3.6 Lamellidens sp. Juvenile (Plate 1, Figure 27, 28, 29)

Characters:

- Thick-shelled.
- Well-developed hinge.
- Ventral margin curved and anterior part tapered.

Distribution: This species of bivalve was observed in River Ganga near bridge at Fatehpur and Allahabad bypass, bathing ghat – 1 Varanasi in Uttar Pradesh and downstream of FTPS (Farakka Thermal Power Station at Frakka in West Bengal during the months from February to May, 2015.

Habitat: The water temperature of River Ganga at these locations was 30°C supported by substratum composition of 15% of sand and silt, 20% clay, 5% detritus and 45% of macrophytic vegetation present in a clean to moderately polluted biological water quality. The length of animals observed ranged from 13.11 to 13.89 mm, width of 6.68 to 6.96 mm.

3.1.1.4 Family Sphaeriidae

- Shell valves not much longer than broad (length never more than 1.5 times the width).
- Most species under 15 mm, the largest always under 30 mm.

3.1.1.4.1 Pisidium annandalei (Plate 1, Figure 30)

Characters:

- Thin shelled, oval outline, shell surface with fine regular striations.
- Periostracum pale.
- Hinge.
- Anterior and posterior teeth shorter and swollen.

- Cardinal teeth C2 and C3 curved.

Distribution: The smallest bivalve, few specimens were collected from River Ganga at Kachla Ghat bridge at Badaun in Uttar Pradesh, downstream of FTPS, Farakka and downstream of Nabadwip in West Bengal during the time span from December, 2014 to May, 2015.

Habitat: *P. annandalei* was found in a wide range of water temperature from 17°C – 34°C. The river bed composition of the sites was found in the range as 10 – 40% sand, silt 10 - 15%, clay 5 – 25%, detritus 5 – 10% and macrophytic vegetation cover at 35 – 45% in a clean to moderately polluted biological water quality. The size range of the collected animals ranged from a length 3.0 – 4.58 mm, width 2.0 – 4.04 mm and height of 1.4 – 3.35 mm.

3.1.1.4.2 Musculium indicum (Plate 1, Figure 31)

Characters:

- Shell thin, fragile, light grey yellowish color, with distinct caps.
- It lives abundantly in the lower reaches of small or medium sized midhill streams, where a rich amount of organic matter and detritus is found.
- It can also be found in small eutrophic ponds and temporary paddy fields.
- Its occurrence correlates closely with intensive agriculture and natural water bodies of shallow water, which are warm in summer.
- It is largely absent from upstream headwaters, springs and forest streams.

Distribution: *Musculium indicum* is also a small bivalve species collected from downstream of River Tons near Sirsa in Uttar Pradesh in the month of February, 2015.

Habitat: The animal was found to be surviving in water with water temperature at the location at 19°C with the river bed substratum composition of approximately 2% sand, 70% clay, 3% detritus and 25% of macrophytic vegetation was observed. The collected animal had a body length of 4.58 mm, width 4.04 mm and height of the shell was 3.35 mm and it was found in a place with moderately polluted biological water quality.

3.1.1.5 Family Arcidae

- In freshwaters only one plesiomorphic genus Scaphula is known from a very few river systems in, South- and Southeast Asia around the Bay of Bengal.

3.1.1.5.1 Scaphula celox (Plate 1, Figure 32, 33)

Characters:

- Small and thin shell with dark brownish or black thick periostracum.
- Parallel margin is straight linear.
- It has a tolerance to high salinity and brackish water, pollution sensitive with high oxygen demand.
- It is more dominant than *'S.deltae'* in the fresh water system.
- Its habitat is, attached to stones often on shells of other molluscs mainly fixed on the posterior part of living large bivalves (Unionacea) and on living snails of *Brotiacostula*, *ballamya bengalensis* and *mekongiacrassa*.
- The occurrence of this species is locally restricted on a few places with suitable substrate, all along the erosion banks of the river.

Distribution: A few specimens of this bivalve were collected from River Ganga downstream of FTPS Farakka in West Bengal in the month of May, 2015.

Habitat: The *Scaphula celox* individuals were found to be inhabiting in slightly polluted water in terms of biological water quality with a clear preference for water temperature at 30°C. The river bed substratum near the point of collection was found to be composed of 15% sand and silt, 20% clay, 5% detritus and 45% of macrophytic vegetation. The body size of the collected animals varied from a length of 6.5 – 8.1 mm, width of 2.1 to 3.0 mm and height ranging 2.9 – 3.8 mm.

3.1.1.5.2 Scaphula deltae (Plate 1, Figure 34)

- Small shell with dark greyish thick periostracum, greater timidity of the valves.
- Nearly twice as thick as the height.
- Its preference to high salinity.
- *S. deltae* has a similar ecology like S.celox, but it prefers the tidal zone.
- It is more dominant than S.celox in the brackish water section.

Distribution: Another species of *Scaphula* was observed in River Ganga at downstream of Murshidabad (downstream Berahampur) in West Bengal, during the month of May, 2015.

Habitat: *Scaphula deltae* was slightly tolerant species living in moderately polluted biological water quality of River Ganga at a water temperature of 31°C and a substratum composed of 15% sand, 20% silt & clay, 5% detritus and 45% of macrophytic vegetation. Its size was smaller than that of *S.celox*. The length varied from 5.0-6.1 mm, width 2.0 -2.1 mm and height 2.0 – 2.6 mm.

3.1.1.6 Family Solecurtidae

- The marine family ranges from tropical to temperate sea.
- All species inhabit soft sediments like mud, silt, clay or sand.
- The animals are burrowing in vertical direction with a very strong foot.
- In fresh waters of India, they are regarded as marine elements or relicts.

3.1.1.6.1 Novaculina gangetica (Plate 3, Figure 35, 36, 37, 38)

Characters:

- Periostracum colour usually light yellowish-brown.
- The colour of periostracum can change in to dark brown in very large specimens of mud sediments.

Distribution: This bivalve was collected from River Ganga stretch of Bihar from Barari ghat Bhagalpur, Kastharni ghat upstream of Munger, Jahajghat Kahalgaon and in Jharkhand stretch of River Ganga at Ferry ghat (LCT ghat) downstream Sahibganj, Syedbazar ghat near Mangalhaat upstream Rajmahal and Ferry ghat near Sangi Dalan downstream Rajmahal during the month of January 2016.

Habitat: *Novaculina gangetica* prefers soft sand and silt bottom of lotic reaches. It is burrowing therein vertical direction, that usually only the posterior end can be seen on the sediment surface. Living animals remain fixed in the substrate even in strong water waves due to their very large extended foot. The species inhabit pure fresh water as well as slightly brackish water. It is able to colonize the littoral of the tidal zone. *Novaculina gangetica* is confined to the River Ganga habitat and may reach high density of individuals where it is often associated with the polychaetes. *Nephthys oligobranchia, N. polybranchia* and the amblemids *Parreysia spp*. Therefore, it is a useful indicator for stable good ecological river- quality. The water temperature preference of this bivalve ranged from17.5°C – 19.5°C. The substratum composition of river Ganga at its habitat was sand 8-40%, silt

5-70%, clay 15 – 65%, detritus 5-15% and macrophytic vegetation covered 10-15% in water bodies. The length of *Novaculina gangetica* ranged from 9.0 – 49.0 mm, width 4.2 – 17.5 mm and height 2.1 – 13.7 mm.

Class Gastropoda

Figure 4 : Classification of Class Gastropoda

Figure 5 : Classification of Order Prosobranchia (Operculata)

3.1.2 Class Gastropoda

- Snails with a single shell which is helically wound, coiled in one plane, or limpet-like (snails)

3.1.2.1 Order Pulmonata

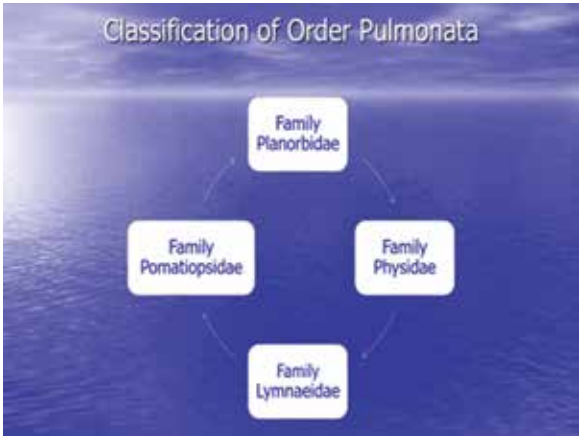

Figure 6 : Classification of Order Pulmonata

3.1.2.1 Order Pulmonata

- Snails without an operculum.
- Respiration by means of lungs.
- If the snails body feels squishy on squeezing it, the respiration is by means of lungs.

3.1.2.1.1 Family Planorbidae

- Shell either a coil or a spiral.
- Shell coiled in one plane and flat (as in Catherine wheel)

3.1.2.1.1.1 Indoplanorbis exustus (Plate 3, Figure 1)

Characters:

- Largest shells are thick and solid.
- Shell of strong red-brown colour.

Distribution: *Indoplanorbis exustus* is a gastropod commonly observed in River Ganga and its tributaries. It was collected from River Ganga at Barawali in Bijnaur district, Garhmukteshwar, Narora, Ghatia ghat at Farrukhabad and Tarighat at Ghazipur in Uttar Pradesh. In the West Bengal stretch of River Ganga, it was observed at Farakka upstream and downstream of barrage at Katwa, Nabadwip, Tribeni and at Palta. It was also collected from tributaries of Ganga in River Saloni at Sukartal Ghat, River Kali at Kanpur – Farrukhabad Road and in River Yamuna at Rajapur near Allahabad in Uttar Pradesh. The animals were collected from afore mentioned places during the months from December, 2014 to May, 2015.

Habitat: The water temperature at the place of collection of the *Indoplanorbis sp.* was in the range from 16°C - to 34.0°C.The substratum composition range in UP was estimated at sand 5% to 40%, silt at 5% to 30%, clay 5 – 70%, detritus 5- 10% and macrophytic vegetation covered 40 – 80%. The *I. exustus* species preferred biological water quality ranging from slight pollution to moderate pollution. Size of the animal varied from a width of 3.41 mm to 12.0 mm and height of 0.97 – 6.0 mm.

3.1.2.1.1.2 Gyraulus convexiusculus (Plate 3, Figure 2)

Characters:

- Shell usually with dark brownish periostracum, not sharply carinate.

Distribution: This species of *Gyraulus* is small and fragile gastropods found commonly throughout the stretch of River Ganga from Uttar Pradesh, Bihar and West Bengal. In Uttar Pradesh it was observed in River Ganga at Madhya Ganga Barrage, Garhmukteshwar, Narora and at before barrage upstream of Kanpur. In Bihar, it was observed at Buxar only and in West Bengal at locations of downstream of Farakka, Raghunathganj, Katwa, Nabadwip and Tribeni, covering all the seasons from December, 2014 to May, 2015.

Habitat: *Gyraulus convexiusculus* species was found in the water with biological water quality ranging from slight pollution to heavy pollution at water temperature ranging from 18°C – 35°C in West Bengal where as in Buxar, Bihar water temperature was recorded at 26°C. In the entire stretch of River Ganga, the substratum composition range of the habitat of *G. convexiusculus* preferred sand 5 – 70%, silt 5 – 20%, clay 5 – 35%, detritus 4 – 55% and macrophytic vegetation coverage was 35 – 80%. Its size varied in width of 2.0 – 6.8 mm and shell height of 0.9 mm to 1.4 mm.

3.1.2.1.2 Family Physidae

- Shell spiraled.
- Shell sinistral or left handed (if it is held with the apex up and with the aperture towards the observer, the aperture is to the shell's left side).
- Shell thin and relatively fragile.

3.1.2.1.2.1 Physa (Haitia) mexicana (Plate 3, Figure 3)

Characters:

- Shell synistral left-coiled.
- Periostracum colour brown-greyish.

Distribution: This species of gastropod belonging to *Family- Physidae* was very common in the entire stretch of River Ganga in Uttarakhand,

Uttar Pradesh, Bihar and West Bengal. In Uttarakhand *Physa maxicana* was collected from barrage at Rishikesh and downstream of Haridwar near the confluence of outlet point of Jagjeetpur STP with River Ganga in Haridwar district. In Uttar Pradesh stretch of River Ganga, the *Physa* species was obtained from Madhya Ganga barrage at Bijnour, Garhmukteshwar, Narora, at barrage upstream of Kanpur and Kanpur bridge on river Ganga as well as at Fatehpur, Allahabad bypass, Dengurpur, Varanasi, Mirzapur and at Ghazipur in Uttar Pradesh. It was also observed in tributaries of Ganga as River Garra, River Yamuna, River Tons and River Varuna in Uttar Pradesh. In the state of Bihar *P. maxicana* was collected from River Ganga at Buxar and near the Bridge Mahatma Gandhi Setu in Patna right Bank. In the stretch of the West Bengal, this species was observed at Farakka, Katwa, Tribeni, Chinsura, Srirampur and Belgharia. The animal specimens were collected during all seasons of the year from June, 2014 to May, 2015.

Habitat: In Uttarakhand stretch of the River Ganga the water temperature of the location was measured at 19.8°C and the biological water quality was found in a range of clean to heavy pollution with a substratum composition commonly found for boulders 5 – 100%, cobbles 90%, sand 2 – 70%, silt 5 – 35%, clay 5 – 80%, detritus 5 – 45% and macrophytic vegetation in a range of 5 – 80%. The observed width of the benthic animal ranged from 1.2 to 8.3 mm and height 2.0 to 14.0 mm.

3.1.2.1.3 Family Lymnaeidae

- Shell dextral or right handed.
- Shell thicker but may be fragile or robust.

3.1.2.1.3.1 Lymnaea accuminata

Characters:

- Large sized fragile Lymnaeid with light reddish-brown
- Shell with very large aperture.

Distribution: This benthic animal of Family *Lymnaedae* was commonly observed in River Ganga in Uttar Pradesh, Bihar and West Bengal stretches of the River. In Uttar Pradesh it was collected from River Ganga at Madhya Ganga barrage, Narora, Varanasi and Mirzapur. In Bihar, it was observed at Buxar, near Mahatma Gandhi Bridge right bank, whereas in West Bengal stretch its presence was recorded at Farakka, Raghunathganj, Murshidabad downstream, Katwa and Nabadwip. This species of *Lymnaea* was also collected from tributaries of River Ganga such as River Garra, River Tons, and River Varuna in Uttar Pradesh. This animal was collected during all seasons during the months of December, 2014 to May, 2015.

Habitat: The water temperature in the preferred habitat of *Lymnaea accuminata* was recorded in the range of 12.5°C to 35°C and the river substratum at different locations ranged from 5 – 70% of sand, silt 2 – 30%, clay 5 – 70%, detritus 5 – 45% r and macrophytic vegetation covering around 5 – 50% of the habitat. It has wide range of tolerance to biological water quality ranging from slight pollution to heavy pollution. The width of the animal varied from 2.3 to 13.9 mm and height of 3.9 to 26.8 mm.

3.1.2.1.3.2 Lymnaea andersoniana simulens (Plate 3, Figure 7)

Characters:

- Inner lip of operculum of shell is much enlarged.

Distribution: This species of Lymnaea was observed in River Ganga at downstream of Nabadwip in West Bengal in the month of May, 2015.

Habitat: The water temperature recorded at the habitat of this animal was 34.0°C in a moderately polluted biological water quality. The substratum preference of this species ranged from 10% sand, 15% silt, 25% clay, 5% detritus and 45% of macrophytic vegetation. This animal was found having a width range of 6.0 – 8.8 mm and height of 9.3 mm to 14.7 mm.

- Slug-like marine or terrestrial gastropods.

3.1.2.1.4 Family Onchidiidae

- The family of shell-less marine gastropods has a tough and often warty skin.
- Reaching a length of 6cm when fully extended.
- They are usually found in the tidal zone of tropical and subtropical sea-coast.
- A very few species are entering estuaries and are able to live in low salinity of the Hypopotamon biocoenotic zone.

3.1.2.1.4.1 Onchidium typhae (Plate 3, Figure 8, 9)

Characters:

- The dorsal surface is densely covered by numerous warty papillae.
- The living colour is dark greenish-brown.
- Colour of preserved animal dorsal side is dark grey.
- Found at palta, upstream to Haora in River Hugly.
- General habitat is tidal zone of the river bank. Shadowed places under riparian woody vegetation or reeds.
- The animals are grazing on algae and lichen on hard substrate (roots of trees, leaf litter) at low tide.

- Here *O.typhae* is associated with numerous freshwater-and brackish-water invertebrates.

Distribution: It is slug like marine or terrestrial gastropod without a hard shell on the body. The species was collected from River Ganga (Hoogly) at Falta during the month of September 2012.

Habitat: The size of the collected animals varied in the range of a length of 29 – 40 mm, width 19.0 – 28.0 mm and height of the body between 17 to 20.0 mm. The biological water quality at the location was heavily polluted with water temperature 26°C. The substratum composition was having maximum clay content of 90% and remaining 5% contained sand and detritus.

3.1.2.2 Order Operculata/Prosobranchia

- Snails with an operculum (horny or calcified plate which closes the mouth of the shell when the animal is retracted and which is carried on the back when the animal is active).
- Respiration by means of gills.

3.1.2.2.1 Family Viviparidae

- Shell taller than broad.
- Shell is cone shaped and banded, and often large (up to 40 mm high and 20-30 mm broad).
- If the shell is dark green in colour rub it to remove algae.
- Operculum horney with concentric rings.

3.1.2.2.1 Bellamya bengalensis (Plate 2, Figure 1, 2)

Characters:

- Shell with greenish periostracum and several to numerous brown spiral colour bands.

Distribution: The most common gastropod found in many sampling locations of River Ganga such as Narora, Kachla Ghat, Ghatiaghat in Farrukhabad, Bithur, Fatehpur, Allahabad, Dengurpur, Varanasi, Mirzapur in Uttar Pradesh, Buxar, Danapur, Patna in Bihar stretch and Farkka barrage, Raghunathganj, upstream of Jiaganj and Katwa in West Bengal stretch. In river Yamuna at Allahabad, River Gomti at Rajwari in Utar Pradesh and River Ghaghra near Manjhi in Bihar. The presence of this animal in the above mentioned stretches of River Ganga was recorded during the months of December, 2014 to May, 2015.

Habitat: *B. bengalensis* was found in a water temperature ranging from 11°C to 35°C with biological water quality ranging from slightly pollution to moderately polluted water. *Bellamyabengalensis* were found to colonizing in

the substratum composition ranging from 5% boulders, 5 – 90% sand, 5- 35% silt, 5 – 80% clay, 5 – 45% detritus and 10 – 80% macrophytic vegetation. The body width of animal was found in between 1.8 to 23.0 mm and height 2.0 to 34.0 mm.

3.1.2.2.1.2 Makongia crassa (Plate 2, Figure 3, 4) 3.1.2.2.1

Characters:

- Shell thick, short with smooth surface.
- Uniform colored yellow-brown. It lives in mud, silt and loam in lotic zones, usually in very large numbers of individuals as dominating Viviparidae species.
- In main river-channel *M.crassa* is often associates with the less abundant *B.bengalensis*.

Distribution: *Mekongia crassa* is a species more sensitive than *Bellamya bengalensis*. It was collected from River Ganga at Fathepur and Dengurpur in Uttar Pradesh and Danapur, Patna in Bihar stretch, Farakka, Raghunathganj and Katwa in West Bengal stretch. It was also observed in River Ghagra near Manjhi in Bihar. The animals were collected during the months of February, 2015 to May, 2015.

Habitat: The biological water quality at all the locations where this animal was observed ranged from slight pollution to moderate pollution in water temperature ranging from 16°C – 35°C. The substratum preference was found to be similar to *Bellamya bengalensis* which was 5% boulders, 5 – 20% sand, 5 – 25% silt, 10 – 75% clay, 5% detritus and 40 – 50% of macrophytic vegetation. The size of the animals were also found similar to *B. bengalensis* with a characteristic higher width to height ratio in juvenile individuals observed in *M. crassa*. The size was found to vary between a width of 7.0 to 19.0 mm and height of 5.0 to 27.9 mm.

3.1.2.2.1.3 Idiopoma dissimilis (Plate 2, Figure 5)

Characters:

- Shell smaller and shorter than in *B.bengalensis*.
- Color yellow-brown with two broad red-pinkish bands.
- *I.dissimilis* prefers stagnant waters, wetlands and even temporary water bodies. It is rarely found in rivers, but numerously in riparian floodplains.
- It reaches at an elevations of 1470 to 1900 MSL.

Distribution: *Idiopoma dissimilis* is a small gastropod species collected from River Ganga at Tribeni, Chinsura and Diamond Harbor in West Bengal in the month of May, 2015.

Habitat: The animal was found to be living in a habitat with water temperature ranging in between 31°C – 33°C. The biological water quality at the locations where *I. dissimilis* was collected was found to be moderate to heavily polluted with composition of substratum ranging from 5% sand, 10% silt, 35% clay, 10% detritus and 40% macrophytic vegetation. Animal size was recorded as width ranging from 2.0 to 6.2 mm and height of shell ranging from 3.0 – 11.6 mm.

3.1.2.2.2 Family Ampullariidae

1. The shell is large to very large.
2. The mostly amphibious species prefer temporary waters or periodically drying shallow banks of slowly running rivers.
3. The snails are omnivorous feeding also on living plants.

3.1.2.2.2.1 Pila globosa

Characters:

- Shell very large and solid.
- Up to 68 mm height.
- Color is dark green with numerous brown spiral lines and bands.
- *P. globosa* lives in temporary water bodies which are dry for at least one time per year (important for reproduction).
- Adults survive the dry-season buried in soil.
- It inhabits wetlands, where it is usually very common. The species prefers the stagnant water.
- Often animals may migrate into running waters or they are drifted by flood.

Distribution: This is the biggest gastropoda observed in Ganga basin, found at the origin of the River Gomti in Madhotanda, District Pilibhit, downstream up to Ghungchai bridge during the Month of September, 2008. These animals were also observed in River Ganga at Banaras, from a collection of fishermen nets. It was observed in abundance at origin of River Gomti, in Madhau Tanda, 30 km from Pilibhit district in Uttar Pradwsh on 8.9.2008, near temple in the Tank 1, attached to boundaries, under moderate pollution in biological water quality. Further downstream it was only observed in River Gomti near Biharipur bridge, Puranpur road, 5km near Gomti Gurudwara bridge, and near Ghugchai bridge.

Habitat: Its abundance was found to be maximum at origin of the river Gomti, where it was found attached to 80% of boulders of water tank, 5% cobbles and 10% sand. Abundance of animal reduced where substratum

composition changed to 40% sand, 40 – 95% clay and 5 to 40% of detritus. The water temperature where *P. globosa* was found to be in the range of 29°C – 32°C. Its width ranged from 24.1 mm to 53.0 mm and height of 28.0 mm to 56.0 mm *P. globosa* was found to be preferring moderate biological water quality.

3.1.2.2.3 Family Thiaridae

- Shell mostly turreted (long and narrow).
- Mantle border fringed. With a broad pouch.

3.1.2.2.3.1 Melanoides tuberculatus (Plate 2, Figure 6, 7)

Characters:

- Shell considerably longer and slender than M.pyramis.
- Periostracum is usually uniform-coloured brown, red-brown or greenish only sometimes with a few pinkish irregular spots on the last whorl.

Distribution: This gastropod *(Thiara tuberculata)* was collected from River Ganga at Kanpur in Uttar Pradesh and River Gandak near Hajipur in Bihar state during the duration from January to April, 2015.

Habitat: The water temperature at the site of collections ranged from 12.5°C to 27°C having biological water quality from slight pollution to moderate pollution. The substratum of the habitat in River Ganga was found to contain 70% of sand, 10% of silt, 15% clay and 5% detritus. The size of *T. tuberculata* ranged from a width of 2.8 to 13.0 mm and height of shell from 7.0 – 41.0 mm.

3.1.2.2.3.2 Melanoides pyramis (Plate 2, Figure 8, 9)

Characters:

- The shell is considerably shorter and broader than *M.tuberculatus*.
- Body- whorl larger and more swollen.
- Periostracum colour is orange – brown, red-brown or greenish-brown with distinct dark pinkish to blue cross bands.

Distribution: *Melanoides pyramis* is a commonly observed gastropod in River Ganga, found at Aunpsahar, Narora, Allahabad, Varanasi, Mirzapur, and Ghazipur in Uttar Pradesh, Buxar, and Danapur, Patna in Bihar stretch of the River. It was also collected from River Yamuna at Rajapur, Allahabad in Uttar Pradesh and in River Ghagra at Manjhi in Bihar. It was also observed in West Bengal stretch of River Ganga at Farakka, Raghunathganj, Jiaganj, Murshidabad, Katwa, Nabadwip, Tribeni, Chinsura and Palta. This species

was observed in River Ganga throughout the season from December 2014 to May, 2015.

Habitat: *M. pyramis* was found surviving in the water temperature in the range of 18°C – 35°C. The substratum composition of the habitat at all places of their presence was found having boulders at 5%, sand 5 – 90%, silt 4 – 35%, clay 2 – 70%, detritus 4 – 10% and macrophytic vegetation of 10 – 80% at different locations. The width of animal varied from 1.8 mm to 8.0 mm and height of the shell was in range of 4.0 to 26.5 mm. This species was found to prefer biological water quality in the range from slight pollution to Moderate pollution.

3.1.2.2.3.3 Thiara (Thiara) scabra (Plate 2, Figure 10, 11)

Characters:

- Shell with dark reddish-brown periostracum.
- Surface sculptured with distinct spiral rows of spines.

Distribution: In the River Ganga presence of *Thiara scabra* was not very common and was observed at Anupsahar in Uttar Pradesh, Farakka, Raghunathganj, Murshidabad and Katwa in Gangetic plains of West Bengal. This species was also observed in River Yamuna at Rajapur in Uttar Pradesh. It was observed in the above mentioned places during December, 2014 to May, 2015.

Habitat: The water temperature in the habitat of *T. scabra* was observed in the range of 19°C – 35°C with biological water quality varying from slight to moderately polluted. The substratum composition of the river bed at the places of their presence ranged from 10 – 90% of sand, 4 – 20% of silt, clay 2 – 60%, detritus 4 – 5% and macrophytic vegetation cover upto 20 – 50% at different locations. The size of animal varied from a width of 2.0 – 9.1 mm and height of 3.8 – 24.0 mm.

3.1.2.2.3.4 Thiara (Tarebia) lineata (Plate 2, Figure 12, 13)

Characters:

- Shell with grey-yellowish periostracum and dark brown transverse lines.
- It inhabits all types of rivers and stream in low lands.
- It is most abundant and pollution – tolerant species. It often occurs in high densities of individuals and is even found in organically polluted rivers.

Distribution: This gastropod is commonly observed in River Ganga at Varanasi in Uttar Pradesh and Farakka Barrage in West Bengal. It was

collected from River Gandak near Hajipur in Bihar State during the months from March to May, 2015.

Habitat: The water temperature in the habitat of *T. lineata* was found in the range of 21°C – 35°C. The width of animals varied from a range of width 3.2 – 11.0 mm and height of shell from 7.0 – 28.0 mm. the substratum composition of the river bed at the locations was found in the range of 10 – 15%, silt 20 – 30%, clay 15%, detritus 5% and 40 – 45% macrophytic vegetation observed mostly in slight pollution to moderate pollution in biological water quality of River Ganga.

3.1.2.2.3.5 Thiara (Sermyla) requeti juvenile (Plate 2 Figure 14, 15, 16, 17)

Characters:

- Shell similar to *T. lineata*, but always with colourful pinkish spiral bands.
- It is predominantly a brackish water species that enters also pure fresh water of nearby coastal river systems.

Distribution: The juveniles of *Thiara (Sermyla) requeti* was found in West Bengal stretch of River Ganga at Farakka, Raghunathganj, Jiaganj, Murshidabad, Katwa and Chinsura. It was also observed inhabiting River Gandak at Hajipur in Bihar during the months of April to May 2015.

Habitat: The biological water quality in the habitat of these juveniles ranged from slight to moderately polluted. The shell size of the animal varied from a width of 1.7 to 16.0 mm and shell height of 3.0 – 47.9 mm.

3.1.2.2.4 Family Pleuroceridae

- This family of fresh water gastropod is distinguished only anatomically, but by their shell similar to family Thiaridae.
- Shell larger than all other Thiaridae, uniform, colored dark brown with one transverse pinkish band, better visible in juvenile than adults.

3.1.2.2.4.1 Brotia costula costula (Plate 2, Figure 18)

Characters:

- Shell larger than all other Thiaridae or Pleuroceridae.
- Uniform-colored dark brown with one transverse pinkish band, better visible in juveniles than adults.
- It lives in moderately fast running streams and rivers of lowlands with rich invertebrate diversity.

Distribution: The big gastropod was commonly observed in River Ganga stretch of Bihar at Mahatma Gandhi Setu right bank of river in Patna and in most of the locations in West Bengal like Farakka, Raghunathganj, Jiaganj,

Murshidabad, Katwa and Chinsura. Few species were also collected from River Ghagra near Manjhi in Bihar. The specimen were collected during the month of April and May 2015.

Habitat: The water temperature was found in the range of 28°C – 35°C with a substratum consisting of 5% of boulders, 5 – 25% sand, 10 – 35% silt and clay, 5 – 10% detritus and 20 – 50% of macrophytic vegetation. This *Brotia* species was found in abundance in slight to moderately polluted biological water quality. The shell size of the animal ranged in width from 5.0 mm – 19.0 mm and height from 12.5 mm – 60.0 mm.

3.1.2.2.5 Family Assimineidae

- These are medium –sized prosobranche feed on living plants, decaying organic matter or detritus.
- They have an amphibious life –style.
- Mostly found in coastal and brackish water. Shells are grey –brown with dark red-brown spiral bands.

3.1.2.2.5.1 Assiminea francesiae (Plate 2, Figure 19)

Characters:

- Shell gray-brown with dark red-brown spiral bands.
- Height up to 9 mm.

Distribution: *Assiminea francesiae* was commonly found in the tributaries of River Ganga such as River Yamuna at Rajapur, Allahabad, River Tons near Sirsa, River Gomti at Rajwari in Uttar Pradesh. In the main River Ganga stretches of river, it was collected from Dengurpur, Mirzapur, Ghazipur, in Uttar Pradesh and the entire stretch of the River Ganga in West Bengal at Farakka barrage, Raghunathganj, Murshidabad, Katwa, Nabadwip, Tribeni and Chinsura. The animal specimen were collected during the months of February, March and May 2015.

Habitat: The water temperature recorded at the locations of collections of *A. fraincaise* was found in the range of 28°C – 35°C. The tolerance range to Biological water quality has ranged between slight, moderate to heavy pollution making this animal tolerant to a wide range of water quality. The substratum composition of their habitat ranged from 5% boulders, 5 – 30% sand, 2 – 25% silt, 5 – 60% clay, 3 – 10% detritus and 10 – 50% of macrophytic vegetation. The size of the collected individuals ranged from a width of 3.6 – 8.0 mm and height of 7.6 – 21.0 mm.

3.1.2.2.6 Family Bithyniidae

- Operculum calcareous with concentric marks and as large as aperture.

- The operculum cannot be withdrawn inside.

3.1.2.2.6.1 Digoniostoma pulchella (Plate 2, Figure 20, 21)

Characters:

- Shell with pale brownish periostracum, often with dark algae cover.
- Maximum height exceeds not more than 9 mm.

Distribution: Small gastropods of *Diagnostoma pulchella* species were collected from River Ganga at Baravali Rail-Road Bridge in Bijnaur, Kachlaghat at Badaun and Bithur at Kanpur in Uttar Pradesh stretch of the river. In West Bengal stretch of River Ganga this species was collected from Farakka Barrage, downstream of FTPS Farakka, Murshidabad, Nabadwip and Tribeni during the months of December, 2014 to May, 2015.

Habitat: The size of the collected individuals of *Diagnostomapulchella Sp.* was found to vary from a width of 2.0 to 5.0 mm and a height of 2.8 mm to 9.0 mm in the habitat with substratum containing 5 – 40% sand, 5 – 20% silt, 5 – 80% clay, 5 – 10% detritus and 35 – 45% of macrophytic vegetation. The preferred biological water quality was found to be slight to moderate pollution and water temperature ranging from 17°C – 35°C.

3.1.2.2.6.2 Digoniostoma lithoglyphoides (Plate 2, Figure 22, 23)

Distribution: This species of *Diagnostoma* was collected from River Ganga stretch restricted to West Bengal at downstream of Nabadwip and upstream of Tribeni in the month of May, 2015.

Habitat: The water temperature in the habitat of *D. lithoglyphoides* was found to be in the range of 33°C – 34°C having biological water quality ranging from moderate to heavy pollution. Substratum composition at different locations of the river stretch was 10% of sand, silt 15%, clay between 25 – 30%, detritus 5% and 40 – 45% macrophytic vegetation. Its width was 4.0 mm and height of shell was 5.2 – 6.7 mm.

3.1.2.2.6.3 Gabbia stenothyroides (Plate 2, Figure 24)

Characters:

- Shell light brown.
- General form similar to *Stenothyra*, but well distinguished by the strong calciferous operculum (horny operculum in Stenothyra).
- Very rare species.

Distribution: This small gastropod species of *Gabbia* was collected from only one location of River Ganga i.e. Jiaganj in West Bengal in the summer month of May, 2015.

Habitat: The water temperature at the above mentioned location was recorded at 35°C at the time of collection. The river substratum composition was found to contain 15% sand and silt, 20% of clay, 5% of detritus and 45% of macrophytic vegetation. The width of the gastropod ranged from 2.0 – 3.2 mm and height 3.2 – 6.8 mm. The preferred biological water quality of this gastropod was moderately polluted.

3.1.2.2.6.4 Gabbia orcula (Plate 2, Figure 25, 26)

Characters:

- Shell dark brown, up to 7.5 mm height.
- It is distinguished from *Diagnostoma* by the inner lateral position of the nucleus on the operculum.
- It occurs sporadically but abundant in stagnant waters with dense vegetation, e.g. wetland, small ponds and paddy fields from where this species enters small running headwaters of streams.
- It is absent from lakes and large rivers, although empty shell can be found drifted by flood.

Distribution: This is another small species of *Gabbia*, collected from River Ganga at downstream of Nabdwip in West Bengal in the month of May, 2015.

Habitat: The biological water quality preferred by *G. orcula* in the River Ganga was found to be moderately polluted. The water temperature of River Ganga at the site location was recorded at 34°C at the time of observation. Composition of substratum was 10% sand, 15% silt, 25% clay, 5% detritus and 45% of macrophytic vegetation. The width of shell of collected individuals of *Gabbia orcula* was recorded in the range of 4.5 – 4.9 mm and height between 6.0 – 7.1 mm.

3.1.2.2.7 Family Stenothyridae

- This family includes small or very small peripheral freshwater snails of the coastal zones in brackish water.
- A few are entering pure freshwaters far away from sea.
- They prefer soft sediment bottom like sand and mud, where they are buried, feeding on decaying organic matter.

3.1.2.2.7.1 Stenothyra ornata (Plate 2, Figure 27, 28, 29)

Characters:

- Shell with spiral lines and very small spines.
- Periostracum with bright orange-brown color.

- Height up to 4.8 mm in brackish water, usually smaller in pure freshwater.
- It inhabits soft mud and silt substrate. It lives in fresh-and brackish waters.

Distribution: This small gastropod *S. ornata* was found restricted to West Bengal stretch of River Ganga mainly at Farakka Barrage, downstream of FTPS Farakka, Raghunathganj, Jiaganj, Murshidabad, Katwa, Nabadwip, Tribeni and Chinsura, collected in the month of May, 2015.

Habitat: The water temperature at the above mentioned location on River Ganga was found in the range of 30°C – 35°C. *Stenothyra ornata* were collected from the river bed substratum composed of 5% boulders, 5 – 15% sand, 10 – 20% silt, 15 – 35% clay, 5 – 10% detritus and 35 – 50% of macrophytic vegetation. The width of this gastropod varied from 1.9 – 3.0 mm and shell height in range of 3.0 – 5.0 mm, which were found living in a habitat having slight to moderate pollution in biological water quality.

3.1.2.2.8 Family Septaridae

- The small family of peripheral freshwater gastropods is limited on the subtropical and tropical rivers of the Indo-pacific Ocean.
- Most of the species occur on lithal substrate in fast running riffles of rocky streams.
- A very few can be found in brackish waters.
- Like Neritidae the Septaridae feed as grazers on diatoms and are very pollution-sensitive.

3.1.2.2.8.1 Septaria tesselata (Plate 2, Figure 30, 31)

Characters:

- Limpet-like, thin-shelled with dark blackish color pattern and triangular white spots.
- The snail prefer hard substrate, where this species is associated with *Neritina violacea*.

Distribution: This species of *Septeria* was collected from River Ganga at Chinsura in West Bengal during the summer season in the month of May, 2015.

Habitat: The *Septaria tesselata* species was observed in River Ganga water having biological water quality of moderately polluted at water temperature recorded at the location at 33°C. The substratum of river habitat was found to be composed of 5% sand, 10% silt, 35% clay, 10% detritus and 40% of macrophytic vegetation. The length of the shell ranged from 13.0 to 15.1 mm,

width of the shell ranged 9.9 – 11.0 mm and the height of the shell measured at 4.0 to 5.1 mm.

3.1.2.2.8.2 Septaria sp. (Plate 2, Figure 32, 33)

Characters:

- Limpet-like, thin-shelled with dark blackish color pattern and triangular white spots.

Distribution: Another species of *Septaria* was collected from the same location of River Ganga at Chinsura under the similar ecological habitat of water temperature and substrate as preferred by *Septaria tesselata*, collected in the month of May, 2015.

Habitat: The *Septaria sp.* was found to prefer moderately polluted biological water quality at a water temperature of the habitat at 33°C. The length of *Septaria sp.* was 10.0 mm, width 7.8 mm and height of 3.2 mm.

3.1.2.2.9 Family Neritidae

- Neritidae is a remarkable and abundant family in the tidal mud-flats.
- The species neither survive in higher salinity nor occur in pure freshwater.
- They feed as grazers on diatoms.
- They are pollution-sensitive.

3.1.2.2.9.1 Neritina (Dostia) violacea (Plate 2, Figure 34, 35)

Characters:

- Thin-shelled with dark Brownish pink color.
- The snails live in the tidal zone.
- They prefer hard substrate of stones, wood, tree trunks and submerged macrophytes, where they are attached in high density of individuals.

Distribution: This species of *Neritina* was found restricted to River Ganga stretch in the state of West Bengal especially near Belgharia and Diamond Harbour and collected in the month of May, 2015.

Habitat: The water temperature of River Ganga at its habitat, ranged from 31°C – 32°C at the location having substratum composition of 5% sand, 10% silt, 35% clay, 10% detritus and 40% of macrophytic vegetation. The species was found to prefer moderate pollution as per the biological water quality. The length of *Neritina violacea* varied from 9.5 to 19.0 mm, width from 6.8 – 14.0 mm and the height was measured in the range of 4.0 – 9.0 mm.

3.1.2.2.9.2 Neritina (Vittina) smithi (Plate 2, Figure 36, 37)

Characters:

- Thick-shelled with light brownish color and black zigzag pattern.
- The snails have an amphibious life-style in the upper tidal zone.
- They prefer shadowed loam and mud under dense woody riparian vegetation.

Distribution: This species of *Neritina* was collected from River Ganga at Diamond Harbour only in the month of May, 2015.

Habitat: The ecological habitat of *N. smithi* was found similar to *N. violacea* for water temperature and substrate composition in a moderately polluted biological water quality. This species is larger than *N. violacea* and its width ranged from 9.0 to 19.0 mm and the height ranged between 11.0 – 28.0 mm.

3.2 Phylum Arthropoda:

- Body with jointed limbs.
- Body with fewer than 15 visible segments.
- Sclerotized mouthparts visible (may be reduced and not protruding from thorax.
- Prolegs (unjointed stubby limbs) may be present on some segments.

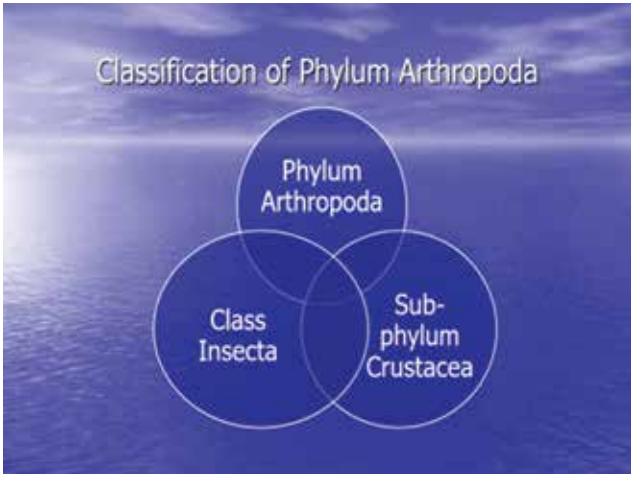

Figure 7 : Classification of Phylum Arthropoda

3.2.1 Sub – Phylum Crustacea

Figure 8 : Classification of Sub – Phylum Crustacea

3.2.1 Sub-Phylum Crustacea:

- The body is divided into head, thorax and abdomen.
- Head and thorax are often fused together to form cephalothorax.
- Cephalothorax is often covered by a carapace which protects the anterior region of the body.
- Crustaceans have 2 pairs of antennae or feelers in front of their mouth.
- Behind the mouth parts, crustaceans have at least 5 pairs of limbs.
- Body typically flattened either dorso-ventrally or laterally.
- Usually more than 6 legs.

Figure 9 : Classification of Order Amphipoda

3.2.1.1 Order Amphipoda

- The animals laterally flattened, seldom cylindrical
- With a carapace.
- A large number is marine fauna, inhabiting the oceans between the tidal zone and the deep sea.
- Amphipods are well represented in the cold and temperate freshwaters throughout the northern hemisphere, because they usually have a high oxygen demand.
- Only a very few occur in the subtropical Ganga River System.

3.2.1.1.1 Family Gammaridae

- Eyes present.
- Thorns and / or hairs on the last 3 abdominal segments.
- Last pair of tail legs never shorter than the second last pair.
- Body slightly curved.
- Swims sideways.

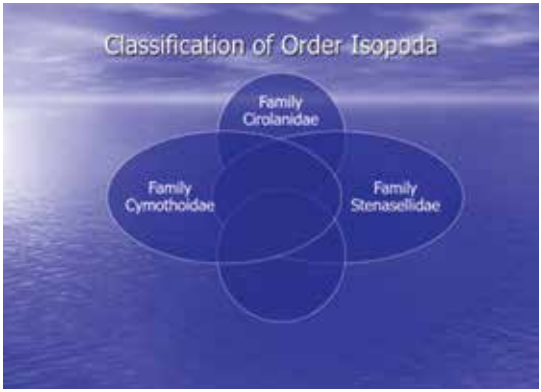

Figure 10 : Classification of Order Isopoda

3.2.1.2 Order Isopoda

- Uropods positioned and articulating terminally (or sub-terminally) on pleotelson, uropods styliform (slender).
- Uropods positioned anterolaterally or anteroventrally on pleotelson, rami lamellar or robust, never styliform.
- The animals are dorso-ventrally flattened.
- Without a carapace.
- There is a distinct cephalothorax which represents the head and the first thoracic segment.

- ❖ The rest of the thorax consists of 7 segments expanded laterally.
- ❖ The abdomen is relatively short and projects as a shield at the posterior end.
- ❖ The thoracic appendages are well developed but those of the abdomen are reduced, except the last pair which project backwards.

3.2.1.2.1 Family Cirolanidae

- Uropods positioned anterolaterally or anteroventrally on pleotelson, rami lamellar or robust, never styliform.
- Body not markedly elongate.
- Length usually less than 4 times as long as wide.
- Uropodal exopod not curving over pleotelson.
- Pleon with 5 free pleonites.
- Both uropod articulating.
- Pereopods 4-7 ambulatory, not prehensile.
- Free living or micro-predators of fishes and crustaceans.
- Pereopods 1-3 ambulatory (i.e. not hooked or claw-like).
- Mouthparts not forming a ventrally directed cone.
- Mandible incisor wide, tridentate.

3.2.1.2.1.1 Cirolana parva (Plate 4, Figure 1, 2)

Characters:

- Colorful animals.
- Dorsal side yellowish with black pigment pattern.
- In freshwater found attached on hard substrate of moderately lotic places with pure sand substrate.

Distribution: This crustacean was collected from River Ganga at Farakka barrage, transmission tower upstream of Tribeni, Ghat downstream of Srirampore, and Diamond Harbour in West Bengal during May 2015.

Habitat: *Cirolana parva* preferred slight to moderate pollution in biological water quality of River Ganga at water temperature range of 31-35°C. The substratum composition of water body consisted of 5-15% sand, 10-20% silt. 15-35% clay, 5-10% detritus and 35-45% of macrophytic vegetation. The length of preserved specimen ranged from 3.5 – 10.0 mm and width 2.0 – 5.0 mm.

3.2.1.2.1.2 Annina (Plate 4, Figure 3, 4)

Characters:

- Antenna 2 with massive peduncle and geniculate flagellum.

Distribution: *Annina* was collected from River Ganga at downstream of Murshidabad in West Bengal during May 2015.

Habitat: This species of *Annina* was collected from moderate pollution in biological water quality of River Ganga at water temperature of 31°C.The substratum composition of water body in its habitat was 15% sand, 20% silt and clay, 5% detritus and 45% of macrophytic vegetation. The length of preserved specimen was 4.0-10.0 mm and width 2.1 to 5.0 mm.

3.2.1.2.1.3 Annina Kumari (Plate 4, Figure 5, 6)

Characters:

- Antenna 2 with massive peduncle and geniculate flagellum.
- Male head, pereonites 1 and 2 each with 2 dorsally directed processes.
- Pereonite 2 with median acute tubercle.

Distribution: This crustacean was collected from River Ganga at upstream of Tribeni in West Bengal during May 2015.

Habitat: The preference of habitat of *Annina Kumari* was heavy pollution in biological water quality of River Ganga at water temperature of 33°C. The substratum composition of water body at this location was 10% sand, 15% silt, 30% clay, 5% detritus and 40% of macrophytic vegetation. The length of preserved specimen was 8.0 mm, width 2.8 mm and height 1.8 mm.

3.2.1.2.2 Family Stenasellidae

- Uropods positioned and articulating terminally (or sub-terminally) on pleotelson.
- Uropods styliform (slender).

3.2.1.2.2.1 Stenasellus (Plate 4, Figure 7, 8, 9,10)

Characters:

- Uropods positioned and articulating terminally (or sub-terminally) on pleotelson.
- Uropods styliform (slender).

Distribution: *Stenasellus* was collected from River Ganga at upstream of Jiaganj, downstream of Murshidabad, upstream of Tribeni, transmission tower upstream of Tribeni, Chinsura,Palta Water intake, Ghat downstream of Srirampore and Diamond Harbour in West Bengal during May 2015.

Habitat: *Stenasellus* preferred mostly moderate to heavy pollution in biological water quality of River Ganga at water temperature range of 29.9 – 35°C. The substratum composition in water bodies ranged from 5-15% sand, 10-20% silt, 20-35% clay, 5-10% detritus and 35-45% of macrophytic vegetation. The length of preserved specimen ranged from 2.9-11.0 mm and width 1.0 – 4.0 mm.

3.2.1.2.3 Family Cymothoidae

- Uropods positioned anterolaterally or anteroventrally on pleotelson, rami lamellar or robust, never styliform.
- Body not markedly elongate.
- Length usually less than 4 times as long as wide.
- Uropodal exopod not curving over pleotelson.
- Pleon with 5 free pleonites.
- Both uropod articulating.
- All pereopods prehensile, with dactylus strongly recurved (hooked or claw-like).
- Obligate parasites of fishes.

3.2.1.2.3 Nerocilia deprassa (Plate 4, Figure 11, 12)

Characters:

- Occasionally venture into freshwater rivers.

Distribution: These crustaceans were collected from River Ganga at upstream of Tribeni in West Bengal during May 2015.

Habitat: The *Nerocilia deprassa* preferred moderate pollution in biological water quality of River Ganga at water temperature of 33°C. The substratum composition of river bed was 10% sand, 15% silt, 30% clay, 5% detritus and 40% of macrophytic vegetation. The length of preserved specimen was 3.0 – 7.0 mm and width 1.5 – 2.8 mm.

3.2.1.2.4 Family Corrallanidae

- Uropods positioned anterolaterally or anteroventrally on pleotelson, rami lamellar or robust, never styliform.
- Body not markedly elongate.
- Length usually less than 4 times as long as wide.
- Uropodal exopod not curving over pleotelson.
- Pleon with 5 free pleonites.
- Both uropod articulating.
- Pereopods 4-7 ambulatory, not prehensile.

- Free living or micro-predators of fishes and crustaceans.
- Pereopods 1-3 ambulatory (i.e. not hooked or claw-like).
- Mouthparts not forming a ventrally directed cone.
- Mandible incisor narrow, uni-or bidentate.

3.2.1.2.4.1 Corallana grandiventra (Plate 4, Figure 13, 14)

Characters:

- Maxilliped elongate, slender, palp with 5 distinct articles.

Distribution: This species of crustacean was collected from River Ganga at Ghat downstream of Srirampore during May 2015.

Habitat: The habitat of *Corallana grandiventra* preferred moderate pollution in biological water quality of River Ganga at water temperature of 33°C. The substratum composition of River Ganga at this location composed of 5% sand, 15% silt, 35% clay, 5% detritus and 40% of macrophytic vegetation. The length of preserved specimen was 4.0 mm and width 1.9 mm.

Figure 11 : Classification of Order Decapoda

3.2.1.3 Order Decapoda

- Carapace present, extending down over sides of thorax and enclosing branchial chamber.
- Five pairs of legs.
- Eyes on stalks
- Includes are prawns and shrimps

- Fresh water crabs are significant organisms playing a key role in recycling nutrients through their scavenging of plant and animal material.
- They are present in almost all clean fresh water bodies, from low land to high mountains.

- Like all crabs, they breathe with gills, but they do not always need to be in water.
- As long as their gill chamber is moist or has a water bubble trapped inside, they are able to breath and move about.
- There are many plants that trap rainwater, forming temporary pools all over the forest, even many meters above the ground.
- Such small aquatic ecosystems, called phytotelms provide crabs with moisture for their gills as well as food.
- Some crabs have been found in pitcher plants.

3.2.1.3.1 Sub-Order Caridea

- ➢ Abdomen extended and well developed.
- ➢ Tail fan present.
- ➢ Conspicuous rostrum projecting infront of eyes.

Character 1

- ✓ Eyes partly or entirely covered by carapace.
- ✓ Rostrum short.
- ✓ First pereiopods bigger than second periopods.
- ✓ Second pereiopods with carpus consisting of 5 articles…. Family Alpheidae

Charactrer 2

- ➢ Eyes not covered by carapace.
- ➢ Rostrum normal.
- ➢ First pereiopods smaller than second pereiopods.
- ➢ Second pereiopods with carpus present as one article.

3.2.1.3.1.1 Family Palaemonidae

- ➢ Rostrum very long, distinctly sinuous, ventral margin with 10 to 12 teeth.
- ➢ Rostrum slightly curved upwards or blade-like, not greatly elongated, ventral margin with less than 7 teeth.
- ➢ Eyes not covered by carapace.
- ➢ Rostrum normal.
- ➢ First pereiopods smaller than second pereiopods.
- ➢ Second pereiopods with carpus present as one article.
- ➢ Carapace with hepatic spine.
- ➢ First and second pereiopods without dense tufts of setae at the end of the fingers.

- First pair of gripping legs shorter than the second pair.
- Ends without hair bristles.
- Inhabiting shallow and subterranean waters.
- They are found in plants and can be seen crawling on the bottom in search of food.
- Generally they are always hidden during day time and active during the night.

3.2.1.3.1.1.1 *Macrobrachium rosenbergii*

Characters:

- Rostrum very long, distinctly sinuous.
- Ventral margin of rostrum with 10 to 12 teeth.

Distribution: This amphipod is not very common in fresh waters of River Ganga and tributaries. It was collected from River Ganga (Hugli) at Behrampur in West Bengal during September 2012.

Habitat: This species of *Macrobranchium* preferred moderate pollution in biological water quality at a water temperature of 30°C. The substratum composition of River Ganga at this location was 95% of clay and 5% detritus.

3.2.1.3.1.1.2 *Macrobrachium idea (Plate 5, Figure 1, 2)*

Characters:

- Rostrum slightly curve upwards or blade like.
- Rostrum not greatly elongated.
- Ventral margin of rostrum, with less than 7 teeth.
- Second pereiopods not covered by appressed scales.
- Third to fifth periopods glabrous.
- Second pereiopods with carpus longer than merus.
- Carpus sub cylindrical.
- Post antennular carapace margin straight or concave.
- Second pereiopods with chela shorter than carpus.
- Surface of carapace, telson and uropod tuberculate in mature males.

Distribution: Commonly observed fresh water species of *Macrobranchium* was collected from River Ganga at Barawali, Narora, Ghatiaghat at Farrukhabad, Bithur, barrage at upstream Kanpur, Kanpur-2 at NH25, and Dhonighat at Kanpur -5, Fatehpur, Allahabad bypass, NH-2, Dengurpur, SH-98 at Varanasi in Uttar Pradesh. In West Bengal stretch of River Ganga, it was

observed at downstream of FTPS Farakka, downstream of *Macrobranchium*, Katwa and Diamond Harbour This species of macrobrachium was also collected from tributaries like River Garra, River Kali at Kanpur- Farrukhabad road, River Yamuna near Rajapur and NH-27, River Tons near Panasa and Sirsa in Uttar Pradesh. In Bihar state, it was observed in River Ghagra near Manjhi during the months December 2014 and January to March 2015.

Habitat: These crustaceans preferred slight to moderate pollution in biological water quality at a water temperature ranging from 11-32°C. The substratum of all the water bodies of its habitat, composed of 5% boulders, 2-70% sand, 2-30% silt, 5-85% clay, 3-55% detritus and 5-85% of macrophytic vegetation. The length of preserved specimen ranged from 7.0-43.0mm, width 1.2-6.4 mm and height 1.3 – 7.0 mm.

3.2.1.3.1.1.3 *Macrobrachium callirrhae (Plate 5, Figure 3)*

Characters:

- Rostrum slightly curved upwards or blade like.
- Rostrum not greatly elongated.
- Ventral margin of rostrum, with less than 7 teeth.
- Second pereiopods not covered by appressed scales.
- Third to fifth pereiopods glabrous.
- Second pereiopods with carpus shorter than or equal to merus.
- Carpus conical or cup-shaped.
- Rostrum short to moderately long with very low basal crest.
- Second pereiopods with spinules or spines.
- Fifth pereiopods about as long as fourth.
- Rostrum with1-3 teeth on carapace.
- Second pereiopods with chelae completely glabrous or bearing only a few scattered setae not concealing surface.
- Preanal carina absent.
- Rostrum with 1-3 ventral teeth.
- Rostrum slender.
- Maximum depth clearly less than maximum dorsoventral diameter of cornea.
- Carpus of second pereiopods slightly shorter than merus, conical.
- Chela of second pereiopods with a ridge along both sides of each finger.

Distribution: This species of *Macrobranchium*, was collected from River Ganga at upstream Narora, Kachla ghat Badayun, and Mirjapur upstream at Vindhyachal ghat in Uttar Pradesh during December 2014 – January 2015.

Habitat: The biological water quality in the habitat of *Macrobranchium* was moderately polluted at a water temperature ranging from 17 – 25°C. The substratum of water bodies composed of 5-40% sand, 5-10% silt, clay detritus and 35-70% of macrophytic vegetation cover. The length of preserved specimen ranged from 14.7-42.0 mm, width 2.0 – 8.5 mm and height 2.4-8.0 mm.

3.2.1.3.1.1.4 *Macrobrachium lopopodus (Plate 5, Figure 4, 5, 6)*

Characters:

- Rostrum slightly curved upwards or blade likes.
- Rostrum not greatly elongated.
- Ventral margin of rostrum, with less than 7 teeth.
- Second periopods covered by appressed scales.
- Third to fifth periopods covered by appressed scales.
- Carpus of second periopods longer than palm and merus.

Distribution: This species of *Macrobranchium* was collected from River Ganga at Barawali, Anupshahar, upstream Narora, and Mirzapur downstream in Uttar Pradesh. In West Bengal stretch, it was collected from downstream of Murshidabad, Katwa, downstream of Nabadwip, upstream of Tribeni, Chinsura, and Palta water intake in West Bengal. It was also collected from tributaries like River Saloni at Sukratal ghat, River Gomti at Rajwari in Uttar Pradesh, River Gandak near Hajipur in Bihar during December 2014 to March –April 2015.

Habitat: This species of *Macrobranchium* possess a wide range of sensitivity to Slight, moderate and heavy pollution in biological water quality at a water temperature ranging from18-34°C. The substratum of river bed on these water bodies ranged for 5% boulders, 5-90% sand, 4-10% detritus and 35-70% of macrophytic vegetation. The length of preserved specimen was 9.0 – 56.0 mm, width 1.8-11.0 mm and height 1.9-12.3 mm.

3.2.1.3.1.1.5 *Macrobrachium horstii (Plate 5, Figure 7)*

Characters:

- Rostrum slightly curved upwards or blade like.
- Rostrum not greatly elongated.
- Ventral margin of rostrum, with less than 7 teeth.
- Second pereiopods covered by appressed scales.

- Third to fifth pereiopods covered by appressed scales.
- Carpus of second pereiopods slightly or distinctly shorter than palm, longer than merus.
- First pereiopods without appressed scales on merus and ischium.
- No longitudinal sulcus on proximal part of palm and carpus of major second pereiopod.
- Less than 9 tubercles on each side of cutting edges of major second peeriopod chela in adult males.

Distribution: This species of *Macrobranchium* was collected from River Ganga at upstream of Narora in Uttar Pradesh and Diamond Harbour in West Bengal during the month of December 2014.

Habitat: The biological water quality in the vicinity of habitat of *Macrobranchium horstii*, was moderately polluted at a water temperature ranging from 18-31°C. The substratum composition of its habitat composed of 5% sand, 5-10% silt, 10-35% clay, 10% detritus and 40-70% of macrophytic vegetation cover. The length of preserved specimen ranged from 16.5 -39.0 mm, width 3.0-8.0 mm and height 3.5 – 8.4 mm.

3.2.1.3.1.1.6 *Macrobrachium lanchasteri (Plate 5, Figure 8, 9)*

Characters:

- Rostrum slightly curved upwards or blade like.
- Rostrum not greatly elongated.
- Ventral margin of rostrum, with less than 7 teeth.
- Second pereiopods not covered by appressed scales.
- Third to fifth pereiopods glabrous.
- Second pereiopods with carpus longer than merus.
- Carpus sub cylindrical.
- Post antennular carapace margin rounded.
- Second pereiopod chelae with each finger not bearing row of tubercles.
- Entire length of fingers covered by soft dense pubescence.
- Preanal carina present.
- Rostrum convex proximally, flattened distally with 1-2 apical teeth.
- Second pereiopods with only fingers covered by soft, dense pubescence (in mature males).

Distribution: This species of *Macrobranchium* was collected from River Ganga at Farakka Barrage in West Bengal during May 2015.

Habitat: This sensitive species of *Macrobranchium* survived slight pollution in biological water quality at a water temperature of 35°C. The substratum of River Ganga at this location, composed of 15% sand, 20% silt, 15% clay, 5% detritus and 45% of macrophytic vegetation. The length of preserved specimen was 28.2 mm, width 3.9 mm and height 4.8 mm.

3.2.1.3.1.1.7 *Macrobrachium nipponense*

Characters:

- Rostrum slightly curve upwards or blade like.
- Rostrum not greatly elongated.
- Ventral margin of rostrum, with less than 7 teeth.
- Second pereiopods not covered by appressed scales.
- Third to fifth pereiopods glabrous.
- Second periopods with carpus longer than merus.
- Carpus sub cylindrical.
- Post antennular carapace margin straight or concave.
- Second pereiopods with chela longer than carpus.
- Surface of carapace, telson and uropod spinulate, tuberculate or glabrous (in mature males).
- Second pereiopods similar form, equal in size, with sub-cylindrical chelae.
- Both fingers of chelae covered by pubescence or setae, not gaping.
- Surface of telson and uropod spinulate or tuberculate.
- Rostrum convex, blade –like or straight.
- Second pereiopod chelae with both fingers covered by stiff setae (in mature males).
- Surface of telson and uropod tuberculate.

3.2.1.3.1.1.8 *Macrobrachium niphanae (Plate 5, 6)*

Characters:

- Rostrum slightly curve upwards or blade like.
- Rostrum not greatly elongated.
- Ventral margin of rostrum, with less than 7 teeth.
- Second pereiopods not covered by appressed scales.
- Third to fifth periopods glabrous.

- Second pereiopods with carpus shorter than or equal to merus.
- Carpus conical or cup-shaped.
- Rostrum short to moderately long with very low basal crest.
- Second peeriopods with spinules or spines.
- Fifth peeriopods about as long as fourth.
- Rostrum with 1-3 teeth on carapace.
- Second pereiopods with chelae completely glabrous or bearing only a few scattered setae not concealing surface.
- Preanal carina present.
- Rostrum with 2-4 ventral teeth.
- Carpus, merus and ischium of major second pereiopod lightly covered with pubescence.
- More than 10 equal-size teeth along fingers of chela of major second pereiopod.

Distribution: This species of *Macrobrachium niphanae* was collected from River Ganga at Ramnagar road bridge near Varanasi in Uttar Pradesh during the month of March 2015.

Habitat: The biological water quality in the habitat of this crustacean was moderately polluted at a water temperature of 22°C. The substratum of river bed at this location composed of 15% sand, 30% silt, 10% clay and 45% of detritus material. The length of preserved specimen was 21 – 26.2 mm, width 3.0-3.4 mm and height 3.3 – 4.0 mm.

3.2.1.3.1.1.9 *Macrobrachium equidens*

Characters:

- Rostrum slightly curve upwards or blade like.
- Rostrum not greatly elongated.
- Ventral margin of rostrum, with less than 7 teeth.
- Second pereiopods not covered by appressed scales.
- Third to fifth pereiopods glabrous.
- Second pereiopods with carpus longer than merus.
- Carpus sub cylindrical.
- Post antennular carapace margin straight or concave.
- Second pereiopods with chela longer than carpus.
- Surface of carapace, telson and uropod spinulate, tuberculate or glabrous (in mature males).
- Second pereiopods similar form, equal in size, with sub-cylindrical chelae.

- Both fingers of chelae covered by pubescence or setae, not gaping.
- Surface of telson and uropod spinulate or tuberculate.
- Rostrum curve upwards distally or almost straight.
- Second pereiopod chelae with both fingers covered by soft, dense pubescence (in mature males).
- Surface of telson and uropod spinulate.

3.2.1.3.1.1.10 *Macrobrachium mirabile (Plate 5, Figure 12, 13)*

Characters:

- Rostrum slightly curve upwards or blade like.
- Rostrum not greatly elongated.
- Ventral margin of rostrum, with less than 7 teeth.
- Second pereiopods not covered by appressed scales.
- Third to fifth periopods glabrous.
- Second pereiopods with carpus shorter than or equal to merus.
- Carpus conical or cup-shaped.
- Rostrum short with high basal crest.
- Second pereiopods glabrous.
- Fifth pereiopods distinctly larger than fourth.

Distribution: This species of *Macrobrachium mirabile* was not common in fresh waters of River Ganga. It was collected from River Ganga at Diamond Harbour in West Bengal during May 2015.

Habitat: *Macrobrachium mirable* preferred moderate pollution in biological water quality of River Ganga at a water temperature of 31°C. The substratum composition of water body at this location, was 5% sand, 10% silt, 35% clay, 10% detritus and 40% of macrophytic vegetation. The length of preserved specimen was 9.1 – 41.0 mm, width 1.8 – 4.8 mm and height 2.0 -5.3 mm.

3.2.1.3.1.1.11 Macrobrachium lar (Plate 5, Figure 14, 15)

Characters:

- Rostrum blade-like not greatly elongated.
- Rostrum with less than 7 teeth on ventral margin.
- Second pereiopods not covered by appressed scales.
- Third and fifth pereiopods glabrous
- Carpus shorter than merus. Carpus length 2.52 mm, palm length 2.07 mm and merus length 4.09 mm
- Carpus conical

- Rostrum moderately long
- Second pereiopod with spines
- Rostrum with 1 teeth on carapace.
- Chelae bearing only a few scattered setae
- Rostrum with 4 ventral teeth
- Preanal carina present on telson.

Distribution: This Single species of Macrobrachium was collected from River Ganga at downstream of Buxar in Bihar during the month of December, 20015.

Habitat: The water quality of River Ganga in the vicinity of *Macrobrachium lar*, was moderately polluted, at a water temperature of 17ºC the river bed substratum at this habitat composed of 10% sand, 30% silt, 50% of clay and 10% of macrophytic vegetation. The length of preserved specimem was... mm and width... mm.

3.2.1.3.1.2 Family Atyidae

- Rostrum unarmed dorsally.
- Rostrum armed dorsally with at least 5 teeth.
- Carapace without hepatic spine.
- First and second pereiopods with dense tufts of setae at the end of the fingers.
- First and second pair of gripping legs of equal length, with hair bristles on the ends,
- They inhabit shallow and subterranean water and are found among water plants as they eat vegetable matter, debris and organic detritus.

3.2.1.3.1.2.1 *Caridina peninsularis (Plate 6, Figure 1)*

Characters:

- Rostrum armed dorsally with at least 5 teeth.
- Rostrum nearly horizontal or slightly down curved anteriorly, reaching to or slightly extending beyond edge of scaphocerite.
- Rostrum nearly horizontal.
- Rostral teeth throughout dorsal margin.
- Rostrum with less than 7 postorbital teeth on carapace.
- Stylocerite not reaching end of basal segment of antennular peduncle.
- Endopod of male first pleopod with appendix interna.

- Rostrum long, narrow, reaching to or slightly extending beyond the edge of scaphocerite.
- Rostrum with less than 3 postorbital teeth on carapace.

Distribution: This species of *Caridina* was collected from River Ganga at Anupshar, upstream of Narora and barrage, Kachlaghat Badayun, Bithur, Kanpur-2 at NH 25, Fatehpur and Allahabad bypass in Uttar Pradesh. It was also observed in River Yamuna near Rajapur in Uttar Pradesh during December 2014 and January – May 2015.

Habitat: *Caridina peninsularis* preferred mostly moderate pollution in biological water quality at a water temperature range of 16-19°C. The substratum of river bed consisted of 5-40% sand, 4-15% silt, 2-85% clay, 4-10% detritus and 10-89% of macrophytic vegetation. The length of preserved specimen was 7.0 – 23.0 mm, width 1.5 -3.0 mm and height 1.7-4.0 mm.

3.2.1.3.1.2.2 *Caridina bruneiana (Plate 6, Figure 2, 3)*

Characters:

- Rostrum armed dorsally with atleast 5 teeth.
- Rostrum nearly horizontal or slightly down curved anteriorly, reaching to or slightly extending beyond edge of scaphocerite.
- Rostrum nearly horizontal.
- Rostral teeth throughout dorsal margin.
- Rostrum with less than 7 postorbital teeth on carapace.
- Stylocerite not reaching end of basal segment of antennular peduncle.
- Endopod of male first pleopod with appendix interna.
- Rostrum short, high, not reaching edge of scaphocerite.
- Rostrum with3 or more than 3 postorbital teeth on carapace.
- Rostrum reaching end of third segment of antennular peduncle or slightly extending beyond it.
- Uropodal diaeresis with 12-14 spinules.
- Dactylus of fifth periopod with less than 30 spinules on flexor margin.

Distribution: This species of *Caridina* was collected from River Ganga at Garhmukteshwar, Anupshahar, SH-74 upstream Varanasi in Uttar Pradesh, Danapur, Patna in Bihar. In West Bengal stretch of River Ganga, it was collected from Farakka Barrage, downstream of FTPS Farakka, palta Water Intake, Katwa, downstream of Nabadwip and Srirampore. It was also collected from tributaries like River Saloni at Sukratal ghat, River Gomti at

Rajwari, River gandak near Hajipur during December 2014 and February to May 2015.

Habitat: *Caridina bruneiana* preferred slight to moderate pollution in biological water quality at a water temperature ranging from 18-35°C. The substratum composition of water bodies at these location ranged from 5% boulders, 5-90% sand, 4-25% silt, 2-35% clay, 4-10% detritus, 40-60% of macrophytic vegetation cover. The length of preserved specimen was 4.9 – 26.2 mm, width 0.9 – 4.0 mm and height 1.0 – 5.5 mm.

3.2.1.3.1.2.3 *Caridina endehensis (Plate 6, Figure 4)*

Characters:

- Rostrum armed dorsally with at least 5 teeth.
- Rostrum ascendant in anterior half, slightly or distinctly extending beyond edge of scaphocerite.
- Rostrum unarmed on anterior half of dorsal margin.
- First pereiopod with carpus deeply excavated anteriorly.
- Length of carpus of first pereiopod distinctly larger than or subequal to height. Length of carpus 0.801 mm, height 0.528 mm.
- Telson with median projection on posterior margin.

Distribution: This species of *Caridina* was collected from River Ganga at bridge on SH-98 at Varanasi in Uttar Pradesh and upstream of Jiaganj and Diamond Harbour in West Bengal during March-May 2015.

Habitat: The biological water quality preference of *Caridina endehensis* was moderate pollution in water bodies at a water temperature ranging from 19-35°C. The substratum composition of water bodies ranged from 5-15% sand, 10-30% silt, 10-35% clay, 5-10% detritus and 40-45% macrophytic vegetation. The length of preserved specimen ranged from 10-25 mm, width 1.4-4.0 mm and height 1.7-5.5 mm.

3.2.1.3.1.2.4 *Caridina gracilipes*

Characters:

- Rostrum armed dorsally with at least 5 teeth.
- Rostrum ascendant in anterior half, slightly or distinctly extending beyond edge of scaphocerite.
- Rostrum with 1-3 sub apical teeth separated from rest of dorsal series.
- First pereiopod with carpus moderately excavated anteriorly.
- Length of carpus of first pereiopod distinctly longer than height.

- Telson with or without median projection on posterior margin.
- Rostrum long and slender, reaching nearly to or slightly extending beyond edge of scaphocerite.
- Rostrum less than 1.5 times as long as carapace.
- Rostrum armed on posterior portion of dorsal margin with more than 12 teeth, including at least 1 post orbital teeth on carapace.
- Rostrum armed ventrally with less than 20 teeth.
- Prennal carina with a spine.
- Male first pleopod without appendix interna, or with a vestige of it on endopod.

3.2.1.3.1.2.5 *Caridina gracilirostris*

Characters:

- Rostrum armed dorsally with at least 5 teeth.
- Rostrum ascendant in anterior half, slightly or distinctly extending beyond edge of scaphocerite.
- Rostrum with 1-3 sub apical teeth separated from rest of dorsal series.
- First pereiopod with carpus moderately excavated anteriorly.
- Length of carpus of first pereiopod distinctly longer than height.
- Telson with or without median projection on posterior margin.
- Rostrum very long and slender, extending far beyond edge of scaphocerite.
- Rostrum more than 1.5 times as long as carapace.
- Rostrum armed on posterior portion of dorsal margin with 5-11
- Rather widely spaced teeth, including at most 1 postorbital tooth on carapace.
- Rostrum armed ventrally with 28-36 teeth.

3.2.1.3.1.2.6 *Caridina celebensis (Plate 6, Figure 5, 6)*

Characters:

- Rostrum armed dorsally with atleast 5 teeth.
- Rostrum nearly horizontal or slightly down curved anteriorly, reaching to or slightly extending beyond edge of scaphocerite.
- Rostrum nearly horizontal.

- Rostral teeth throughout dorsal margin.
- Rostrum with 7-10 postorbital teeth on carapace.
- Stylocerite distinctly extending beyond end of basal segment of antennular peduncle.
- Endopod of male first pleopod without appendix interna.

Distribution: This species of *caridina* was collected form River Ganga at downstream of Mirzapur after the confluence of two drains in Uttar Pradesh during March 2015.

Habitat: The biological water quality of River Ganga at its habitat was moderately polluted at a water temperature of 22°C. The substratum composition of water body at this location was 35% sand, 20% silt, 10% detritus and 35% of macrophytic vegetation. The length of preserved specimen was22.0 mm, width 4.0 mm and height 5.2 mm.

3.2.1.3.1.2.7 Caridina bakoensis (Plate 6, Figure 7, 8, 9)

Character:

- Rostrum armed dorsally with more then 5 teeth.
- Rostrum horizontal, reducing edge of scaphocerite.
- No teeth on anterior portion of dorsal margin of rostrum.
- Appendix interma present an endopod of male.
- Rostrum short reaching end of basal segment of antennular peduncle.

Distribution: This species of *Caridina* was collected from River Ganga at Downstream of Buxar in Bihar, during December, 2015.

Habitat: *Caridina bakoensis* preferred moderately polluted biological water quality of River Ganga at water temperature of 17ºC and substratum of river bed composed of 10% sand 30% silt, 50% of clay and 10% of Macrophytic vegetation. The length ranged from 11.05-17.23mm and width 1.33-2.28 mm.

3.2.1.3.2 Suborder Brachyura

- Abdomen folded beneath thorax.
- Body rather flattened and rounded.
- Rostrum lacking.
- Tail fan absent.

Character 1

- Eyes very large relative to carapace.
- Cornea often reaching to edge of carapace.

- Third maxillipeds forming distinct rhomboidal gap between them when closed.
- Ischium and merus with prominent oblique setose ridge.
- Pterygostomial region with dense setae arranged in distinct regular pattern.
- Male first pleopod with distinct pectinated lip or projection.

Character 2

- Eyes small relative to carapace.
- Cornea never close to edges of carapace.
- Third maxillipeds closing tightly, not forming rhomboidal gap between them.
- Ischium and merus without distinct ridges.
- Pterygostomial region with scattered setae or glabrous.
- Male first pleopod without prominent pectinated lip or projection, or unpectinated throughout.

3.2.1.3.2.1 Family Potamidae

- Eyes small relative to carapace.
- Cornea never close to edge of carapace.
- Third maxillipeds closing tightly, not forming rhomboidal gap between them.
- Ischium and merus without distinct ridges.
- Pterygostomial region with scattered setae or glabrous.
- Male first pleopod without prominent pectinated lip or projection, or unpectinated throughout.
- Carapace usually quadrate to transversely ovate.
- Regions usually distinct.
- Anterolateral margin may be entire or with tooth, lobes or spines.
- Exopod of third maxilliped slender.
- Anteroexternal angle of merus not expanded.
- Legs with distal segments subcylindrical or cylindrical in cross-section, not densely lined with setae.
- Male first pleopod stiff but not hard, distal part normal, never pectinated.
- Mandibular palp with single terminal lobe.
- Male abdomen distinctly triangular in shape.

3.2.1.3.2.1.1 *Johora (Plate 7, Figure 1, 2)*

Characters:

- Eyes small relative to carapace.
- Third maxilliped with well-developed flagellum on exopod of third maxilliped which extends to at least half width of merus.
- Dorsal surface of carapace with granules, striae, punctae and / or scattered setae.
- Epi-and postorbital cristae distinct.
- Male second gonopod shorter, sub equal to or slightly longer than male first gonopod, never twice the length of male first pleopod.
- Male first gonopod not elongate, usually gently or strongly curved inwards, sometimes hook-like, distal part gently tapering to tip.

3.2.1.3.2.1.2 *Cerberusa*

Characters:

- Third maxilliped without flagellum on exopod of third maxilliped, or if present, very short, distinctly less than half width of merus.
- Carapace with reduced or without pigmentation.
- Epigastric cristae weak or absent.
- Eyes reduced.
- Cornea of eye degenerated to varying degrees.
- Ambulatory legs-slender, long.
- Male second gonopod about twice length male first gonopod.

3.2.1.3.2.1.3 *Isolapotamon (Plate 7, Figure 3, 4)*

Characters:

- Eyes small relative to carapace.
- Third maxilliped with well-developed flagellum on exopod of third maxilliped which extends to atleast half width of merus.
- Dorsal surface of carapace with granules, striae, punctae and / or scattered setae.
- Epi-and postorbital cristae distinct.
- Male second gonopod shorter, subequal to or slightly longer than male first gonopod, never twice the length of of male first pleopod.

- Male first gonopod very long, slender, distal part usually dilated to different degrees.

Distribution: This species of crab was collected from West Bengal stretch of River Ganga at upstream of Tribeni and Diamond Harbour duringMay 2015.

Habitat: The biological water quality preference of this species of crab, ranged from moderate to heavy pollution at water temperature ranging from 31 – 33°C. The substratum composition of water bodies at its habitat ranged from 5-10% sand, 10-15% silt, 30-35% clay, 5-10% detritus and 40% of macrophytic vegetation. The length of preserved specimen was 3.0 -12.4 mm, width 3.0-14.0 mm and height 1.7-6.2 mm.

3.2.1.3.2.2 Family Parathelphusidae

- Eyes small relative to carapace.
- Cornea never close to edge of carapace.
- Third maxillipedes closing tightly, not forming rhomboidal gap between them.
- Ischium and merus without distinct ridges.
- Pterygostomial region with scattered setae or glabrous.
- Male first pleopod without prominent pectinated lip or projection, or un pectinated throughout.
- Carapace usually quadrate to transversely ovate.
- Regions usually distinct.
- Anterolateral margin may be entire or with tooth, lobes or spines.
- Exopod of third maxilliped slender.
- Antero external angle of merus not expanded.
- Legs with distal segments subcylindrical or cylindrical in cross-section, not densely lined with setae.
- Male first pleopod stiff but not hard, distal part normal, never pectinated.
- Mandibular palp with terminal part bilobed.
- Male abdomen T-shaped in shape to varying degrees.

3.2.1.3.2.2.1 *Perithelphusa (Plate 7, Figure 5, 6, 7)*

Characters:

- Anterolateral margin with 1-3 teeth (including external orbital tooth).

- Anterolateral margin with 1 or 2 teeth (including external orbital tooth).
- Frontal median triangle incomplete.
- Dorsal and lateral cristae absent and /or weak, sometimes strong, not completely fused.
- Larger adult male chela with gently curving fingers, rounded in cross section.
- Male first pleopod with sides of terminal segment gently tapering along most of length.

Distribution: This species of crab was collected from River Ganga at Raghunathganj, Chinsura and Diamond harbor in West Bengal during May 2015.

Habitat: *Perithelphusa* was collected from a biological water quality of slight to moderate pollution in River Ganga at a water temperature ranging from 31-33°C. The substratum composition of water bodies at this location composed of 5-10% sand, 10-20% silt, 20-35% clay, 5-10% detritus and 40-45% of macrophytic vegetation cover. The length of preserved specimen was 2.0-7.2 mm, width 2.1 – 8.0 mm and height 2.1 to 4.1 mm.

3.2.1.3.2.2.2 *Salangathelphusa (Plate 7, Figure 8, 9)*

Characters:

- Anterolateral margin with 4 teeth (including external orbital tooth).
- Male first pleopod very short.
- Entire terminal segment swollen, resembling bird's head.

Distribution: These crabs were collected from River Ganga at Diamond Harbour in West Bengal during May 2015.

Habitat: The biological water quality requirement of its habitat was moderate pollution at water temperature of 31°C. The substratum composition of River Ganga at this location was 5% sand, 10% silt, 35% clay, 10% detritus and 40% of macrophytic vegetation. The length of preserved specimen was 3.1-4.0 mm, width 3.2 – 4.2 mm and height 1.3 to 2.0 mm.

3.2.1.3.2.3 Family Hymenosomatidae

- The Hymenosomatidae are among the smallest crabs with only very few species are entering freshwaters.
- The small crabs have a seasonal appearance from winter to early summer.

- The observation of breeding behavior and different size classes indicates an annual migration to the brackish waters for reproduction, whereas the adults can survive in pure freshwater using the food resources.

3.2.1.3.2.3.1 *Neorhynchoplax nasalis juvenile (Plate 7, Figure 10, 11)*

Characters:

- Smaller than *H.carteri.*
- Females are carrying their eggs in special sack-like brood pouches which are fixed under the abdomen in March and April.

Distribution: The juveniles of *Neorhynchoplaxnasalis* were collected from River Ganga at Farakka barrage, Raghunathganj, Chinsura, Palta Water Intake and Ghat downstream of Srirampore in West Bengal during May 2015.

Habitat: At all the locations of its habiat, the biological water quality ranged from slight to moderate pollution at water temperature ranging from 29.9- 35°C. The substratum composition at these locations of River Ganga composed of 5-15% sand, 10-20% silt, 15-35% clay, 5-10% detritus and 40-45% of macrophytic vegetation.

3.2.1.3.2.4 Family Varunidae

- Eyes small relative to carapace.
- Cornea never close to edges of carapace.
- Third maxillipeds closing tightly, not forming rhomboidal gap between them.
- Ischium and merus without distinct ridges.
- Pterygostomial region with scattered setae or glabrous.
- Male first pleopod without prominent pectinated lip or projection, or unpectinated throughout.
- Carapace distinctly squarish.
- Regions poorly developed.
- Anterolateral margin with low teeth or lobes.
- Rarely dentiform.
- Exopod of third maxilliped very stout.
- Anteroexternal margin may be entire or with teeth, lobes or spines.
- Exopod of third maxilliped very stout.
- Anteroexternal angle of merus expanded, ear- like.

3.2.1.3.2.4.1 *Varuna yui (Plate 7, Figure 12, 13, 14)*

Characters:

- Legs with distal segments laterally flattened, densely lined with setae.
- Male first pleopod very stiff, hard, tip bilobed with tip pectinated.

Distribution: This species of crab, was collected from West Bengal stretch of River Ganga at Farakka barrage, downstream of FTPS Farakka, upstream of Jiaganj, Chinsura, downstream of Srirampore and Diamond Harbour during May, 2015.

Habitat: *Varuna yui* was collected from a slight to moderate pollution in biological water quality of River Ganga at water temperature ranging from 31-35°C. The substratum of water bodies at its habitat composed of 5-15% sand, 10-20% silt, 15-35% clay, 5-10% detritus and 40-45% of macrophytic vegetation. The length of preserved specimen ranged from 2.8-18.2 mm, width 3.0 – 19.7 mm and height 1.0 to 8.0 mm.

3.2.1.3.2.5 Family Sesarmidae

- Eyes very large relative to carapace.
- Cornea often reaching to edge of carapace.
- Third maxillipeds forming distinct rhomboidal gap between them when closed.
- Ischium and merus with prominent oblique setose ridge.
- Pterygostomial region with dense setae arranged in distinct regular pattern.
- Male first pleopod with distinct pectinated lip or projection.

3.2.1.3.2.5.1 *Sesarmoides (Plate 7, Figure 15, 16)*

Characters:

- Frontal margin distinctly shorter than posterior carapace margin. Second and third ambulatory legs long.

Distribution: These crabs were collected from River Ganga at transmission tower upstream of Tribeni and Diamond Harbour in West Bengal during May 2015.

Habitat: The habitat of these crabs preferred moderate pollution in biological water quality at water temperature ranging from 31-32°C. the substratum composition at these locations ranged from sand 5-10%, silt 10-15%, clay 35%, detritus 5-10% and 35-40% of macrophytic vegetation.

3.2.1.3.2.5.2 *Geosesarma (Plate 7, Figure 17, 18)*

Characters:

- Frontal margin equal to or broader than posterior carapace margin.
- Second and third pair of ambulatory legs not elongate.
- Basal antennular segment swollen, rounded.
- Adult females with large eggs.
- Completely freshwater.

Distribution: *Geosesarma* was collected from River Ganga at Ghat downstream of Srirampore and near Belgharia in West Bengal during May 2015.

Habitat: *Geosesarma* preferred a biological water quality of moderate pollution in water body at water temperature range of 32-33°C. The substratum composition of River Ganga at this location, composed of 5% sand, 10-15% silt, 35% clay,5-10% detritus and 40% of macrophytic vegetation. The length of preserved specimen was 9.1-10.0 mm, width 11.0-11.0 mm and height 5.0 -6.0 mm.

3.2.1.3.2.5.3 *Sesarmops (Plate 7, Figure 19, 20)*

Characters:

- Frontal margin equal to or broader than posterior carapace margin.
- Second and third pair of ambulatory legs not elongate.
- Basal antennular segment not swollen, broader than long.
- Adult female with small eggs(distinctly less than 0.5mm),
- Carapace with lateral margins gently diverging.
- Male first pleopod with distal chitinous process slender, elongate.

Distribution: *Sesarmops* were collected from River Ganga at Ghat downstream of Srirampore and Diamond Harbour in West Bengal during May 2015.

Habitat: *Sesarmops* preferred mostly moderate pollution in biological water quality at water temperature of 31-33°C. The substratum composition of river bed of River Ganga at these habitats composed of 5% sand, 10-15% silt, 35% clay,5-10% detritus and 40% of macrophytic vegetation. The length of preserved specimen was 2.5-16.0 mm, width 3.1 – 17.4 mm and height 1.2 – 10.0 mm.

3.2.1.3.2.5.4 *Pseudosesarma (Plate 7, Figure 21, 22)*

Characters:

- Frontal margin equal to or broader than posterior carapace margin.
- Second and third pair of ambulatory legs not elongate.
- Basal antennular segment not swollen, broader than long.
- Adult female with small eggs(distinctly less than 0.5mm),
- Marine.
- Carapace with lateral margins parallel or almost so.
- Male first pleopod with very short or very stout chitinous process, slender.

Distribution: *Pseudosesarma* was collected from River Ganga at Diamond Harbour in west Bengal stretch during May 2015.

Habitat: *Pseudosesarma* was collected from moderately polluted biological water quality of River Ganga at water temperature of 31°C. The substratum composition of water body at this location was 5% sand, 10-15% silt, 35% clay, 5-10% detritus and 40% of macrophytic vegetation. The length of preserved specimen ranged from 3.0 -6.4 mm, width 3.0 – 8.0 mm and height 1.6-3.1 mm.

3.2.1.3.2.6 Family Gecarcinucidae

- Eyes small relative to carapace.
- Cornea never close to edge of carapace.
- Third maxillipeds closing tightly, not forming rhomboidal gap between them.
- Ischium and merus without distinct ridges.
- Pterygostomial region with scattered setae or glabrous.
- Male first pleopod without prominent pectinated lip or projection, or unpectinated throughout.
- Carapace usually quadrate to transversely ovate.
- Regions usually distinct.
- Anterolateral margin may be entire or with tooth, lobes or spines.
- Exopod of third maxilliped slender.
- Anteroexternal angle of merus not expanded.
- Legs with distal segments subcylindrical or cylindrical in cross-section, not densely lined with setae.

- Male first pleopod stiff but not hard, distal part normal, never pectinated.
- Mandibular palp with terminal part bilobed.
- Male abdomen T-shaped in shape to varying degrees.
- Anterolateral margin with 1-3 teeth (including external orbital tooth).
- Anterolateral margin with 1 or 2 teeth (including external orbital tooth).
- Frontal median triangle incomplete.
- Dorsal and lateral cristae absent, and /or weak, sometimes strong, not completely fused.
- Posterior margin of epistome with a broad median triangular tooth.
- Lateral margins evenly concave.
- Ischium of third maxilliped with shallow or undiscernible median sulcus.
- Exopod short, without trace of flagellum.

3.2.1.3.2.6.1 *Lepidothelphusa (Plate 7, Figure 23, 24)*

Characters:

- Carapace slightly broader than long.
- Anterolateral margin entire.
- Antero-and posterolateral margins not clearly demarcated.
- Lateral carapace margins almost subparallel.
- Ambulatory legs either slender or elongate.

Distribution: This species of crab was collected from River Ganga at Palta Water Intake in West Bengal during May 2015.

Habitat: *Lepidothelphusa* was collected from moderately polluted biological water quality at water temperature of water body 31°C. The substratum compositon of River Ganga at its habitat composed of 5% sand, 10-15% silt, 35% clay, 5-10% detritus and 40% of macrophytic vegetation.

3.2.1.3.2.6.2 *Bakousa*

Characters:

- Anterolateral margin with 1-3 teeth (including external orbital tooth).

- Anterolateral margin with 1 or 2 teeth (including external orbital tooth).
- Frontal median triangle incomplete.
- Dorsal and lateral cristae absent and /or weak, sometimes strong, not completely fused.
- Posterior margin of epistome with a median triangular tooth, lateral margins sinuous.
- Ischium of third maxilliped with distinct oblique median sulcus.
- Exopod long with distinct flagellum.
- Ambulatory legs normal length, not elongate.
- Carapace with dorsal surface gently convex to almost flat, not swollen.
- Branchial regions not distinctly inflated.
- Fully aquatic species or found in muddy, swampy areas near water.
- Male abdomen narrowly T-shaped.
- Male first pleopod with terminal segment slender.
- Male first pleopod terminal segment relatively longer, at least one third or more length of sub terminal segment.
- Male first pleopod with stout, short terminal segment.
- Male second pleopod with distal segment longer than half length of but shorter than basal segment.

3.2.1.3.2.6.3 *Juvenile crabs*

Distribution: Juvenile crabs were collected from River Ganga at Ghat downstream of Srirampore and Diamond Harbour in West Bengal during May 2015.

Habitat: The habitat of juvenile crabs was confined to moderately polluted biological water quality in River Ganga at water temperature range of 31-33°C. The substratum composition preferred by these juvenile crabs was5% sand, 10-15% silt, 35% clay, 5-10% detritus and 40% of macrophytic vegetation. The length of juvenile crabs ranged from 3.7-4.5 mm and width 2.3 -2.5 mm.

Figure 12 : Classification of Order Mysidacea

3.2.1.4 Order Mysidacea

Primary freshwater Malacostruca are the large crabs Potamidae, Parathelphusidae and the Atyid shrimps, whereas the Grapsidae. Hymenosomatidae, Palaemonidae, Cirrolanidae and the Mysid shrimps are young peripheral invaders into the Ganga River system.

3.2.1.4.1 Family Mysidae

- They are the recent invaders of estuaries and fresh waters.
- Three species were already known from the brackish Hypopotamon regions of the Gangetic delta.
- Out of which single species *Gangemysis assimilis* was found in several rivers of the Lower Gangetic plains in Nepal more than 1000 km far away from sea coast in elevation of 73 msl.
- Since these water bodies are not used for navigation, it is most likely to assume the natural occurrence of Mysid by active upstream migration. The recently recorded species are *Gangemysis assimilis*, occurring in India.

3.2.1.4.1.1 Gangemysis assimilis (Plate 8, Figure 1)

Characters:

- They inhabit slowly running lowland streams and smaller rivers with very rich invertebrate diversity.

Distribution: This species of Mysis was collected from River Ganga at Buxar and Danapur Patna in Bihar state during April 2015.

Habitat: The habitat of Mysis was having moderately polluted biological water quality in River Ganga at water temperature ranging from 26-28°C.

The substratum composition of water bodies ranged from 10-15% sand, 20-255 silt, 15-30% clay, 5% detritus and 35-40% of macrophytic vegetation. The length of preserved specimen was 2.52 to 5.15 mm, width 0.31 -0.75 mm.

3.2.2 Class Insecta

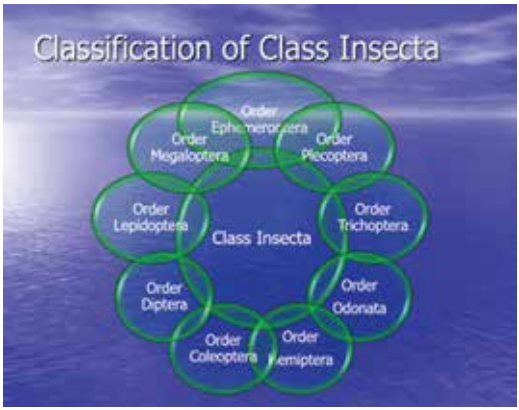

Figure 13 : Classification of Class Insecta

3.2.2 Class Insecta

- Body is divided into three distinct region i.e. head, thorax and abdomen.
- Head bearing the mouthparts, one pair of antennae, and other sensory equipment;
- Thorax bearing 3pairs of legs; abdomen bearing usually 9 visible segments without appendages except cerci (tail bristles) at the end.

3.2.2.1 Order Ephemeroptera

Figure 14 : Classification of Order Ephemeroptera

3.2.2.1 Order Ephemeroptera

- Animal is a nymph.
- Three or sometimes only two tail filaments (Cerci) on the last abdominal segment.
- Abdomen with plate- or leaf like gills.
- Single claw on feet.

3.2.2.1.1 Family Baetidae

- Body not flattened without broad thorax and head.
- Eyes placed laterally.
- Head hypognathous.
- Antennae long, length more than three times width of head.
- Seven pairs of gills that clearly project beyond the side of abdomen.
- Gills not feathery, consisting of one plate.
- Hind corners of abdominal segments not drawn out to form spines.
- Tails either of similar length or middle tail shorter than others.
- Postero-lateral projections usually absent or small to moderately developed on abdominal segments 8-9.
- Larvae are good swimmers and are found under stones.

3.2.2.1.1.1 Baetis (Plate 9, Figure 1, 2)

Characters:

- Usually three caudal filaments fully developed.

- Terminal filament shorter and thinner than cerci (rarely vestigial).
- Femur, tibia and tarsus without rows of long fine bristles.
- Head relatively short and high.
- Antennae inserted at about midpoint on height of head.
- Gills present on abdominal segments 1-7 (or 2-7).
- Gills single on all segments, usually all obovate (rarely narrow and lanceolate on segment 6 and 7).
- Positive rheotropic orientation (The nymphs swim short distances by vigorous vertical abdominal undulations. When they stop swimming, they spread the legs, raise the tail, and settle to the bottom

  [somehow similar to the scorpion-like movements] known from the Ephemerellidae.).
- Claws with only one row of denticles, apical denticles largest.

Distribution: May fly nymph commonly observed at various locations on River Ganga at upstream Rishikesh near Luxman Jhula in Uttarakhand, upstream of Narora, Fatehpur, SH-98 and badging ghat-1 at Varanasi in Uttar Pradesh. *Baetis* were also collected from tributary River RamGanga downstream of Muradabad in Uttar Pradesh during December 2014 and February to June 2015.

Habitat: *Baetis* normally preferred moderate pollution in biological water quality at a water temperature range of 11-25°C. The substratum composition of these water bodies ranged 5-70% of boulders, 20% cobbles, 2% pebbles, 8% gravel, 5-10% of sand, 5-30% of silt, 5-70% of clay, 5-20% detritus and 10-70% of macrophytic vegetation. The length of nymph was 6.87 mm to 7.1 mm and width 1.19mm to 1.36 mm.

3.2.2.1.1.2 Pseudocloeon (Plate 9, Figure 3)

Characters:

- Body relatively flattened.
- Head somewhat depressed.
- Antennae usually inserted low at head.
- Legs rather long and held out to side.
- Hind wing pads absent.
- Two well-developed caudal filaments.
- Terminal filament represented by a minute rudiment.
- Caudal filaments with a narrow, dark band at apex of every

fourth to fifth segment.

- Each claw about one-third as long as tarsus, denticulate, the basal denticles always larger.
- Gills on abdominal segments 1-7 oval, either double or single, and broad, or with recurved dorsal flap on anterior segments (1-2, rarely up to segment 6).
- Tracheae branched more or less palmately or with branches better developed on mesal side.

Distribution: The small nymph was collected from River Alaknanda after confluence of River Mandakini at downstream of RudraPrayag during the month of July 2014.

Habitat: The nymph survived in water temperature of 17.2°C in a clean biological water quality. The substratum composition of water body at its habitat was 60% boulders, 35% cobbles, and 5%pebbles. The length of nymph was 4.29 mm and width 0.602 mm.

3.2.2.1.1.3 Platybaetis (Plate 9, Figure 4, 5)

Characters:

- Two well developed cerci.
- Terminal filament reduced to a few segments.
- Head barely wider than long, nearly quadrangular shaped, nearly as wide as pronotum.
- Antennae comparatively short: a little longer than head capsule.
- Hind wing pads very small or lacking.
- Body somewhat flattened.
- Gills somewhat projected laterally.
- Gills smooth, without teeth, only a few bristles – mostly on hind margin, with distinctly branched trachea.

Distribution: *Platybaetis* were collected from tributary River Alaknanda after confluence of River Mandakini at Rudra Prayag in the state of Uttarakhand during November, 2015.

Habitat: The insect nymph preferred slight pollution in biological water quality at water temperature of 12°C. The substratum of river bed composed of 60% boulders, 35 % cobbles and 5% pebbles. The length of nymph was 4.62 mm and width 0.666 mm.

3.2.2.1.2 Family Caenidae

- First pair of gills on first abdominal segment is vestigial and reduced to tapering filaments.
- Other gills stalked under large pair of gill covers (formed from second pair of gills).
- Gills on segment two operculate, quardate in shape and meeting (or meeting nearly) in the middle.
- Larvae found in mud and vegetation debris in still and flowing waters.
- Gills on second segment covering all following gills.

3.2.2.1.2.1 Caenis (Plate 9, Figure 6, 7)

Characters:

- Gills on segment 2 operculate.
- Gills quadrate in shape and meeting (or meeting nearly) in middle.
- Gills on segment 2 covering all following gills.
- Gills on segment 3-7 with fringed margins.
- Gills on abdominal segment 1 vestigeal (reduced to thin filaments).
- Maxillary and labial palpi 3-segmented.

Distribution: Small nymphs were collected from River Ganga at Luxmanjhula, Rishikes and upstream of Narora and Bithur in Uttar Pradesh. It was also collected from downstream of tributary River Tons near Sirsa during the months of December 2014, February and November, 2015.

Habitat: This nymph preferred moderate pollution in biological water quality at a water temperature closely ranged from 17-19.8°C. The substratum composition of these waterbodies consisited of boulders 35%, cobbles, 45%, pebbles and gravels 5% sand, 2-10% silt, 10-70 % clay, 3-10 % detritus and 25-70% of macrophytic vegetation cover. The length of nymph ranged from 3.83 to 9.93 mm and width 1.14 to 2.23 mm.

3.2.2.1.3 Family Ephemeridae

- Most abdominal gills clearly visible held on dorsal or lateral surface of abdominal segments.
- Gills feathery, consisting of two branches each, thickly fringed with filaments.
- Gills 2-7 doubled and uniform in structure with fringed margins.

- Fore tibiae and tarsi more or less flattened, adapted for burrowing.
- Ventral apex of hind tibiae projected into distinct acute point.
- Mandibles with large tusks projected forward and visible from above head.
- Mandibular tusk curved upward apically as viewed laterally
- Larvae of a typical 'burrowing" type.

3.2.2.1.3.1 Eatongenia (Plate 9, Figure 8, 9, 10, 11, 12)

Characters:

- Forelegs fossorial, tibia flattened, adapted for digging.
- Ventral edge of apex of the tibiae of the hind legs projected into a distinct acute point.
- Abdominal gills dorsal.
- On abdominal segment 1, gill reduced to a double lanceolate filament.
- On abdominal segments 2-7 gills do have fringed margins.
- Inner border of wing pads not fused with mesonotum.
- Mandibular tusk bent outwards, without spine on them.
- Uniramous frontal process.
- Highly reduced tarsal claws in the fore legs.

Distribution: This large ephemerid nymph was for the first time collected and identified form River Ganga at Bithoor in Uttar Pradesh and at Mokama downstream of Patna in Bihar during January 2015 and December 2015. It was also collected from tributary River Gandak, near Hajipur and from River Ghaghra before confluence to River Ganga at Manjhi upstream in Bihar during April 2015.

Habitat: Although *Eatongenia* is a clean water indicating nymph but it could withstand slight to moderate pollution in biological water quality with gradual reduction in its abundance. The water temperature preference of its habitat was 15-27ºC and substratum composition at its habitat in water bodies ranged from 5-15% sand, 40% silt, and 45-80% of clay particles. The length of preserved nymph ranged from 17.05-28.0 mm and width 3.12-6.0 mm.

3.2.2.1.3.2 Ephemera sp. (Plate 9. Figure 12)

Characters:

- Forelegs fossorial, tibia flattened, adapted for digging.
- Ventral edge of apex of the tibiae of the hind legs projected into a distinct acute point.

- Abdominal gills dorsal.
- On abdominal segment 1, gill reduced to a double lanceolate filament.
- On abdominal segments 2-7 gills do have fringed margins.
- Inner border of wing pads not fused with mesonotum.
- Mandibular tusk bent outwards, without spine on them.
- Non-spuriferous bifurcate frontal process.
- Long setae whorled over most of the length of the antennal flagellae.
- Distally rounded tibiae of the forelegs.

3.2.2.1.3.3 Ephemera Ephemera

Characters:

- Frontal process of head longer than wide, but less than twice as long as wide.
- Gill 1 with both forks similar in size.
- Mandibular tusk slightly asymmetrical.

3.2.2.1.3.4 Ephemera Aethephemera

Characters:

- Frontal process of head as long as wide.
- Right mandibular tusk much shorter than the left one (dorsal view).

3.2.2.1.3.5 Ephemera Dicrephemera

Characters:

- The characters are given to distinguish above two species of Ephemera.
- Frontal process of head twice as long as wide.
- Gill 1 with outer fork much larger than inner fork.

3.2.2.1.4 Family Heptageniidae

- Body strongly flattened dorso-ventrally with very broad head, thorax and femur of legs.
- Head and body distinctly flattened.
- Eyes and antennae dorsal.
- Head prognathous (pointing in the same direction as the main axis of the body).

- Seven pairs of gills each consisting of a flat plat and a separate tuft of filaments.
- Gills consisting of one plate, two plates, one large plate with a tuft of filaments, or one small plate with up to 12 filaments.
- Gills on abdominal segment 1-7 (gill on segment 1 well developed, not vestigial, not thread-like).
- Gills at least long enough to reach the border of the following tergit or (clearly) longer.
- Gills consist of single semi oval or rarely slender lamellae usually with fibrillifom tufts at or near base.
- Two or three caudal filaments.
- Caudal filaments without hairs or with a few hairs or spines.
    - ❖ Two tailed (caudal filaments) genera of Family Heptageniidae

3.2.2.1.4.1 Ironodes (Plate 9, Figure 13, 14, 15)

Characters:

- Two caudal filaments.
- Well developed paird tubercles present on abdominal terga 1 – 4.

Distribution: *Ironodes* were collected from tributary River Alaknanda after confluence of River Mandakini at Rudra Prayag in the state of Uttarakhand during November, 2015.

Habitat: The insect nymph preferred slight pollution in biological water quality at water temperature of 12°C. The substratum of river bed also composed of 60% boulders, 35 % cobbles and 5% pebbles. The length of nymph was 13.81 mm and width 3.38 mm.

3.2.2.1.4.2 Epeorus

Characters:

- Two caudal filaments.
- Abdominal terga with dense median row of setae.
- Poorly developed paird tubercles present on abdominal terga

3.2.2.1.4.2.1 Epeorus Epeorus (Plate 9, Figure 16, 17, 18)

Characters:

- Two caudal filaments.
- Gill leaflets 1 and 7 large, extending beneath the ventral side of abdominal segments but not forming a closed disk on the ventral side

Distribution: *Epeorus Epeorus* was collected from tributary River Alaknanda after confluence of River Mandakini at Rudra Prayag in the state of Uttarakhand during November, 2015.

Habitat: The insect nymph preferred slight pollution in biological water quality at water temperature of 12°C. The substratum of river bed also composed of 60% boulders, 35 % cobbles and 5% pebbles. The length of nymph was 10.04 mm and width 2.18 mm.

3.2.2.1.4.2.2 *Epeorus Ironopsis*

Characters:

- Two caudal filaments.
- Gill leaflets 1 and 7 forming a closed disk on ventral side.

3.2.2.1.4.3 Iron

Characters:

- Two caudal filaments.
- Abdominal terga without dense median row of setae.
  - Three tailed (caudal filaments) genera of Family Heptageniidae

3.2.2.1.4.4 Afronurus (Plate 9, Figure 19, 20)

Characters:

- Three caudal filaments.
- Lateral margins of pronotum not extending up to the side of the mesonotum.

Distribution: *Afronurus* was collected from tributary River Alaknanda after confluence of River Mandakini at Rudra Prayag in the state of Uttarakhand during November, 2015.

Habitat: The insect nymph preferred slight pollution in biological water quality at water temperature of 12°C. The substratum of river bed composed of 60% boulders, 35 % cobbles and 5% pebbles. The length of nymph was 4.19 mm and width 0.965 mm.

3.2.2.1.4.5 Ecdyonurus

Characters:

- Three caudal filaments.
- Lateral margins of pronotum with sharply expressed discoidal dilations extending on to the side of the mesonotum.

3.2.2.1.4.6 Rhithrogena (Plate 9, Figure 21, 22, 23)

Characters:

- Three caudal filaments.
- Gill leaflets of abdominal terga 1 and 7 forming a closed disk on the ventral side.
- All gills composed of plate-like lamellae and tufts of filaments.
- With the help of the closed disk of gills on their ventral side, the nymphs attach themselves to stones in swift to moderate currents.
- When a rock is lifted from the water, some specimens remain perfectly motionless until an attempt is made to remove them.
- They adhere so tightly to the rocks that they cannot be removed easily.

Distribution: Nymph of *Rhithrogena* was collected from River Ganga at Luxmanjhula, barrage at Rishikesh and in tributary River Alaknanda at Rudra Prayag after confluence of River Mandakini in the state of Uttarakhand during July 2014, June and November 2015.

Habitat: The insect nymph preferred only clean to slight pollution in biological water quality at water temperature ranged from 12 to 19.3 °C. The substratum of river bed also composed of 10 -60% boulders, 35 – 90 % cobbles and 5% pebbles and gravels and 10% sand. The length of nymph ranged from 4.0 – 6.96 mm and width 0.6 – 1.51 mm.

3.2.2.1.4.7 Cynigmina (Plate 9, Figure 24, 25, 26)

Characters:

- Three caudal filaments.
- Anterior margin of head entire, sometimes weakly convex.
- Gill tufts well developed.
- Gill leaflets on abdominal segment 5(sometimes also on abdominal segment 2-6) with acutely pointed apical elongation.

Distribution: The nymph was commonly collected from River Ganga at Rishikesh Barrage near Luxman Jhula and in tributary River Alaknanda after confluence to River Mandakini at Rudra Prayag during July 2014, June, November 2015.

Habitat: The nymph preferred clean biological water quality at water temperature ranging from 17.0 to 19.3°C. in a river bed substratum composed of 10 -60 % boulders, 35 – 90 % cobbles and 5% of pebbles and gravel and

10% of sand. The length of nymph varied from 4.13 – 7.97 mm and width 0.661 – 2.13 mm.

3.2.2.1.5 Family Siphlonuridae

- Outer tails (cerci) with dense fine hairs only at the inner side.
- Antennae short, length less than twice width of head
- Body cylindrical and eyes lateral.
- Head forming a right angle with the body (seahorse-like).

3.2.2.1.5.1 Ameletus (Plate 9, Figure 27, 28, 29)

Characters:

- Gills single. Oval, and small, with sclerotized bands.
- Posterolateral projections moderately to poorly developed on the last segments (9-9).
- Pectinate spines on crown of maxillae.

Distribution: Nymphs were collected from River Ganga at Haridwar barrage and tributary River Alaknanda after confluence to River Mandakini at Rudra Prayag in Uttarakhand state during the months of July 2014, June and November 2015.

Habitat: The biological water quality in the vicinity of these nymph ranged from clean to slight pollution and the substratum composition ranged from 5-60% boulders, 35-90% cobbles, 4-5% pebbles and gravel and 10% of sand. The length of this nymph 4.63 – 8.15 mm and width 0.719 -1.43 mm.

3.2.2.1.6 Family Ephemerellidae

- The nymph clings to stones and boulders on lake shores and in streams and rivers.
- Body not flattened. Without broad head and thorax.
- Eyes placed laterally. Gills consisting of a flat plate with a separate tuft of filaments.
- Gills consist of anterior (dorsal) oval lamella and posterior (ventral) lamella with numerous lobes.
- If lamellate gills on abdominal segment 2 than with posterio-median tubercles. Often with dorsal tubercles on head, thorax or abdomen.
- Paired tubercles often present on abdominal terga.
- Two or three caudal filaments.
- Caudal filaments without hairs or with a few hairs or spines

3.2.2.1.6.1 Torleya

Characters:

- Legs with long hair and spines.
- Long hair-like spines on terminal filaments.
- Semi-operculate gills on abdominal segments 3-7.

Distribution: These were small nymphs of ephemeroptera, collected from tributary of River Ganga the River Alaknanda after confluence to River Mandakini at Rudra Prayag during the month of July 2014.

Habitat: The habitat of this nymph preferred clean biological water quality at water temperature of 17.2°C. The river bed substratum at its habitat composed of 60% boulders, 355 cobbles and 55 of pebbles.

3.2.2.1.6.2 Ephemerella Eurylophella (Plate 9, Figure 30, 31)

Characters:

- Without well developed paired tubercles on the head and thorax, and without having tubercles on the ventral margin of fore femora.
- With posterolateral projections on abdominal terga
- Caudal filaments subequal and with heavy intersegmental setae and without whorls of spines on apex of each segment.
- Segment 9 is distinctly longer than segment 8.

Distribution: Nymph was collected from tributary River Alaknanda after confluence to River Mandakini at Rudra Prayag in Uttarakhand state during the month of November 2015.

Habitat: The biological water quality in the vicinity of these nymph was having slight pollution and the substratum composition of 60% boulders, 35% cobbles and 5%. The length of this nymph was 5.51 mm and width 0.766 mm.

3.2.2.1.6.3 Ephemerella sp. (Plate 9, Figure 32, 33)

Characters:

- Without well developed paired tubercles on the head and thorax, and without having tubercles on the ventral margin of fore femora.
- With posterolateral projections on abdominal terga
- Caudal filaments subequal and with heavy intersegmental setae and with whorls of spines on apex of each segment.

Distribution: Nymph was collected from River Ganga at Haridwar barrage and tributary River Alaknanda after confluence to River Mandakini at Rudra

Prayag in Uttarakhand state during the months of July 2014, June and November 2015.

Habitat: The biological water quality in the vicinity of these nymph ranged from clean to slight pollution and the substratum composition ranged from 5-60% boulders, 35-90% cobbles, 4-5% pebbles and gravel and 10% of sand. The length of this nymph 4.63 – 8.15 mm and width 0.491 -1.43 mm.

3.2.2.1.6.4 Drunella (Plate 9, Figure 34, 35)

Characters:

- Paracercus present, equal or subequal to cerci in length.
- Head with spines or tubercles.
- Inner margin of fore tibia with seperated pointed projection directed distally along inner side of tarsus.
- Anterior margin of fore femora mostly with pointed teeth.
- Clypeus crossed transversely by a distinct stripe of bristles projected forwards.
- Robust bodyform.
- Well developed abdominal tubercles
- With tubercles on the ventral edge of fore femora.

Distribution: Nymph was collected from tributary River Alaknanda after confluence to River Mandakini at Rudra Prayag in Uttarakhand state during the month of November 2015.

Habitat: The biological water quality in the vicinity of these nymph was having slight pollution in water body and the substratum composition of 60% boulders, 35% cobbles and 5%. The length of this nymph was 5.08 mm and width 0.995 mm.

3.2.2.1.7 Family Neoephemerelidae

- The operculate gills on abdominal segment 2 covering all or most of the following gills.

3.2.2.1.7.1 Neoephemeropsis (Plate 9, Figure 36)

Characters:

- *Neoephemeropsis* sp. can be distinguished from Caenidae because the operculate gills are not meeting in the middle and are not quadrate.

Distribution: This nymph was collected from River Ganga at Rishikesh barrage near Luxman Jhula and River Alaknanda after confluence to River

Mandakini at Rudra Prayag in Uttarakhand state during the months of July 2014 to June 2015.

Habitat: The nymph was collected from waterbody having clean biological water quality at water temperature of 17.2 – 19.3°C. The substratum composition of water body at this location composed of 10-60% boulders, 35-90% cobbles and 5% of pebbles. The length of nymph was 3.01 – 3.22 mm and width 0.987 – 1.11 mm.

3.2.2.1.8 Family Leptophlebiidae

- Head usually prognathous (pointing straight forward).
- Six or seven pairs of gills that clearly project beyond the sides of the abdomen when the nymph is viewed from above.
- Each gill consisting of either two strap-like filaments or a plate that tapers to a single filament, or a small base that supports two filaments.
- Abdominal gills either forked, formed of two lamellae with margins fringed or terminated in filaments or points.
- Each tail has short, sparse hairs on both sides.
- Often with paracercus present, equal or subequal to cerci in length.
- The nymphs are poor swimmers and are usually found under stones or among bryophytes (mosses) and other macrophytes in stream, rivers and occasionally in lakes.
- The nymph crawls on the substratum or swim in a labored fashion and are found in ponds, lakes, streams and rivers. Larvae of the "walking" type.

3.2.2.1.8.1 Choroterpides

Characters:

- Abdominal terga extending to lateral sides of abdomen.
- All abdominal gills arise apparently laterally or dorsally.
- Maxillary and labial palps greatly elongated and highly setaceous extending well beyond the sides of the head so that they are conspicuous in the dorsal view.
- Abdominal gills present on segments 2-7.
- Denticles on tarsal claws about equal in length.

Distribution: These nymphs were collected from River Ganga at Rishikesh barrage in Uttarakhand during July 2014.

Habitat: The nymph preferred a clean biological water quality in its habitat at a water temperature of 19.3°C with a river bed substratum of 10% boulders and 90% cobbles.

3.2.2.2 Order Plecoptera

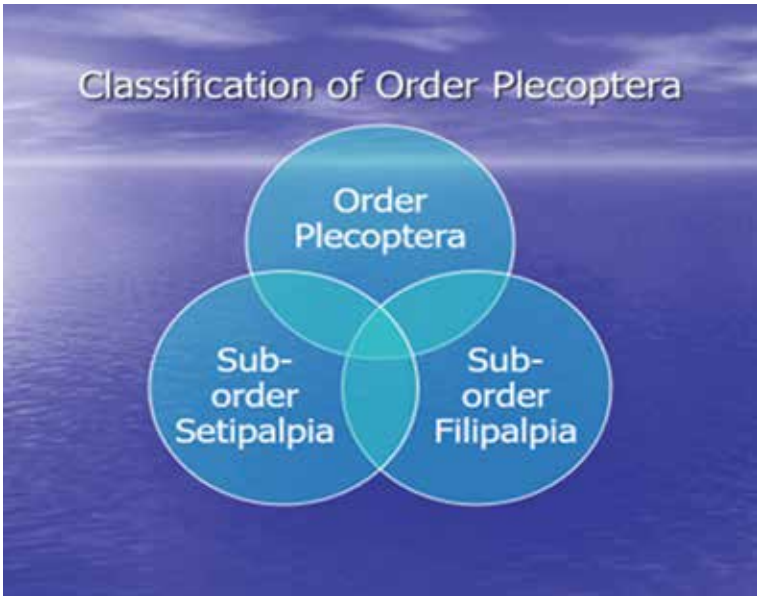

Figure 15 : Classification of Order Plecoptera

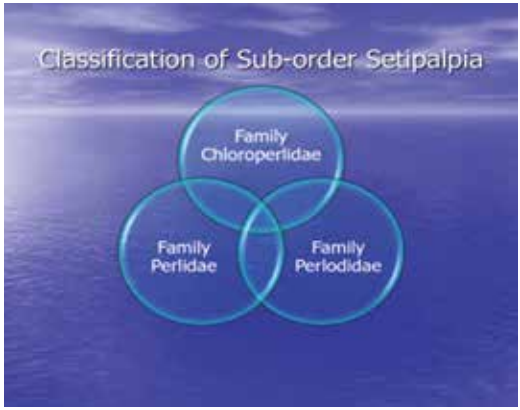

Figure 16 : Classification of Sub Order Setipalpia

3.2.2.2 Order Plecoptera

- Animal is a nymph. Two posterior tail filaments (Cerci) on the last abdominal segment.
- Two claws on feet.
- Commonly called Stone Flies.

3.2.2.2.1 Suborder Setipalpia

- Usually big larvae with less developed wing pads which are not well visible.
- First and second tarsi are very small, the third tarsi are very long,
- Antennae thinner.

3.2.2.2.1.1 Systellognatha

- Glossae reduced

3.2.2.2.1.1.1 **Family Perlidae / Acroneuridae**

- Finely branched gills present on sides and on the underside of all thoracic segments (finely branched gill tufts absent from abdominal sterna (breast plates).

3.2.2.2.1.1.1.1.1 Tetropina (Plate 10, Figure 1, 2)

Characters:

- Row of short stout bristles (pegs) across the occipital ridge complete and straight.
- 2 ocelli

Distribution: These are stonefly nymphs collected from River Ganga at Rishikesh barrage near Luxman Jhula, Gang Nahar downstream Har ki Poudi in Hardwar in Uttarakhand. It was also collected from tributary River Alaknanda after confluence to River Mandakini at RudraPrayag in Uttarakhand during the month of July 2014.

Habitat: The stonefly nymph was collected from a water body having clean biological water quality of river at water temperature ranging from 17.2 to 19.8°C. The substratum composition at its habitat ranged from 10 to 100% boulders, 35 – 90% cobbles and 55 of pebbles. The length of this nymph varied from 8.11mm to 28,0mm and width 2.11 mm to 8.00 mm.

3.2.2.3 Order Trichoptera

Figure 17 : Classification of Trichoptera

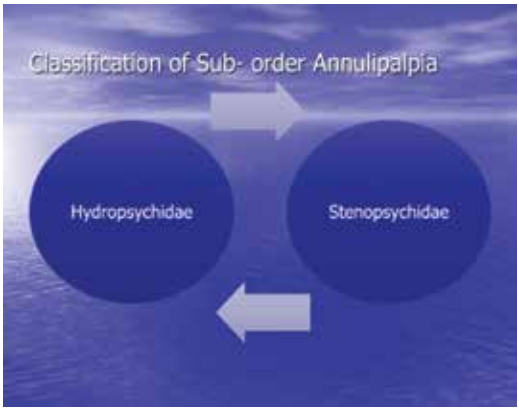

Figure 18 : Classification of Sub-order Annulipalpia

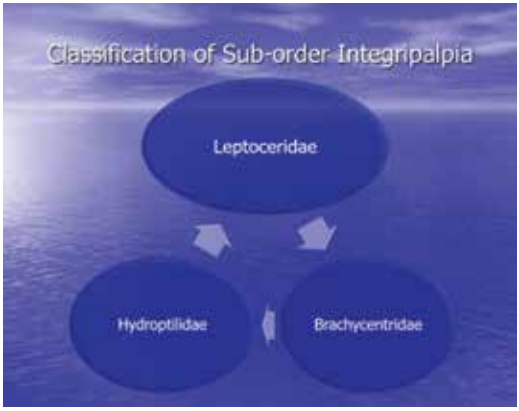

Figure 19 : Classification of Sub-order Integripalpia

3.2.2.3 Order Trichoptera

- Animal is larva.
- Commonly called Caddis flies.
- Various degree of sclerotization of the pro-, meso- and meta-notum (dorsal surface of the three thoracic segments).
- The end of the abdomen is equipped with a pair of hooks
- There may be minute gill filaments on each abdominal segment.
- The animals live in different shape and type of cases/tubes constructed from spun fibres, sand, stones, or vegetation. Some of them are case less.
- There may be presence or absence of abdominal and anal gills
- Various patterning on the head especially on the clypeus (the circular plate on the front of the head above the labium.

3.2.2.3.1 Suborder Annulipalpia

- Larvae pale.
- Anal prolegs long with prominent claws.
- Animal without portable case

3.2.2.3.1.1 **Family Hydropsychidae** (Plate 11, Figure 1)

- Anal claw hook shaped.
- Larvae not constructing a portable case.
- Backside of each thoracic segment largely covered by sclerotized plates, usually closely appressed along the mid-dorsal line, sometimes subdivided with thin transverse sutures, or some sclerites undivided.
- Abdomen with ventrolateral rows of branched gills.
- Larvae in fixed retreat.

3.2.2.3.1.1.1 *Cheumatopsyche (Plate 11, Figure 2)*

Characters:

- Genae of capsule touching ventrally, separating ventral apotome into anterior and posterior parts, or posterior part inconspicuous.
- Posterior ventral apotome much less than one-half as long as median ecdysal line or inconspicuous.
- Abdominal gills with up to 10 filaments arising mostly near the apex of the central stalk.
- Fore trochantin usually forked. Sometimes not.

- Prosternum with pair of usually small sclerites posterior to prosternal plate.
- If sclerites large, frontoclypeus with shallow mesl excision.
- Anterior ventral apotome without anteromedial projection.
- Mandibles not flanged.
- Fore trochantin forked.

Distribution: The caddis fly larvae were collected from River Ganga at Barawali near rail and road bridge, Kachla ghat Badayun, Bithur, bridge on Lord Curzon road, right bank, Allahabad in Uttar Pradesh. It was also collected from tributaries River Kali at Kanpur –Farrukhabad road, River Tons near Panasa in Uttar Pradesh during the months of December 2014 and January – February 2015.

Habitat: *Cheumatopsyche* was collected from biological water quality ranging from slight to moderate pollution in water bodies at a water temperature ranging from17 to 21°C. The substratum of river bed at these locations composed of sand 2 – 40%, silt 3 – 30%, clay 5-80%, detritus 5 – 40% and macrophytic vegetation cover of 10 – 35%. The length of larvae ranged from 10.95 mm to 11.57 mm and width 2.56 mm to 3.0 mm.

3.2.2.3.1.2 **Family Stenopsychidae**

- Only pronotum sclerotised.
- Extremely elongated head.
- Pronotum narrower than the other thoracic segments.
- Fore-trochantin bifurcated.
- No abdominal gills.
- Long anal prolegs.

3.2.2.3.1.2.1 *Stenopsyche (Plate 11, Figure 3)*

Characters:

- Body length goes up to 40 mm.
- Head prolonged, more than two times as long as wide.
- Labium suboval with small palps.

Distribution: *Stenopsyche* was collected from tributary River Alaknanda after confluence of River Mandakini at Rudra Prayag in the state of Uttarakhand during November, 2015.

Habitat: The insect nymph preferred slight pollution in biological water quality at water temperature of 12°C. The substratum of river bed also composed of 60% boulders, 35 % cobbles and 5% pebbles. The length of nymph was 25.6mm and width 19.1 mm.

3.2.2.3.2.1 **Family Polycentropodidae**

3.2.2.3.1.3.1 *Polycentropus*

Characters:

- Larvae without cases.
- Fore trochantin acute
- Only pronotum sclerotized
- anal claws with teeth.

Distribution: These larvae were observed in River Ganga at Manjhi in Bihar, during December 2015..

Habitat: *Polycentropus* preferred moderately polluted biological water quality in River Ganga at a water temperature of 16ºC. The substratum of River Ganga at this location, consisted of mainly 10% sand, 40% silt and 40% of clay particles. The length of preserved specimen was 9.493 mm and width 0.933 mm.

3.2.2.3.2 Suborder Integripalpia

- Larvae more stout.
- Anal prolegs as well as anal claws short.
- Larvae with portable cases

3.2.2.3.2.1 **Family Leptoceridae**

- Larvae construct portable cases of various materials.
- Metanotum and sometimes mesonotum entirely .membranous or largely so with several pairs of smaller sclerites or hairs.
- Sclerotized plates on mesonotum lightly pigmented except for pair of dark curved lines on posterior half.
- Antennae very long and prominent, at least six times as long as wide.
- Third pair of legs up to three times as long as first pair.
- Up to 15 mm in length.

3.2.2.3.2.1.1 *Triaenodes (Plate 11, Figure 4)*

Characters:

- Head of last instar larva with secondary cephalic ecdysial lines which surround eyes at least anteriorly and ventrally and extend to occipital foramen.
- Metanotum without sclerites or with only one pair of small sclerites at setal area sa3

- Mesonotum without pair of dark bars.
- Abdomen more gradually tapered and with gills arranged in clusters or singly or absent.
- Maxillary palpi extending little, if any, beyond anterior edge of labrum.
- Mandibles short and wide, with dorsal and ventral cutting edges surrounding mesal cavity.
- Middle legs each with tarsal claw slightly curved and slender.
- Tarsus straight.
- Ventral apotome of head long and rectangular, separating genae completely.
- Gills not in cluster or absent.
- Tibia of each hind leg with or without apparent subdivisions.
- Tibia of each hind leg apparently divided into two sub segments by pale transverse band.
- Anal prolegs without spinous concave plates, although patches of spines or setae may be present.
- Hind legs each with two close-set fringes of long hairs.
- Slender case a spiral of plant pieces.

Distribution: The larvae were collected from River Ganga at Bithur and tributary River Tons near Panasa in UttarPradesh during January to February 2015.

Habitat: These caddis fly larvae were observed in a biological water quality ranging from slight to moderate pollution in water bodies. The substratum on river bed of these water bodies composed of 2-5% sand, 3-5% silt, 80% clay, and detritus 5-10% along with 10% of macrophytic vegetation in water bodies. The length of larvae was 7.38mm to 7.51 mm and width 1.75 mm to 1.80 mm.

3.2.2.3.2.1.2 Triplectides (Plate 11, Figure 12)

Characters:

- Length of antennae 0.210 mm and width 0.193 mm to length 0.135 mm and width of 0.0225 mm.
- Autennae very long and prominent, at length 6 times as long as wide.
- Larvae construct portable case of gastropod shell material and other particles.
- Sclerite on mesonotum lightly pigmented.
- Larvae head without secondary cephatic ecdysal lines.

- Metanotum with two pairs of sclerite on lateral sides
- Large pair of sclerite on setal area 1 (middle)
- Each antenved (not including termined hair-like segment) less then 0.2 times as long as anterior edge of frontoclypeas is wide.
- Antenna length 0.136 mm and width of frontoclypeus 0.232-0.275 mm length of antenna and width of frontoclypeas 0.275 mm.

Distribution: *Triplectydes* was observed in River Ganga at Mokawa downstream of Patna in Bihar, during December, 2015 and at Byasi upstream of Kodiyala in Uttarakhand during April, 2016.

Habitat: The larvae preferred moderate pollution in biological water quality of River Ganga at water temperature of 15.5-20ºC. The substratum of River Ganga at its habitat, composed of 50% boulders, 40% cobbles, and 10% pebbles at Byasi and 15% sand, 40% silt and 45% of clay material at Mokama. The length of larvae was 6.66 mm and width 1.03 mm at Byasi.

3.2.2.3.2.2 **Family Brachycentridae**

- Case straight or bent tube-like and made of sand, or spinning of larvae,or straight and squarely and made of vegetation rests.
- Case four sided or cylindrical.
- Mesonotum covered with one or two pairs of fused sclerotized plates.
- Metanotum with two or three pairs of little oblong sclerotized spots arranged arc like.
- Either middle or hind legs much longer than foreleg or pronotum with a sharp rim.
- Middle and hind legs distinctly longer than first leg.

3.2.2.3.2.2.1 *Brachycentrus (Plate 11, Figure 5, 6)*

- Rectangular and straight case.
- Middle and hind legs not distinctly longer than first leg.

Distribution: *Brachycentrus* was collected from tributary River Alaknanda after confluence of River Mandakini at Rudra Prayag in the state of Uttarakhand during November, 2015.

Habitat: The insect nymph preferred slight pollution in biological water quality at water temperature of 12°C. The substratum of river bed also composed of 60% boulders, 35 % cobbles and 5% pebbles. The length of nymph was 2.86 mm and width 0.736 mm.

3.2.2.3.2.3 **Family Hydroptilidae**

- Small larvae with peculiar cases.
- Backside of each thoracic segment largely covered by sclerotized plates.
- Abdomen without gills.
- Central abdominal segments obviously bigger than thorax and head.
- Claws at pygopodia are away from each other.

3.2.2.3.2.3.1 *Oxyethira (Plate 11, Figure 7, 8, 9, 10)*

Characters:

- Middle and hind legs are very long.
- Abdominal sternites are deeply cleft.
- Case long thin or narrow at one end and wider at opposite end.
- Segment I to VIII without distinct abdominal tergites.
- Larval case visible but not fixed to substrate. It was observed in side empty Glossosoma case.
- Mid and hind legs slender, much longer than forelegs.
- Meso and meta-thoracic legs about 2.5 times as long as prothoracic leg.
- The length of foreleg was 1.77 mm and length of hindleg was 3.89 mm.
- Case entirely of silk, shaped like aflask open posteriorly.

Distribution: Nymph was collected from River Ganga at Luxmanjhula , Rishikesh in Uttarakhand during the month of November 2015.

Habitat: The biological water quality in the vicinity of these nymph was having slight pollution in water quality and the substratum composition of boulders 35%, cobbles 45%, 5% pebbles and gravel and 10% of sand. The length of this nymph was 0.4 mm and width 0.1 mm.

3.2.2.3.2.3.2 Orthotrichia (Plate 11, Figure 4e, f, g, h) and empty cases of barrel shaped Stactobiella (Plate 11, Figure 4, i)

Characters:

- Larvae constructing fixed cases of silk. Silk case fusiform, of secretion only with longitudinal ridges. Length of cas 2.94 mm and width 0.780 mm.
- Abdominal tergum 9th with sclerite.

- Abdominal segment 2 with lateral humps.
- Length of prothoracic leg 0.348 mm, length of mesothoracic leg 0.468 mm and length of metathoracic leg 0.615. Length of prothoracic leg not more than 1.5 times length of metathoracic leg.
- Labrum with asymmetrical beak.

Distribution: The larvae were collected from River Ganga at Byasi upstream of Kodiyala in Uttrakhand during April, 2016.

Habitat: Orthotrichia were collected from River Ganga having slight pollution in Biological water quality at a water temperature of 20ºC. The river bed substratum at this location of River ganga, composed of 50% boulders, 40% cobbles and 10% of pebbles. Length of preserved specimen was 2.17 mm and width 0.668 mm.

3.2.2.3.2.4 **Family Glossosomatidae**

- Larvae construct tortoise - like portable cased of small stones.
- Only pronotum sclerotized.
- 9th tergit sclerotized.
- Basal half of anal proleg broadly jointed with the segment 9th.
- Anal claw with one dorsal accessory hook.

3.2.2.3.2.4.1 Sub Family Agapetinae

- Mesonotum with 2 sclerite.

3.2.2.3.2.4.1.1 Agapetus (Plate 11, Figure 13)

Characters:

- Head with ventromesal margin of genae not thickened.
- Posterior median ventral ecdysal line about 1.5 times as long as each anterior divergent branch.
- Length of ecdysal line 0.160 mm, length of anterior branch 0.0739 mm.
- Anal opening without dark sclerotized line on each side.

Distribution: The larvae were collected from river Ganga at at Byasi upstream of Kodiyala in Uttrakhand during April, 2016.

Habitat: *Agapetus* were collected from river ganga having slight pollution in biological water quality at a water temperature of 20ºC. The river bed substratum at this location of River Ganga, composed of 50% boulders, 40% cobbles and 10% of pebbles. The length of preserved larva was 4.038 mm and width 0.755 mm.

3.2.2.4 Order Odonata

Figure 20 : Classification of Order Odonata

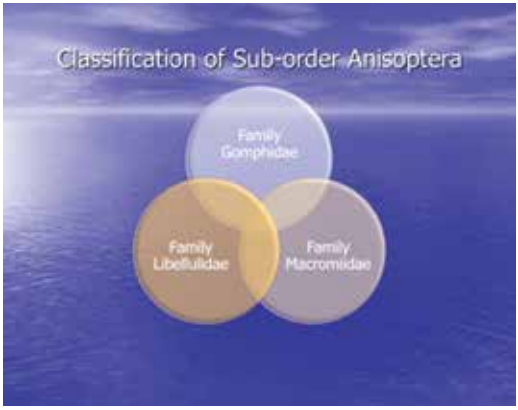

Figure 21 : Classification of Sub-Order Anisoptera

3.2.2.4 Order Odonata

- Animal is a nymph. Lower lip (labium) modified to form a protrudable mask to capture prey.

3.2.2.4.1 Suborder Anisoptera

- Dragonfly larvae are much more robust with an abdomen terminating in five points consisting of a pair of cerci, a pair of paraproct, and a single epiproct.
- The shape of the lower lip (labium) can be a diagnostic character for separating families.

- The shape of antennal segments is also an important character in identification of odonates.
- Abdomen rather short and stout, lacking caudal gills.
- Head usually narrower than thorax and abdomen.
- Five short stiff, pointed appendages at tip of abdomen ending in five points
- The three largest of which form an "anal pyramid".

3.2.2.4.1.1 **Family Gomphidae**

- Tarsal segments 2-2-2
- Tarsal segments 2-2-3
- Pre-mentum flat or nearly flat, without stout setae.
- Antennae four segmented, segment three is very large.
- Fore and middle leg tarsi with two and those of the hind legs with three segments.
- Labium square with two strong hooks on the lateral side.

3.2.2.4.1.1.1 *Sinictinogomphus (Plate 12, Figure 1, 2)*

Characters

- Tarsal segments 2-2-2
- Abdomen distinctly longer than wide.
- Abdominal segments 1 to 7 more or less trapezoid, widest at apical margin of segment 7 which bears elongate lateral spines.
- Prementum longer than wide.

Distribution: The nymph of this odonata *Sinictinogomphus* was collected from river Ganga at Garhmukhteshwar, Anupshahar, Narora, Kachlaghat, Badaun,Bithur,Kanpur, Allahabad bypaas, Varanasi, Vindhyachal ghat, Mirzapur, Uttar Pradesh and it was also found in tributaries like River Garra, River RamGanga, River East Kali in Uttar Pradesh and River Ghagra, River Gandak and Nalla at Patna, Bihar during the months from December, 2014 and January to April, 2015.

Habitat: The substratum composition of the locations mentioned above has ranged between 5-90% for sand, 4-25% for silt, 2-85% for clay, 4-55% for detritus and 5-80% for macrophytic vegetation. The water temperature of all the water bodies with habitat of *Sinictinogomphus*, ranged between 12.5˚C - 27˚C and biological water quality was found to be slight to moderately polluted. The body length of the nymph varied between 9-28mm and width 3-7mm.

3.2.2.4.1.1.2 *Heliogomphus (Plate 12, Figure 3)*

Characters:

- Tarsal segments 2-2-3.
- Body thick, not especially flat.
- Third segment of antenna elongate or finger –like or slightly flattened.
- Wing cases parallel.
- Anterior margin of prementum armed with about 23 quadrate teeth.

Distribution: The nymph of *Heliogomphus* was collected from river Saloni at Sukartal ghat in Bijnore, Uttar Pradesh in the month of December, 2015.

Habitat: The water of River Saloni at location was found to have moderately polluted biological water quality with water temperature at the time of noting the observation as 19˚C. The substratum composition included 40% sand, 4% silt, 2% clay, 4% detritus and 50% macrophytic vegetation. This animal was collected during December 2015. The body length and width of the animal measured was found as 12mm and 3mm respectively

3.2.2.4.1.1.3 *Orientogomphus (Plate 12, Figure 4)*

Characters:

- Tarsal segments 2-2-3.
- Body thick, not especially flat.
- Third segment of antenna elongate or finger –like or slightly flattened.
- Wing cases divergent.
- Anterior margin of pre-mentum armed with many quadrate or finger-like teeth.
- Dorsal hooks present on some abdominal segments.
- Anterior margin of prementum convex.
- Abdominal segments7-9 with lateral spines.
- Third antennal segment slender, about 3 times as long as wide or more.
- Prementum about 1.5 times as long as apical width.

Distribution: The *Orientogomphus* nymph was collected from River Ganga at Allahabad and Vindhyachal ghat, upstream of Mirzapur in Uttar Pradesh. It was also observed in River Yamuna near Rajapur and River Tons, Near Panasa in the month between March and April - 2015.

Habitat: The water temperature at the location ranged between 18˚C-25˚C with slight to moderate pollution biological water quality. The substratum was composed of 5 - 80% sand, 3-10% silt, 2-80% clay, 4-5% detritus and 10-50% of macrophytic vegetation. The body length of the nymph was measured at 9-28 mm and width was 4 - 20 mm.

3.2.2.4.1.1.4 *Paragomphus (Plate 12, Figure 5)*

Characters:

- Tarsal segment 2-2-3.
- Body thick.
- Third segment of antenna finger-like.
- Wing cases divergent.
- Anterior margin of prementum armed with many quadrate or finger –like teeth.
- Dorsal hooks present on some abdominal segments.
- Anterior margin of prementum convex.
- Abdominal segments 2-7 with lateral spines.
- Last antennal segment fingerlike, almost as long as the width of preceding segment.
- Inner margin of palpal lobe smooth.

Distribution: This species of odonata was collected from River Ganga at Tarighat downstream at Ghazipur, Uttar Pradesh and in Bihar, It was found at Danapur, Mahatma Gandhi Bridge, Patna in the months during March and April, 2015.

Habitat: The length of the body of *Paragomphus* nymph collected has varied from 14-29mm and width was found in between 4-6mm. The biological water quality on location was found as moderately polluted with 25˚C-28˚C temperature. The substratum composition included 15-25% sand, 25-35% silt, 10-15% clay, 5% detritus and 20-40% macrophytic vegetation.

3.2.2.4.1.1.5 *Nihanogomphus (Plate 12, Figure 6)*

Characters:

- Tarsal segment 2-2-3.
- Body thick.
- Third segment of antenna finger-like.
- Wing cases divergent.
- Anterior margin of prementum armed with many quadrate or finger –like teeth.
- Dorsal hooks present on some abdominal segments.

- Anterior margin of prementum convex.
- Abdominal segments 2-7 with lateral spines.
- Last antennal segment vestigial.
- Inner margin of palpal lobe armed with many quadrate teeth.

Distribution: *Nihanogomphus* species of Odonata was collected from River Ganga at Mahatma Gandhi Bridge, Patna in Bihar during the month of April, 2015.

Habitat: The water temperature at the above location was recorded at 19˚C and biological water quality observed was moderately polluted. The substratum is composed of 25% sand, 35% silt, 15% clay, 5% detritus and 20% macrophytic vegetation. The length of the nymph was 24 mm and width 4 mm.

3.2.2.4.1.2 **Family Libellulidae**

- Abdomen without dorsal hooks, or spines, or knobs.
- Abdomen with dorsal hooks, or spines, or knobs.
- Prementum and palpal lobes of labium forming a spoon-shaped structure, usually with dorsal premental setae and always with palpal setae.
- Medium sized legs. Cerci less than half of the length of the paraproct.
- The distal margin of the labial palps are formed into shallow or flattened crenellations.
- Each crenulation bearing one or more setae.
- Lateral spines of abdominal segment 9 usually shorter than its mid dorsal length, but if longer, than mid dorsal hooks on abdomen are more spine like, stubby or absent.

3.2.2.4.1.2.1 *Acisoma (Plate 13, Figure 1)*

Characters:

- Abdomen without dorsal hooks, or spines, or knobs.
- Abdominal segment 8 and 9 without lateral spines.
- Premental setae 12 on each side of median line.
- Palpal setae 7.
- Crenation of distal margin of each palpal lobe obsolete.

Distribution: These small odonates were collected from River Ganga at Narora in Uttar Pradesh and downstream of Nabadwip in West Bengal. It was also collected from tributaries like River Saloni at Sukartal Ghat, Bijnor and River RamGanga downstream at Moradabad in Uttar Pradesh during the months from December, 2014 to May, 2015.

Habitat: The body length of collected *Acisoma* ranged between 5-17 mm and width of the body was 2-5 mm. The water temperature at these locations ranged between 11˚C-34˚C in a moderately polluted biological water quality. The substratum composition ranged between 5-50% sand, 4-15% silt, 2-25% clay, 4-20% detritus and 20-80% macrophytic vegetation. These odonates were found in the month of December 2014 and May 2015

3.2.2.4.1.2.2 *Orthetrum albistylum speciosum (Plate 13, Figure 2)*

Characters:

- Abdomen without dorsal hooks, or spines, or knobs.
- Abdominal segments 8 and 9 with lateral spines.
- Lateral spines 8 and 9 small.
- Premental setae 15 or 16 on each side of median line.
- Distal margin of each palpal lobe with about 9 weak crenations.

Distribution: Nymph of *Orthetrum albistylum* was collected from River Ganga at Barawali, Bijnore, Narora, Kachlaghat at Badaun, Kanpur - NH 25, Allahabad, SH-98 at Varanasi and Tarighat downstream Ghazipur, Uttar Pradesh stretch. It was also collected from tributaries like Saloni River at Sukartal Ghat, Bijnore, River RamGanga downstream of Muradabad, river Tons near Sirsa. Presence of this animal was recorded during the months from January-May 2015.

Habitat: The water temperature on the above mentioned locaitons of Ganga and tributaries was found in the range from 11˚C-25˚C with moderately polluted biological water quality. Substratum composition included 5-40% sand, 2-30% silt, 2-70% clay, 3-20% detritus and 10-80% macrophytic vegetation. The length of the body of the animal varied between 9-18mm and a width of 3-6mm.

3.2.2.4.1.2.3 *Sympetrum purvulum*

Characters:

- Abdomen with dorsal hooks, or spines or knobs.
- Abdominal segment 8 with dorsal hooks.
- Abdominal segment 9 and 10 without dorsal hooks.
- Abdominal segment 5-8 with dorsal hooks.
- Premental setae 12-15 on each side of median line.
- Palpal setae 9-12.

Distribution: *Sympetrum purvulum* nymph was collected from River Ganga in Bithur, Uttar Pradesh, MG bridge Patna, Bihar and downstream of FTPS Farakka, Raghunathganj, downstream Murshidabad and Nabadwip in West Bengal stretch during month of December 2014 to May 2015.

Habitat: The preferred biological water quality was found to be slight to Moderately polluted. The water temperature for this location was recorded between 19˚C-34˚C having substratum composition with 5-25% sand, 5-35% silt, 10-80% clay, 5-10% detritus and 20-45% macrophytic vegetation. The body size of the nymph was found varying with length between 7-22mm and width 3-5mm.

3.2.2.4.1.2.4 *Sympetrum sp. (Plate 13, Figure 3)*

Characters:

- Abdomen with dorsal hooks, or spines or knobs.
- Abdominal segment 8 without dorsal hooks.
- Abdominal segment 4 without dorsal hooks
- Lateral spines of abdominal segments 8 and 9 much shorter.

Distribution: Nymph of *Sympetrum sp.* was collected from River Ganga at Mahatma Gandhi Bridge, Patna in Bihar and tributaries like River RamGanga downstream Muradabad and River Gomti at Rajwari in Uttar Pradesh over a time period from December to May at different location.

Habitat: The water temperature of the above mentioned water bodies at locations of observation, ranged between 11˚C-28˚C in moderately polluted biological water quality. Substratum composition preferred by this animal included 15-50% sand, 5-35% silt, 5-25% clay, 5-20% detritus and 20-45% macrophytic vegetation. The body size was found between a length of 10-19mm and width between 3-5mm.

3.2.2.4.1.2.5 *Brachythemis (Plate 13, Figure 4, 5, 6)*

Characters:

- Abdomen with dorsal hooks, or spines or knobs.
- Abdominal segment 8 with dorsal hooks.
- Abdominal segments 9 or 9-10 with dorsal hooks.
- Abdominal segment 3- 10 each with dorsal hook.
- Premental setae 10-12 on each side of median line.
- Palpal setae 5-6.

Distribution: The nymph of *Brachythemis* was collected from different locations at River Ganga at Narora, kachlaghat Badaun, Kanpur at NH 25, Fatehpur, Varanasi at SH98 in Uttar Pradesh. It was collected from tributaries such as river RamGanga downstream of Muradabad, River Yamuna near Rajapur NH 27, River Garra in Uttar Pradesh. This nymph was found during January - May 2015.

Habitat: The water temperature of *Brachythemis* was found preferring by this species ranged between 11˚C-19˚C and moderately polluted biological water quality. The substratum was composed of 5-70% sand, 5-30% silt, 5-80% clay, 5-20% detritus and 10-45% macrophytic vegetation. The length varied between 8-18 mm and width 3-6mm.

3.2.2.4.1.2.6 *Zyxomma (Plate 13, Figure 7)*

Characters:

- Abdomen with dorsal hooks, or spines or knobs.
- Abdominal segment 8 with dorsal hooks.
- Abdominal segments 9 or 9-10 with dorsal hooks.
- Abdominal segment 10 without dorsal hook.
- Abdominal segment 4-9 each with dorsal hooks.
- Legs shorter.
- Abdomen ovoid.
- Body skin thin, surface smooth.
- Lateral spines of 9th abdominal segment, long reaching the apices of the paraproct.
- Lateral spines of abdominal segment 8 and 9 short.
- Lateral spines of abdominal segment 9 reaching or slightly surpassing the posterior margin of abdominal segment 10.
- Lateral margin of middle abdominal segments more or less parallel.
- Palpal setae 7 or 8.

Distribution: Zyxomma nymph was collected from river Ganga at Ramnagar road Varanasi in Uttar Pradesh and Nalla in Patna, Bihar. It was found in the month of March-April 2015.

Habitat: Zyxomma nymph was found in moderately polluted biological water quality with temperature range of 21˚C-25˚C. Substratum preferred by this nymph was having 10-20% sand, 25-30% silt, 10-20% clay, 5-45% detritus, and 30 - 40% macrophytic vegetation. The body of length of nymph ranged between 12-18mm and width 3-5mm.

3.2.2.4.1.2.7 *Tholymis (Plate 13, Figure 8)*

Characters:

- Abdomen with dorsal hooks, or spines or knobs.
- Abdominal segment 8 with dorsal hooks.
- Abdominal segments 9 or 9-10 with dorsal hooks.

- Abdominal segment 10 without dorsal hook.
- Abdominal segment 4-9 each with dorsal hooks.
- Legs shorter.
- Abdomen elongate ovoid.
- Body skin thin, surface smooth.
- Lateral spines of 9 long reaching the apex of the paraproct.
- Lateral spines of abdominal segment 8 and 9 short.
- Lateral spines of abdominal segment 9 reaching or slightly surpassing the posterior margin of abdominal segment 10.
- Palpal setae 4-5.
- Lateral spines of abdominal segment 9 reaching the posterior margin of abdominal segment 10.
- Premental setae 10 on each side of median line.

Distribution: *Tholymis* was collected from river Ganga at Ramnagar road near Varanasi in the month of March, 2015.

Habitat: The water temperature at the above mentioned location was recorded at 22˚C and substratum of water body was found composed of 15% sand, 30% silt, 10% clay and 45% detritus material. Its body length was found at 17mm and width was 5mm.

3.2.2.4.1.2.8 *Hydrobasileus croceus (Plate 13, Figure 9, 10)*

Characters:

- Abdomen with dorsal hooks, or spines or knobs.
- Abdominal segment 8 with dorsal hooks.
- Abdominal segment 9 and 10 without dorsal hooks.
- Abdominal segment 4-8 each with dorsal hooks.
- Eyes large, bulging laterally.
- Head triangular in dorsal view.
- Eyes posteriorly protruded in an acute angle.
- Abdominal segments with large and distinctly hooked dorsal hooks.
- Lateral spines of abdominal segment 9 very long, reaching the apex of the paraproct.

Distribution: *Hydrobasileus* nymph was found only in West Bengal stretch of river Ganga at sites of Farakka barrage and downstream of Srirampore during the month of May, 2015.

Habitat: The water temperature of these sampling locations ranged between 33˚C - 35˚C with slight to moderately polluted biological water quality. The

substratum composition included 5-15% sand, 15-20% silt, 15-35% clay, 5% detritus and 40-45% macrophytic vegetation. This nymph was collected during the month of May 2015. Its body length was observed to vary between 10-14mm and width was found to be 2-4mm.

3.2.2.4.1.2.9 *Nannophya pygmea (Plate 13, Figure 11, 12)*

Characters:

- Abdomen without dorsal hooks, or spines, or knobs.
- Abdominal segments 8 and 9 with lateral spines.
- Lateral spines 8 and 9 small.
- Posterior abdominal segments thickly adorned with long hairs.
- Premental setae 10-12 on each side of median line.
- Palpal setae 6-7.
- Distal margin of each palpal lobe with about 7 weak crenations.

Distribution: *Nannophya pygmea* nymph was also having restricted habitat in West Bengal stretch of River Ganga at Farakka barrage, Farakka STPs, downstream of FTPS Farakka, Upstream Jiaganj and downstream of Nabadwip during the month of May, 2015.

Habitat: The substratum of the habitat of this nymph was found composed of 10-15% sand, 15-20% silt, 15-25% clay, 5% detritus and 45-55% macrophytic vegetation. Its preference to biological water quality is slight to moderate pollution and water temperature was in range of 30-35˚C. It was collected during May 2015. Its length varied between 10-14mm and width 2-4mm.

3.2.2.4.1.2.10 *Rhyothemis (Plate 13, Figure 13)*

Characters:

- Abdomen with dorsal hooks, or spines or knobs.
- Abdominal segment 8 with dorsal hooks.
- Abdominal segments 9 or 9-10 with dorsal hooks.
- Abdominal segment 10 without dorsal hook.
- Abdominal segment 4-9 each with dorsal hooks.
- Legs long.
- Hind femora reaching the posterior margin of abdominal segment 8.
- Abdomen nearly circular.
- Abdominal segment 10 very small.
- Lateral spines very large.

Distribution: The nymph was collected from River Ganga at downstream of FTPS Farakka in West Bengal during the month of May, 2015.

Habitat: The nymph preferred only slight pollution in biological water quality at water temperature of 30°C and a substratum composition in water bodies of 15% sand and silt, 20% clay, 5% of detritus and 45% of macrophytic vegetation. The length of this insect was 15 mm and width 4mm.

3.2.2.4.1.2.11 *Libellula (Plate 13, Figure 14)*

Characters:

- Abdomen with dorsal hooks, or spines or knobs.
- Abdominal segment 8 with dorsal hooks.
- Abdominal segments 9 or 9-10 with dorsal hooks.
- Abdominal segment 10 without dorsal hook.
- Abdominal segment 3-9 each with dorsal hooks.
- Premental setae 12 on each side of median line.
- Palpal setae 7.

Distribution: The nymph of *Libellula* was collected from River Ganga at Raghunathganj in West Bengal During May, 2015.

Habitat: Libellula preferred slight pollution in biological water quality. The water temperature at its habitat in River Ganga, was 31°C. The substratum composition of inhabiting water body, was 10% of sand, 20% of silt and clay, 5% of detritus and 45% of macrophytic vegetation. The length of this insect nymph was14 mm and width of 5.0 mm.

3.2.2.4.1.2.12 *Lyriothemis (Plate 13, Figure 15)*

Characters:

- Abdomen with dorsal hooks, or spines or knobs.
- Abdominal segment 8 with dorsal hooks.
- Abdominal segments 9 or 9-10 with dorsal hooks.
- Abdominal segment 10 without dorsal hook.
- Abdominal segment 4-9 each with dorsal hooks.
- Legs shorter.
- Abdomen ovoid.
- Body skin thick, covered with fine hairs.
- Lateral spines of abdominal segment 9 reaching half the length of the paraprocts.

Distribution: This odonate nymph was collected from River Ganga at downstream of Nabadwip in West Bengal river stretch during May, 2015.

Habitat: *Lyriothemis* was observed only in slight pollution of biological water quality at a water temperature of 34°C and substratum composition of 10% sand, 15% silt, 25% clay, 5% of detritus and 45% of macrophytic vegetation. Cover in water body. The length of nymph was 20 mm and width 5.0 mm.

3.2.2.4.1.2.13 *Sympetrum speciosum speciosum (Plate 13, Figure 16)*

Characters:

- Abdomen with dorsal hooks, or spines or knobs.
- Abdominal segment 8 without dorsal hooks.
- Abdominal segment 4 with dorsal hook.
- Lateral spines of abdominal segments 8 and 9 large.
- Lateral spines of abdominal segments 8 reaching the apical margin of 9.
- Lateral spines of abdominal segments 9 reaching the apex of the Paraproct.
- Premental setae 16-17 on each side of median line.
- Palpal setae 12-13.

Distribution: The nymph was collected from River Ganga at Chinsura in West Bengal during May, 2015.

Habitat: The biological water quality inhabiting water body was moderately polluted. At water temperature of 33°C, the substratum composition of water body was5% of sand, 10% of silt, 35% of clay, 10% detritus and 40% of macrophytic vegetation. The length of nymph was 15 mm and width 5.0 mm.

3.2.2.4.1.3 **Family Macromiidae**

- Prementum and palpal lobes of labium forming a spoon-shaped structure.
- Distal edge of each palpal lobe smooth or evenly crenulated, each crenulation bearing one or more setae.
- Head with a prominent, sub erect horn between the bases of the antennae, metasternum with a broad median tubercle, legs very long, the apex of each hind femur reaching to or beyond the hind margin of abdominal segment 8.

3.2.2.4.1.3.1 *Macromedia (Plate 13, Figure 17)*

Characters:

- Distal margin of palpal lobe of labium with regular dentations.

- Each crenation bearing 1 or more setae.
- Prementum and palpal lobes with setae.
- Prementum setae 16-17 on each side of median line.
- Palpal setae 9.
- Abdominal segments without dorsal hooks.
- Segment 9 with short lateral spines.
- Segment 10 very short, less than ¼ as long as 9.

Distribution: The nymph was collected from River Ganga at Narora and Kachlaghat in Badayun in Uttar Pradesh. It was also collected from River Tons near Panasa during December, 2014 and February, 2015.

Habitat: The nymph was observed in slight to moderate pollution in biological water quality at a water temperature range of 17-21°C. The substratum composition of inhabiting water bodies ranged between 2-5% sand, 3-5% silt, 5-80% clay, 5-10% detritus and 10-80% of macrophytic vegetation. The length of insect nymph was 9-14 mm and width 5-6 mm.

3.2.2.4.1.3.2 *Macromia (Plate 13, Figure 18)*

Characters:

- Distal margin of palpal lobe of labium with regular dentations.
- Each crenation bearing 1 or more setae.
- Prementum and palpal lobes with setae.
- Prementum setae 8-10 on each side of median line.
- Palpal setae 5-7.
- Abdominal segments with dorsal hooks.
- Lateral spines of abdominal segment 8 and 9 long and sharp.
- Abdominal segment 10 about half as long as abdominal segment 9.

Distribution: The nymph was collected from River Ganga at upstream of Kanpur and Bathing Ghat-1 at Varanasi in Uttar Pradesh river stretch during the month of January – March, 2015.

Habitat: The biological water quality of water bodies at these locations was moderately polluted at a water temperature range of 12.5 – 25°C. The range of substratum composition was 5% boulders, 10-70% sand, 10-30% silt, 5-15% clay, 10-55% detritus and up to 40% of macrophytic vegetation. Its length varied between 18-24 mm and width 5-10 mm.

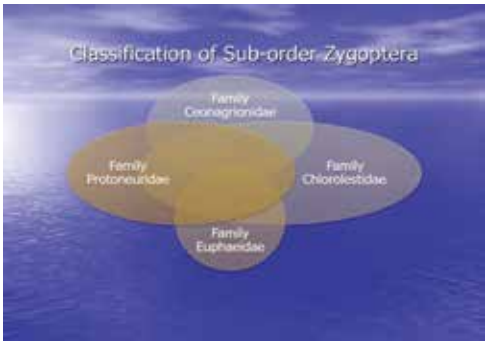

Figure 22 : Classification of Sub Order Zygoptera

3.2.2.4.2. Suborder Zygoptera

- Damselfly larvae are usually more slender than dragonflies and their abdomen terminates in three caudal filaments (gills) resembling leaves.
- The shape of the lower lip (labium) can be a diagnostic character for separating families.
- The shape of antennal segments is also an important character in identification of odonates.
- Larvae slender, head wider than thorax and abdomen.

  Abdomen terminating in three long caudal leaf or sac- like gills (these gills are fragile and are sometimes broken off and lost).

3.2.2.4.2.1 **Family Euphaeidae**

- They are mainly found under stones or amongst detritus in riffles.
- Robust with broad triquetral caudal lamellae, as well as their unique abdominal gills.
- Apex of abdomen with 3 caudal gills, saccoid, fleshy, leaf- or blade-like filamentous gills on the under-side of abdominal segments II-VIII.
- Body depressed.

3.2.2.4.2.1.1 *Euphae decorata (Plate 14, Figure 1, 2, 3, 4, 5, 6)*

Characters:

- Abdomen ventrally with lateral gills.
- Filamentous gills on the under-side of abdominal segments II-VIII.

- Caudal gills saccoid

Distribution: The nymph was observed in River Alaknanda, after confluence to river Mandakini at RudraPrayag in Uttarakhand during July, 2015.

Habitat: This is the only nymph indicating existence of clean biological water quality at water temperature of 17.2°C. The substratum composition at this location on water body was 60% of boulders, 35 % cobbles and 55 of pebbles. It was collected during July, 2015. Its length was 7.03 mm and width 1.86 mm.

3.2.2.4.2.2 **Family Protoneuridae**

- Apex of abdomen with 3 laminate gills.
- First antennal segment distinctly less than the combined length of the remaining segments.
- Prementum with small closed cleft or none.
- Prementum more or less triangular or sub quadrate in shape.
- Movable hooks without setae.
- Premental setae 0-3 on each side of the median line.
- Apex of palpal lobes deeply bifid, the outer branch shorter.

3.2.2.4.2.2.1 *Prodasineura autumnalis (Plate 14, Figure 7, 8)*

Characters:

- Prementum with 1 setae on each side of median line.
- Palpal setae 3-5.

Distribution: The nymph was collected from River Ganga at Garhmukteshwar, Narora, Ramnagar road near Varanasi and SH 98 at Varanasi in UttarPradesh. In West Bengal stretch of River Ganga, the nymph was observed at Farakka, Jiaganj, downstream of Murshidabad, Katwa and Chinsura at downstream of Tribeni. It was also observed in tributaries like River Saloni at Sakurtal ghat, River Tons at at Sirsa, River Gomti at Rajwari, River Kali at Kanpur –Farrukabad road, Kannauj during the months of December, 2014 and January- May 2015.

Habitat: The biological water quality preference to this insect nymph was slight to moderate pollution at water temperature range from 17-35°C. The substratum composition of water bodies composed of 5-40% of sand, 2-30% of silt, 2-70% of clay, 3-45% of detritus and 10-70% of macrophytic vegetation. Its length varied between 7-25 mm and width 1-3mm.

3.2.2.4.2.3 **Family Coenagrionidae**

- Apex of the abdomen with 3 gills laminate.

- First antennal segment not elongate, distinctly less than the combined length of the remaining segments.
- Prementum with small closed cleft or none.
- Prementum not distinctly elongate, more or less triangular or sub quadrate in shape.
- Movable hooks without setae.
- Premental setae 0-3 on each side of median line.
- Apex of palpal lobe apically not produced into 2 long sharp teeth.
- Apex of palpal lobe shallowly divided into 2 portions, the outer portion short, broad, apically subtruncate with crenulations, the inner portion longer, sharp at apex.
- Premental setae 3-5 on each side of median line. Or absent, if only one present, palpal setae 0-6.

3.2.2.4.2.3.1 *Agriocnemis lacteola (Plate 14, Figure 9, 10)*

Characters:

- Caudal gills more than 3 times as long as broad.
- Caudal gills without markings.
- Labium with 3, 4 or 5 setae on each side of median line.
- Palpal lobe with 5 or 6 setae.
- Caudal gills usually acute, or gradually narrowing toward apex.
- Lateral caudal gills more or less spear-shaped, broadest at the middle, narrowing toward both ends.

Distribution: The zygopterean nymph was collected from River Ganga at Garhmukteshwar, Narora, SH98 at Varanasi in Uttar Pradesh and Farakka FSTP, downstream Murshidabad, Katwa and downstream of Nabadwip in West Bengal. It was also observed in tributaries like River Kali at farrukhabad-Kanpur road, river Yamuna near Rajapur and River Gomti at Rajwari in Uttar Pradesh during December, 2014 and February-May, 2015.

Habitat: The nymph preferred moderate pollution in biological water quality at a water temperature range of 17-34°C. The substratum of river bed consisted of 5% boulders, 5-40% of sand, 5-30% silt, 5-60% clay, 5-20% of detritus and 20-70% of macrophytic vegetation in water bodies. The length of nymph varied between 8-24 mm and the width 1-2mm.

3.2.2.4.2.4 **Family Chlorolestidae**

- Apex of abdomen with 3 laminate gills.

- First antennal segment not elongated, distinctly less than the combined length of the remaining segments.
- Prementum without any cleft.
- Prementum not distinctly elongate, more or less triangular or sub-quadrate in shape.
- Movable hook without setae.
- Apex of palpal lobe apically produced into 2 long sharp teeth, the inner tooth longer than the outer tooth.
- Prementum without setae.

3.2.2.4.2.4.1 *Megalestes chengi (Plate 14, Figure 11)*

Characters:

- Second antennal segment shorter than the third.

Distribution: The nymph of this damsel fly was collected from River Varuna near bridge in Varanasi in Uttar Pradesh during the month of March, 2015.

Habitat: *Megalestes* preferred heavy pollution in River Varuna at water temperature of 27°C. The substratum composition of River Varuna at its habitat was 30% sand, 10% silt, 20% clay and 40% of macrophytic vegetation. The length of nymph was 17 mm and width 2 mm.

3.2.2.5 Order Hemiptera

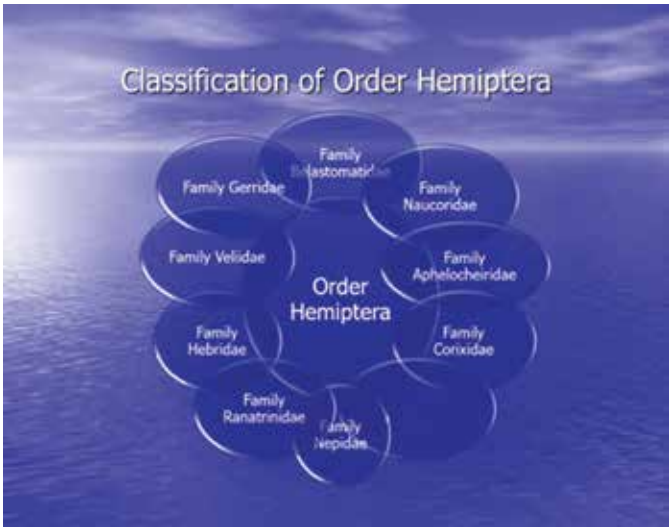

Figure 23 : Classification of Order Hemiptera

3.2.2.5 Order Hemiptera

- Animal is an adult insect.
- Head prolonged into a beak-like structure.
- Forewings modified into wing cases and not hardened.

3.2.2.5.1 Family Belostomatidae

- Giant water bugs.
- The forelegs are for catching prey and the other two pairs are flat, long and hairy to help swimming.
- In some giant water bugs, the female lays her eggs on the back of the male, which carries them till hatching.
- They prefer waters of ponds, lakes, river, canal with vegetation,
- They have voracious feeding upon small fish and other insects.

3.2.2.5.1.1 Lethoceros (Plate 15, Figure 1)

Characters:

- Tibia and Tarsus of each hind leg strongly compressed, thin, much broader than middle tibia and tarsus,
- Basal segment of rostrum about half the length of second segment.
- Body length 40 mm or more.
- *Lethoceros indicus* is also known as the "Electric light bug" because adults leave the water and are attracted to bright lights at night. The males of giant bugs have well- developed metathoracic scent glands which produces a strong smell.

Distribution: Largest species collected from River Ganga at Haridwar barrage in Uttarakhand and in river stretch at bridge on Ramnagar road near Varanasi in Uttar Pradesh during month of June, 2014 and March 2015.

Habitat: The biological water quality of this giant bug ranged from slightly polluted to moderate pollution in biological water quality of River Ganga at a water temperature of 19 – 21.5°C and river bed substratum composed of 5% boulder, 90% cobbles, 4% pebbles, 1% gravel at Hardwar barrage and 15% sand, 30% silt, 10% clay and 45% detritus in river stretch of Varanasi. The length of this animal was 63 mm and width 23 mm.

3.2.2.5.1.2 Diplonychus rusticus (Plate 15, Figure 2, 3)

Characters:

- Tibia and tarsi of middle and hind legs similar.

- Basal segment of rostrum longer than half of second segment.
- Body length 35 mm or less.
- The males of *Diplonychus rusticus* are known to carry eggs on their backs until they hatch.

Distribution: These bugs were collected from River Ganga at Garhmukteshwar, Narora, Bithur, Varanasi and Tarigaht at Ghajipur in Uttar Pradesh. In Bihar, it was observed at Buxar and Mahatma Gandhi bridge in Patna. In West Bengal stretch of River Ganga, it was observed at Farakka, Raghunathganj, Jiaganj, downstream of Murshidabad, Katwa, Nabadwip, Tribeni and Chinsura. It was also collected from River Saloni at sukratal ghat, River Ram Ganga downstream Moradabad, River Varuna, River Gomti in Uttar Pradesh and in River Ghagra in Bihar state. These bugs were collected from water bodies during the month from December, 2014 to May, 2015.

Habitat: *Diplonychus rusticus* preferred a wide range of tolerance to biological water quality ranging from slight pollution to heavy pollution in River Ganga and its tributaries at a water temperature varied from 11 – 35°C. It was collected from river bed composed of 5% boulders, 5-70% sand, 4-30% silt, 5-80% clay, 5-45% detritus and 20-70% of macrophytic vegetation in river. The length of these animals ranged from 5-22 mm and width 3-16 mm.

3.2.2.5.2 Family Naucoridae

- No respiratory tube.
- Flat and oval animals swimming dorsal side up.
- Anterior legs inserted on the anterior margin of pro sternum.
- Head broader than long.
- Rostrum folded under the body reaching the bases of the anterior legs.
- Anterior femur very broad with tibia folded against it.
- Length 10-15 mm.
- Found in streams, pools and ponds and rocky hard substratum.
- They prefer waters with abundant vegetation among which they crawl and come to the surface periodically to replenish their air supply. They sting if disturbed.

3.2.2.5.2.1 Ilyocoris (Plate 15, Figure 4, 5, 6)

Characters:

- Head broad, not prominent.
- Anterior margin of pronotum straight or slightly concave behind interocular space.

- Gula long, tumid or tectiform.
- Eyes without external process.

Distribution: This species was collected from only one location of River Ganga at Hardwar Barrage in Uttarakhand during month of June, 2014.

Habitat: *Ilyocoris* was collected from slight pollution in biological water quality at a water temperature of 21.5°C and substratum of River Ganga composed of 55 boulders, 90% cobbles, 4% pebbles and 1% gravel. The length of animal was 5.85 mm and width 5.85 mm

3.2.2.5.3 Family Aphelocheiridae

- Head as broad as long.
- Rostrum folded under the body, reaching the bases of the posterior legs.
- Length 8-10 mm.
- Only inhabit hilly regions in fast flowing clean waters with saturated dissolved oxygen.

3.2.2.5.3.1 Aphelocheirus (Plate 15, Figure 7, 8)

Characters:

- The body is oval, medium sized, dorsally flat.
- The head is more or less prominent and rounded in front of the eyes.
- The anterior margin of the pronotum is strikingly concave; its lateral angles are sharp or rounded.

Distribution: This hemipterean was collected from River Ganga at Hardwar Barrage and Gang Nahar downstream of Har ki Pouri in Uttarakhand during month of June, 2014.

Habitat: *Aphelocheirus* was the only hemipterean preferred clean to slight pollution in biological water quality in River Ganga at water temperature ranging from 19.8 – 21.5°C. The river bed substratum of River Ganga at its habitat composed of 5-100% boulders, 90% cobbles, 4% pebbles and 1% gravel. The length of this insect ranged from 3.0 – 6.32 mm and width 2.5 mm – 2.84 mm.

3.2.2.5.4 Family Nepidae

- Head with one, long, pointed rostrum;
- Anterior tarsus seldom one segmented, never flattened.
- Scutulum not concealed by the wing cover shields (hemelytra).

- Abdomen with a stiff, elongated structure at the posterior end.
- Forming a single respiratory tube (tail).
- These insects resemble scorpions, and are called water scorpions.
- They are found clinging to various objects or just underneath the surface.

3.2.2.5.4.1 Nepa (Plate 15, Figure 9)

Characters:

- Known as water scorpion.
- Anterior lobe of pronotum wider than head.
- Body flattened.
- Body length, excluding siphon, not exceeding 16 mm.
- Siphon shorter than half of operculum.

Distribution: *Nepa* was collected from River Ganga at Varanasi and Mirzapur in Uttar Pradesh and downstream of Murshidabad in West Bengal during March and May 2015.

Habitat: The biological water quality required for Nepa, was mostly moderate pollution in River Ganga at water temperature of 22 – 31°C and substratum composition of 15-35% sand, 20-30% silt, 5-10% clay, 10-45% detritus, and 10-45% of macrophytic vegetation. The length of this insect varies from 5-14 mm and width 2-5 mm.

3.2.2.5.4.2 Laccotrephes pfepferiae (Plate 15, Figure 10, 11, 12, 13, 14, 15, 16)

Characters:

- Anterior lobe of pronotum wider than head.
- Abdominal sterna divided longitudinally into median-and para-sternites.
- Female subgenital plate broad, flattened.
- Body length, excluding siphon, always exceeding 16 mm.
- Siphon longer than operculum.
- Ventral spiracular apertures vestigial or absent.
- Membrane clearly differentiated from corium with distinct venation.
- Siphon always longer than inner margin of hemelytra.

Distribution: This species of water bug was collected from River Ganga at Madhya Ganga Barrage, Garhmukteshwar, Anupshahar, Narora, Ghatia ghat at Farrukhabad, Allahabad and Mirzapur after confluence of two drains

in Uttar Pradesh, Buxar in Bihar. In West Bengal it was observed in river Ganga at Raghunathganj, Katwa, and Nabadwip. It was also collected from tributaries like River Saloni at sukratal ghat, River Garra, River East Kali in Uttar Pradesh, River Gandak near Hajipur in Bihar. It was collected from water bodies during month of December 2014 to May 2015.

Habitat: The insect preferred slight to moderate pollution in biological water quality in its habitat at water temperature range from 11 – 34°C. The substratum of river bed composed of 5% boulders, 5-80% sand, 5-25% silt, 2-80% clay, 4-20% detritus and 10-75% of macrophytic vegetation. Its length varied from 16 -30 mm and width 5-9 mm.

3.2.2.5.5 Family Corixidae

- Antennae which are not visible in dorsal view, much shorter than head and concealed in pits on the ventral side.
- Head of a characteristic triangular shape in anterior view with a short, broad rudimentary rostrum.
- Anterior tarsus always one segmented and flattened in male.
- Scutulum not visible unless the specimen is very small.
- Length 1.7-15 mm.
- Occurs in muddy habitats in pools and ponds.
- They continuously have a thin air bubble under their wings and are attracted to light.

3.2.2.5.5.1 Agraptocorixa (Plate 15, Figure 17)

Characters:

- Scutellum covered by pronotum.
- Rostrum transversely sulcate.
- Palae scoop-like.
- Hemelytra with embolar groove and well developed nodal furrow and distinct pruina.
- Pronotum and hemelytra unicolorous, hyaline brown.
- Palae triangular in cross section in both sexes.
- Asymmetry of male abdomen dextral.
- Strigil present on apex of a peduncle.

Distribution: Small insects of *Agraptocorixa* was widely distributed at most of the locations on River Ganga at Garhmukteshwar, Anupshahar, Narora, Kachlaghat at Badayun, Ghatiaghat at Farrukhabad, Bithur, Kanpur, Fatehpur, Allahabad Bypass, Dengurpur, Varanasi, Mirzapur, Tarighat downstream

Ghajipur in Uttar Pradesh. In Bihar stretch of River Ganga, it was observed near Mahatma Gandhi bridge in Patna and In West Bengal stretch of River Ganga, it was observed at Farakka, Raghunathganj, Jiaganj and downstream of Murshidabad. It was also observed in tributaries like River Saloni at sukartal ghat, River RamGanga, River Kali, River East Kali, River Yamuna and River Tons in Uttar Pradesh. At all these locations, this insect was observed during December, 2014 to May, 2015.

Habitat: *Agraptocorixa* commonly preferred slight to heavy pollution in biological water quality of River Ganga at a water temperature range from10.5 – 26°C. The substratum of river bed composed of 5% boulder, 5-90% sand, 4-30% silt, 2-85% clay, 3-20% detritus and 10-75% of macrophytic vegetation. Its length ranged from 2-4 mm and width 1-2 mm.

3.2.2.5.5.2 Sigara (Plate 15, Figure 18, 19, 20)

Characters:

- Scutellum covered by pronotum.
- Rostrum transversely sulcate.
- Palae scoop-like.
- Hemelytra with embolar groove and well developed nodal furrow and distinct pruina.
- Pronotum and hemelytra patterned with transverse alternating yellow and dark vermiculations.
- Regular transverse yellow lines or mostly broken lines.
- Male abdominal symmetry dextral.
- Male strigil present on right side.
- Palar pegs in one row, regular or reflexively curving in middle.
- Eyes not protuberant.
- Male pala basally without a small dorsal knob..
- Hind leg tarsomere II not infuscated.
- Hemelytra patterns variable, vermiculate or sometimes somewhat fragmentary.

Distribution: These are small insects collected from River Ganga at Kachlaghat Badayun, Ghatiaghat Farrukhabad, Kanpur and Allahabad in Uttar Pradesh. It was also observed in tributaries like, River Yamuna and River Tons during December, 2014 to February, 2015.

Habitat: These insects could be seen in slight to moderately polluted biological water quality at a water temperature range from 11 -21°C. The river bed substratum in water bodies, was 5-70% sand, 5-20% silt, 5 – 85%

clay, 5-55% detritus and 5 -70% macrophytic vegetation. Its length varied from 6-7 mm and width 2-3 mm.

3.2.2.5.5.3 Corixa (Plate 15, Figure 21)

Characters:

- Scutellum covered by pronotum.
- Rostrum transversely sulcate.
- Palae usually scoop-like.
- Hemelytra with embolar groove and well-developed nodal furrow, and distinct pruina.
- If male, abdominal asymmetry dextral.
- Strigil on the right or strigil absent.
- If male abdominal asymmetry sinistral, strigil on the left or absent.
- Pronotum and hemelytra patterned with transverse alternating yellow and dark vermiculations.
- Regular transverse yellow lines, or mostly broken lines.
- Male abdominal asymmetry sinistral.
- Strigil on left side of sixth abdominal tergite in male.

Distribution: *Corixa* was commonly observed in River Ganga at Varanasi, Mirzapur and Tarigaht downstream Ghajipur in Uttar Pradesh. In Bihar its occurrence was observed at Patna and in West Bengal stretch of River Ganga it occurred at Farakka and downstream of Nabadwip. It was also collected from tributaries like River Gomti, River Ghagra and River Gandak during March to May 2015.

Habitat: Habitat of corixa is common in slight to moderate pollution in biological water quality of water bodies at a water temperature range of 19 -35°C. The substratum of water bodies composed of 10 - 30% sand, 10-35% silt, 5-25% clay, 5-45% detritus and 20 – 60% macrophytic vegetation. Its length ranged from 4-7 mm and width 2-3 mm.

3.2.2.5.6 Family Ranatrinidae

- Respiratory processes cylindrical rigid and non-retactable, usually long and filliform.
- Body cylindrical and stick like, fore femur longer than pronotum.
- These insects spend most of their time suspended from the surface of the water by the respiratory tube. This tube maintains communication between the atmosphere and the tracheal (respiratory) system of the insect.

- The insect remains for long period in this position giving the appearance of a cluster of small twigs or roots thereby deceiving its prey. When the prey approaches within striking distance, the insect captures it by means of its forelegs.
- These insects are common in paddy fields, ponds, tanks and slow running streams.

3.2.2.5.6.1 Ranatra brevicolis (Plate 15, Figure 22, 23, 24, 25)

Characters:

- Smaller species. Usually brown with marking on body and legs.
- Anterior lobe of pronotum not wider than head.
- Body elongate, selenderly cylindrical, stick like.
- Abdominal sterna undivided.
- Female subgenital plate laterally compressed, keel-like.

Distribution: Commonly observed insect in River Ganga at Garhmukteshwar, Anupshahar, Narora, Varanasi, Mirzapur and Ghazipur in Uttar Pradesh. In West Bengal it was collected from River Ganga at Farakka and Nabadwip. It was also collected from tributaries like River Kali and River Gomti during December, 2014 to March 2015.

Habitat: Its abundance was confined to slight to moderate pollution in biological water quality at a water temperature range of 11 -35°C. The substratum composition of its habitat was 10 – 90% sand, 4-30% silt, 2-30% clay, 4-20% detritus and 20 -50% of macrophytic vegetation. Its length varied from 15 – 41 mm and width 2 – 5 mm.

3.2.2.5.6.2 Ranatra brevicolis juvenile

Distribution: The juveniles of Ranatra brevicolis were collected from River Ganga at Mirzapur downstream after the confluence of two drains during March, 2015.

Habitat: These juveniles preferred moderate pollution in biological water quality of River Ganga at a water temperature of 22°C. The substratum composition of River Ganga at this location was 35% sand, 20% silt, 10% detritus and 35% of macrophytic vegetation.

3.2.2.5.7 Family Hebridae

- Head little, if at all, longer than wide.
- Eyes in the back of the head, close to anterior margin of the pronotum.
- Antennae with five segments.

- Neck shield broad with deep dots, length 1 to 3 mm, and the body is covered with velvety water resistant hairs.
- They prefer shady cool places and are generally found near abundant vegetation.
- When they swim under water they are covered with a silvery air film.

3.2.2.5.7.1 Hebrus (Plate 15, Figure 26)

Characters:

- Antennal segments long and slender.
- Antenna at least sub equal to greatest width of pronotum.
- Antenna 5 segmented.
- Rostral groove between longitudinal carinae on venter with parallel sides, not converging to a point.

Distribution: Small bugs collected from River Ganga at Garhmukteshwar in Uttar Pradesh and Nabadwip in West Bengal during December, 2014 and May, 2015.

Habitat: These bugs preferred moderate pollution in biological water quality at a water temperature of 18 -34°C and substratum of river bed composed of 5 -40% sand, 5 – 15% silt,5 – 25% clay, 5 – 10% detritus and 40 – 70% of macrophytic vegetation. Its length varied from 2 – 4 mm and width 1 – 2 mm.

3.2.2.5.7.2 Hyrcanus (Plate 15, Figure 27, 28)

Characters:

- Antennae distinctly shorter than greatest width of pronotum.
- Antennal segments stout, fourth segment sub equal in length to first segment.
- Head narrower and pointed apically.
- Eyes sessile.

Distribution: This small species of insect was collected from River Ganga at Mirzapur downstream after confluence of two drains in Uttar Pradesh during March, 2015.

Habitat: It was collected from moderately polluted biological water quality of River Ganga at a water temperature of 22°C. The substratum of River Ganga at this location, composed of 35% sand, 20% silt, 10% detritus and 35% of macrophytic vegetation. Its length was 4,0 mm and width 2.0 mm.

3.2.2.5.8 Family Veliidae

- The distance between the legs is equal.

- Surface dweller.
- Inhabits slow flowing shallow canals.
- The habitat is usually covered with massy scum.
- These striders live in groups.
- They not only walk on the water but also swim under water.

3.2.2.5.8.1 Rhagadotarsus kraepelini (Plate 15, Figure 29, 30)

Characters:

- First abdominal segment visible.
- Tip of abdomen produced to a rod-like point.

Distribution: This insect was collected from River Ganga at Garhmukteshwar in Uttar Pradesh during December, 2014.

Habitat: It preferred moderate pollution in biological water quality of River Ganga at water temperature of 18°C. The river bed substratum composed of 40% sand, 5% silt, 5% clay,10% detritus and 40% of macrophytic vegetation. Its length was 3.0 mm.

3.2.2.5.9 Family Gerridae

- Legs implanted laterally.
- The legs, particularly the posterior legs are inserted towards or at the lateral margin of the thorax.
- The middle legs are inserted much nearer the posterior end than the anterior legs.
- The posterior femurs extend well beyond the tip of the abdomen. Length 6.5-18 mm.
- They live in small streams, pools canals. The insects live in groups and are found skating on the water surface.

3.2.2.5.9.1 Metrocoris (Plate 15, Figure 31)

Characters:

- First abdominal sternite not visible.
- Abdomen not produced.
- Middle femora slender, distinctly longer than middle tibiae.
- Body less than five times as long as broad.
- Fore tarsi shorter.
- Middle femora shorter or sub equal to body length.
- Metasternum reduced, represented by short triangular plate enclosing the scent gland orifice.

- Body relatively broad and short.
- Length: width ratio less than 3.0.
- Eyes not overlapping anterolateral angles of mesosternum.
- Fore femora of male often robust and incrassate.

Distribution: *Metrocoris* was collected from River Ganga at Garhmukteshwar during the month of December, 2014.

Habitat: The biological water quality at its habitat was moderately polluted at a water temperature of 18°C. At this location of River Ganga, substratum composed of 40% sand, 5% silt, 5% clay, 10% detritus and 40% of macrophytic vegetation. The length of Metrocoris was 2.0 mm.

3.2.2.5.9.2 Halobates (Plate 15, Figure 32)

Characters:

- First abdominal sternum absent or fused with metasternum.
- Female ovipositor short and non-serrate.
- Metasternum extremely reduced represented by a very short subtriangular plate enclosing the scent orifice.
- Claws of hind tarsi modified, straight or S-shaped.
- Clypeus with basal margin well defined.
- Anterior margin of head smoothly rounded.
- Metasternum reduced but reaching metacetabula laterally.
- Hair fringes of middle legs present on each tibia and first tarsal segment.

Distribution: *Halobates* was collected from River Ganga at Diamond Harbour in West Bengal during May, 2015.

Habitat: It survived in moderately polluted biological water quality of River Ganga at water temperature of 31°C and substratum of river bed composed of 5% sand, 10% silt, 35% clay, 10% detritus and 40% macrophytic vegetation. Its length was 5.0 mm and width 2.0 mm.

3.2.2.5.10 Family Notonectidae

- Pronotum wider anteriorly in dorsal view and together with the wing cover shields, smooth.
- Tarsi two segmented.
- They prefer the still waters of slow flowing canals, ponds, tanks and rivers.
- They have large compound eyes and a long third pair of swimming legs with the help of which they swim ventral side up. Thus, they are also known as water boatsman.

- In a resting position they lie on their backs while the tip of the abdomen is kept in contact with atmosphere.
- They are predators, attacking fry and fish

3.2.2.5.10.1 Anisops (Plate 15, Figure 33, 34)

Characters:

- Hemelytral commissure with definite hair – lined pit at anterior end.
- Tarsi of mail fore legs each 1 – segmented.

Distribution: *Anisops* were collected from River Ganga at Ghatiaghat in Farrukhabad and Allahabd in Uttar Pradesh during January - February, 2015.

Habitat: It survived in moderately polluted biological water quality of River Ganga at water temperature ranging from 11 - 19°C and substratum of river bed composed of 5 - 80% sand, 5 - 20% silt, 30 - 80% clay, 5 - 15% detritus and 10% macrophytic vegetation. Its length varied from 5.0 - 7.0 mm and width 2.0 mm.

3.2.2.5.11 Family Hydrometridae

- Antennae as long as, or longer than, head.
- Scutellum not exposed, covered by the posteriorly extended pronotum.
- Head elongate and slender.
- Eyes far removed from base of head.
- Claws of all legs inserted on apex of tarsus.

3.2.2.5.11.1 Hydrometra latreille (Plate 15, Figure 35)

Characters:

- The thorax is elongate and the middle coxae are nearer the fore coxae than the hind coxae.
- Abdominal medioptergites are longer than broad.
- Each tarsus has its second segment distinctly longer than its third segment.

Distribution: The stick – like fragile bug *Hydrometra* was collected from River Ganga at downstream of FTPS, Farakka in West Bengal during May, 2015.

Habitat: It survived in moderately polluted biological water quality of River Ganga at water temperature of 30°C and substratum of river bed composed of

15% sand and silt, 20% clay, 5% detritus and 45% of macrophytic vegetation. Length of *Hydrometra latreille* was 11.08 mm and width 0.44 mm.

3.2.2.6 Order Coleoptera

Figure 24 : Classification of Order Coleoptera

3.2.2.6 Order Coleoptera

- Animal is an adult insect.
- Head equipped with chewing mouthparts.
- Forewings hardened to form a protective covering for the hind wings, which are membranous.

3.2.2.6.1 Family Elmidae/Elmididae/Elminthidae

- Antennae slender or short, but never with a pectinate club.
- Small species (1.1-5.2mm).
- Fore coxae globular, prosternum small, much narrower than head.

3.2.2.6.1.1 Stenelmis larva (Plate 16, Figure 1, 2)

Characters:

- Abdomen with 9 segments with operculum.
- Abdominal segment 9 longer than segment 8.
- Legs 3 segmented, well developed with one claw.
- Abdomen with pleura on first 6 or 7 segments.
- Body slight slender, elongate cylindrical or hemicylindrical.
- Prothorax with a posterior sternum.

- Procoxal cavities open behind.
- Anterior margin of head on each side with a distinct frontal tooth.
- Second segment of antenna less than twice as long as 1st.
- Prostermum with anterior median suture.
- Suture from procoaxal cavity to lateral margin indistinct or absent.

  Pleuron not divided.

Distribution: The larva was collected from river Ganga at Haridwar barrage and from river Alaknanda after confluence with river Mandakini at downstream of Rudraprayag during the month of June-July 2014.

Habitat: Biological water quality of the habitat was in the range of clean to slight pollution. The water temperature preference of this larva was 17.2˚C to 21.5˚C with a substratum requirement of 5-60% of boulders, 35-90% of cobbles, 4-5% of pebbles and 1% of gravel. The larva was collected. The length of the larva was 5.87 mm and width 1.04 mm.

3.2.2.6.1.2 Stenelmis (Plate 16, Figure 3, 4, 5)

Characters:

- Procoxae rounded and trochantin concealed.
- Antenna long, with 11 segments.
- Maxillary palp with the last segment swollen.
- Elytra with distinct striae.
- Pronotum without a broad transverse impression.
- Legs very long.
- Tarsal claws simple, without basal teeth.
- Anterior tibia without fringe of tomentum.
- Granules of head and legs round.

3.2.2.6.1.3 Pseudamophilus (Plate 16, Figure 6, 7)

- Procoxae rounded and trochantin concealed.
- Antenna long, with 11 segments.
- Maxillary palp with the last segment swollen.
- Elytra with distinct striae.
- Pronotum without a broad transverse impression.
- Legs very long.
- Tarsal claws simple, without basal teeth.
- Anterior tibia with fringe of tomentum.

- Pronotum without sublateral carinae.
- Antenna long, the last segment slightly longer than the former one.

Distribution: The adult insect was collected from few locations of river Ganga in Uttar Pradesh, Bihar and West Bengal. In Uttar Pradesh, it was found at Tarighat downstream Gazipur, in Bihar at MG Bridge, Patna and at Raghunathganj in West Bengal. It was collected during different seasons spanning the months of March to May 2015.

Habitat: At all the locations, the water temperature ranged between 25-31˚C. The biological water quality was found to be in the range of slight to moderate pollution. Substratum composition at the habitat included mainly sand 10-25%, silt 20-35%, clay 10-20%, 5% detritus and 20-45% macrophytic vegetation. The length of the organism varied between 5-7mm and width 2-3mm.

3.2.2.6.2 Family Scirtidae

1. Maxillary palpi shorter than antennae.
2. Elytra covering entire abdomen or exposing only one abdominal tergite.
3. Tarsal formula 5-5-5 or 4-4-4. Tarsi 4- or 5 segmented, 4th segment clearly visible.
4. Abdomen with 5 or 6 visible segments.
5. Antennae not elbowed, form varied, club when present usually not compact.
6. Prosternum very short, fore and mid coxae conical,
7. Slightly separate. 4th tarsal segment bilobed, 5th not elongate.
8. Small species (2-10 mm).

3.2.2.6.2.1 Cyphon larva

Characters:

- Head with 1-2 ocelli on each side.
- Cone of hypopharynx with two pairs of spines.
- Side of abdominal segments with only scattered, thin setae, like those of dorsum.
- Last segment of maxillary palp short.

Distribution: The insect was collected from river Ganga at Allahabad in Uttar Pradesh in the month of February, 2015.

Habitat: Biological water quality was found to be moderately polluted having 19˚C water temperature. The substratum of the water body was 5%

sand, 10% silt, 70% clay, 5% detritus and 10% of macrophytic vegetation. The length of the insect was 3.0 mm and width 1.0 mm.

3.2.2.6.3 Family Dytiscidae

- Not with this combination of characteristics.
- Scutulum concealed or exposed.
- If scutulum is visible, tarsi apparently four segmented.
- Hind legs strongly flattened.
- These beetles are found mostly in the bottom of ponds and pools as well as sometimes in running waters.
- The shape of the body may be oval, elliptical or circular, sometimes tapering at the end.

3.2.2.6.3.1 Prionocyphon (Plate 16, Figure 8, 9)

Characters:

- Hind femur similar to front and middle femora, not greatly enlarged for jumping.
- Meso-and metasternal processes in contact between coxae, separating them.
- First antennal segment large, fully twice as broad as any of those following.
- First antennal segment expanded anteriorly.
- Second antennal segment arising from posterior apical angle of 1stand from under a slight margin.

Distribution: The insect was collected from river Ganga at upstream of Tribeni in West Bengal in the month of May, 2015.

Habitat: The biological water quality of this habitat was moderately polluted and water temperature was 32˚C. The substratum was composed of 10% sand, 15% silt, 35% clay, 5% detritus and 35% macrophytic vegetation. The length and width measured was 5.0 mm and 2.0 mm respectively.

3.2.2.6.3.2 Hyphydrus (Plate 16, Figure 10, 11)

Characters:

- Scutellum covered by pronotum.
- Fore and middle tarsi each 4-segmented or with 4th segment small and concealed between lobes of 3rd.
- Hind claws assymetrical.
- Hind tibia straight, of almost uniform width.
- Body length over 4 mm.

Distribution: *Hyphydrus* is the most common beetle observed throughout the stretch of river Ganga including Rishikesh, Haridwar at Uttarakhand, Barawali, Narora, Ghatia Ghat, Farrukhabad, Bithur, Kanpur, Fatehpur, Allahabad, Varanasi, Mirzapur, Tarighat at Downstream Gazipur. In Bihar, this insect was collected from river Ganga at Buxar, Danapur and MG Road, Patna. In West Bengal, it was observed at Farakha, Jiaganj, Katwa and Nabadwip. Hyphydrus was also commonly found in tributaries of river Ganga such as River Saloni at sukratal, River RamGanga at Muradabad, River Kali, River Yamuna, River Tons, River Varuna, River Gomti and River Garra, collected throughout the year from June, December 2014 to May 2015.

Habitat: The water temperature ranged between 10.5˚C to 35˚C at all the locations where *Hyphydrus* was found. The biological water quality preferred was slight to heavy pollution range. *Hyphydrus* preferred a range of substratum composition including 2-80% sand, 2-30% silt, 5-85% clay, detritus 5-55% and macrophytic vegetation ranged between 5-80%.. The length measured was 4.0 – 6.0 mm and width 2.0 – 3.0 mm.

3.2.2.6.3.3 Nipponhydrus (Plate 16, Figure 12, 13)

Characters:

- Scutellum covered by pronotum.
- Fore and middle tarsi each 4-segmented or with 4th segment small and concealed between lobes of 3rd.
- Hind claws assymetrical.
- Hind tibia straight, of almost uniform width.
- Body length less than 3 mm.

Distribution: *Nipponhydrus* beetles were smaller than Hyphydrus, collected from River Ganga at Narora, Bithur, Allahabad, Varanasi and Mirzapur in Uttar Pradesh and in West Bengal at Farakka, Nabadwip and Tribeni, it was also collected from Tributaries of River Ganga such as River Saloni, River RamGanga in Uttar Pradesh and River Gandak near Hajipur in Bihar. It was collected during the month of June, December 2014 to May 2015.

Habitat: Biological water quality was in moderate to heavy pollution range. The length of the collected specimens of *Nipponhydrus* ranged between 2-3mm and width 1-2mm.

3.2.2.6.3.4 Rhantus (Plate 16, Figure 14, 15, 16, 17)

Characters:

- Eye emarginate above base of antenna.
- Basal three segments of fore tarsus of male widened and with adhesion, but never forming an oval or nearly round plate.

- Hind femur without cilia
- Hind claws unequal. Outer claw only from one –third to two-third length of inner claw.
- Elytral sculpture without any transverse striations.

Distribution: These small to large sized beetles *Rhantus* collected from River Ganga at Garmukhteshwar, Anupshahar, Narora, Ghatiaghat, Farukhabad in moderately polluted biological water quality. It was also collected from River Ganga and River RamGanga in Uttar Pradesh. The *Rhantus* specimen were collected during the month of December 2014 - January 2015.

Habitat: The water temperature of the habitat where *Rhantus* were found ranged between 11 – 19˚C and substratum composition ranged between 5 - 90% of sand, 4-20% of silt, 2-30% of clay, 4-20% of detritus and 20-70% of macrophytic vegetation. The length of Rhantus ranged between 4 – 30 mm and width 2 - 17 mm.

3.2.2.6.3.5 Hydrovatus (Plate 16, Figure 18, 19)

Characters:

- Scutellum covered by pronotum.
- Fore and middle tarsi each 4-segmented or with 4th segment small and concealed between lobes of 3rd.
- Hind claws symmetrical.
- Prosternum process large, flattened, and almost truncate behind.
- Hind coxal process with the broad apex divided into 3 parts by 2 oval emarginations.

Distribution: This beetle was collected from River Ganga at Narora, collected during the month of December 2014.

Habitat: The water temperature at the location was found to be 18˚C having moderately polluted biological water quality and substratum composition on the site included 5% sand, 5% silt, 5% clay, 5% detritus and 80% of macrophytic vegetation. The length of *Hydrovatus* insect was recorded at 7mm and width 2mm.

3.2.2.6.3.6 Oreodytes larva (Plate 16, Figure 20, 21)

Characters:

- Head with frontal projections.
- Maxillary palp 3-segmented.
- Frontal projection of head broadly triangular.
- Cercus with more than 7 setae.

- Cercus very long.

Distribution: The larva of *Oreodytes* was collected from river Ganga at Barawali in Uttar Pradesh during December 2014

Habitat: The Biological water quality of the site where the larva was found to be in the category of moderately polluted water temperature at the time of sampling recorded at 19˚C. Substratum composition of the habitat included 40% sand, 30% silt, 10% clay and 10% detritus. Length of insect observed was 10 mm and width was 2 mm.

3.2.2.6.3.7 Deronectes larva (Plate 16, Figure 22, 23, 24, 25)

Characters:

- Head with frontal projections.
- Maxillary palp 3-segmented.
- Frontal projection of head broadly triangular.
- Cercus with more than 7 setae.
- Cercus short.

Distribution: The larva of *Deronectes* was collected from River Ganga at Narora, Fatehpur and Allahabad in Uttar Pradesh. It was also observed in tributaries of River Ganga in River RamGanga, River Garra, River Yamuna and River Tons in Uttar Pradesh. The larva was collected during the months of December 2014, January-February 2015.

Habitat: Biological water quality of the habitat where sampling has been performed was found to be in the range of slight to moderate pollution with water temperature in the range of 11-21˚C. Substratum composition was found consisting of approximately 2-70% sand, 3-10% silt, 5-85% clay, 5-20% detritus and 5-80% of macrophytic vegetation. Its length varied between 6-8 mm and width was recorded at 2 mm.

3.2.2.6.3.8 Hydrovatus larva (Plate 16, Figure 26, 27)

Characters:

- Head with frontal projection.
- Maxillary palp usually 3-segmented.
- Frontal projection of head usually broadly triangular.
- Cercus with only 7 setae.
- Frontal projection without notches.
- Larva greatly widened in middle, greatest width approximately0.25 of total length.

Distribution: The larva of *Hydrovatus* was collected from River Ganga at a location at Varanasi upstream on SH-74 and also downstream of Varanasi at Tarighat in Ghazipur, Uttar Pradesh in the month of March 2015.

Habitat: The water temperature at the time of sampling was measured in the range of 25-26˚C at the locations. Substratum of the river bed was found to be composed of 10-20% of sand, 15-25% of silt, 10% clay, 5% detritus and 40-60% of macrophytic vegetation. Biological water quality indicated to be moderately polluted. The body size measurement of *Hydrovatus* larva has been done and found as a length of 7mm and width at 2mm.

3.2.2.6.3.9 Cybister larva (Plate 16, Figure 28, 29, 30, 31)

Characters:

- Head without frontal projection.
- Maxillary palp with 4 or more segments.
- Head with basal transverse incision, separating a narrow neck-like area.
- Body elongate.
- Head subtriangular.
- Antennae with 5 or more segment.
- Head dentate anteriorly.
- Lingula long.
- Cerci absent.

Distribution: The larva of the *Cybister* beetle was collected from River Ganga at Mirzapur, Tarighat at Ghazipur in Uttar Pradesh and Mahatma Gandhi Setu, right bank at Patna. It was also collected from River Gomti at Rajwari. The organism was collected during the month of March, April 2015 from different locations.

Habitat: The water temperature at the habitat of *Cybister* was found ranging between 22-28˚C with moderately polluted biological water quality. The substratum composition ranged from 20-35% sand, 20-35% silt, 10-15% clay, 5-10% detritus and 20-40% macrophytic vegetation. The length of the collected individual was observed ranging in length at16 - 29 mm and width between 2 - 3mm.

3.2.2.6.3.10 Dytiscus (Plate 16, Figure 32, 33, 34, 35)

Characters:

- Scutellum entirely visible.
- Eyes not emarginated.
- Basal 3 segments of fore tarsus of male greatly broadened, forming a nearly round or oval plate with adhesion discs.

- Hind tarsus with a coarse fringe of golden yellow flat ciliae on the hind margin of basal 4 segments.
- Hind margin of pronotum narrower than the base of elytra.
- Prosternal process not pointed.
- Elytra side margins without serrated spines.

Distribution: The large beetle *Dytiscus* was collected from river Ganga at a location at Tarighat downstream of Ghazipur in Uttar Pradesh during the month of March 2015.

Habitat: The animals were found living in a water temperature measured at 25˚C and substratum composition of the habitat at the site of collection of animals was 20% sand, 25% silt, 10% clay, detritus 5% and macrophytic vegetation 40%. Biological water quality was found to be moderately polluted. Length of the collected individuals varied from 27-28 mm and width 14 mm.

3.2.2.6.3.11 Laccophilus (Plate 16, Figure 36, 37)

Characters:

- Scutellum covered by pronotum, or rarely a small tip visible.
- Fore and middle tarsi distinctly 5-segment, 4th segment not bilobed.
- Prosternal process simple, not furcated.

Distribution: This beetle *Laccophilus* was collected only from one location on river Ganga at Ramnagar Road near Varanasi during a survey/monitoring of the location in March, 2015.

Habitat: Biological Water Quality indicated to be moderately polluted at 22˚C water temperature at the location with substratum composition of this location had 15% sand, 30% silt, 10% clay and 45% detritus. The size of the body of *Laccophilus* has shown its body length as 4 mm and width 2 mm.

3.2.2.6.4 Family Psephenidae

- Antennae have eleven segments and are long, thread-like.
- The antennae originate from underneath a roof shaped vaulting of the forehead.
- They are found under stones of wave swept shores of streams and sometimes of lakes.

3.2.2.6.4.1 Psephenoidinae

Characters:

- Lateral expansions of 7th abdominal segment projecting posteriorly beyond the 9th segment and meeting or nearly

meeting on the midline so that they more or less completely enclose both 8th and 9th segments.

- 8th abdominal segment without lateral expansions.

Distribution: This animal was collected from river Ganga at Rishikesh Barrage in Uttarakhand state in the month of June, 2014.

Habitat: Biological water quality of this location was found in the category of clean and water temperature recorded was 19.8˚C. The substratum was found to be composed of 10% bulders and 90% cobbles.

3.2.2.6.5 Family Gyrinidae

- First visible abdominal sternite (breast plate) completely divided at the middle by hind coaxal (first leg segment) cavities.
- Four eyes (One dorsal and one ventral pair.
- Antennae with the two basal segments strongly developed, rest of antennae short and thick.
- Anterior legs longer than medium or hind legs.
- Hind legs not or practically not visible from dorsal side.
- These beetles live in large groups together and are found on the surface moving swiftly in irregular circles.
- They prefer clean flowing waters.
- Although they are surface dwellers, they dive when disturbed, taking an air bubble with them.

3.2.2.6.5.1 Orectochillus (Plate 16, Figure 38, 39)

Characters:

- Mesothoracic episterna touching the base of the epipleura of the elytra.
- Last abdominal sternite elongate and pyramidal and provided with a longitudinal median row of hairs.
- Most of dorsal surface densely pubescent.
- Elytral punctures not arranged in rows.

Distribution: These fast moving beetles *Orectochilus* were collected from river Ganga (nahar) at DhamKhoti downstream of Har-ki-poudi in haridwar and at SH-98 Bridge in Varanasi, Uttar Pradesh during the months of June, 2014 and March, 2015.

Habitat: The water temperature of the above mentioned locations ranged between 19˚C-19.8˚C. The substratum of water bodies was composed of either 100% boulders or 10% sand, 30% silt, 10% clay, 5% detritus and 45%

of macrophytic vegetation in a biological water quality ranging from clean to moderate pollution. The measured average length was found as 9mm and width was 3mm.

3.2.2.6.6 Family Haliplidae

- Only one pair of eyes.
- Metacoxae expanded into a large plate that covers two or three abdominal sterna and the base of the metafemur.
- These are small insects, 4-5 mm in length, found in all kinds of fresh water habitats.

3.2.2.6.6.1 Haliplus (Plate 16, Figure 40, 41)

Characters:

- Hind coaxal plates smaller, leaving last 3 abdominal sternites exposed.
- Elytron without fine sutural stria.
- Pronotum with sides widest at base, convergent anteriorly.
- Epipleuron evenly narrowed, ending near base of last abdominal sternite, never reaching elytral apex.
- Episternum completely separating metasternum from epipleuron,

Distribution: *Haliplus* is the smallest beetle collected from river Ganga at Madhya Ganga barrage of Bijnore and Anupshehar in Uttar Pradesh. It was also collected from RamGanga River before confluence to river Ganga at Kannauj during the month of December 2014 to May 2015.

Habitat: The water temperature in the above mentioned water bodies at the sampling locations where *Haliplus* was found to range between 18˚C-19˚C and substratum was having 5-90% sand, 4-5% silt, 2-5% clay, detritus 4-10% and 75% of macrophytic vegetation. Biological water quality was found to be moderately polluted. The length of the observed organism was measured in the range of 3-4 mm and width was 2mm.

3.2.2.6.6.2 Haliplidae larva (Plate 16, Figure 42, 43, 44)

Characters:

- Body spines, never stalked or much longer than length of 1st body segment.
- Apical abdominal segment produced posteriorly in a forked or unforked horn.
- Fore legs, if chelate, with 4th segment less produced and without solid row of small teeth.

- Third antennal segment 2-3 times as long as 2nd.
- Body with or without conspicuous spines.
- Fore leg weakly to moderately chelate.
- 4th segment more or less produced, usually bearing 2-3 spines.

Distribution: The larvae of *Haliplidae* family were collected from river Ganga at Tarighat downstream of Ghazipur in Uttar Pradesh

Habitat: The biological water quality at the habitat of *Haliplidae* was found as moderately polluted. The water temperature at this location was 25˚C with substratum composition of 20% sand, 25% silt, 10% clay, 5% detritus and 40% macrophytic vegetation. The animal was collected in March 2015. The length of the organism was 14mm and width was 3mm.

3.2.2.6.7 Family Hydrophilidae

- Antennae short (5-7 mm), (true) segment VI cup shaped, segments beyond that form a differentiated club.
- Head sometimes with Y – shaped impressed line on the vertex.
- Antennal club only with true three segments after the cup.
- The body can be highly arched, with a broad and oval shape.
- Scavanger beetles inhabiting pools, ponds and river banks.
- The hind legs are flattened and move alternately for swimming but usually they crawl on aquatic vegetation.

3.2.2.6.7.1 Helochares (Plate 16, Figure 45, 46)

Characters:

- Pronotum with conspicuous longitudinal furrows.
- Body contour interrupted between pronotum and elytra
- Elytra without intercalary striae
- Apical segment of maxillary palpi asymmetrical.
- Elytra flanks wide, visible from below.

Distribution: *Helochares* beetle was collected from Madhya Ganga Barrage in Bijnor, Garhmukhteshwar, Bithur,SH-74 Bridge upstream of Varanasi in Uttar Pradesh, River Ganga at downstream of Nabadwip in West Bengal. It was also collected from river Saloni at Sukartal Ghat and River Kali before confluence to River Ganga at Kannauj and River RamGanga in Muradabad. This collection was done at different locations in the month of December, 2014 and March - May, 2015

Habitat: It was observed that *Helochares* preferred a moderate to heavy pollution range of biological water quality with water temperature on the location ranging from 10.5˚C-34˚C. Substratum of habitat was composed of 5-40% sand, 4-30% silt, 2-80% clay, 4-30% detritus and 5-75% macrophytic vegetation. Its length varied between 3-6mm and width between 2-3mm.

3.2.2.6.7.2 Helochares (Plate 16, Figure 47, 48)

Characters:

- Pronotum without longitudinal furrows.
- Body contour evenly curved.
- First segment of meso- and metatarsi shorter than 2nd segment.
- Maxillary palp as long as or longer than, antenna.
- Much smaller species not exceeding 10 mm).
- Meso and metasternum markedly raised medially, but not forming a common sternal keel.
- Tibiae without fringes of long swimming hairs.
- Scutellum about as long as wide.
- Length over 2 mm.
- Antennal club loose.
- Terminal segment of maxillary palp shorter than, or as long as penultimate.
- Palpi much longer than antennae.
- Maxillary palp with 2nd segment oppositely curved, or straight and short terminal segment bending inward.
- Antennae 9-segmented.
- Elytra with punctured striae.
- Posterior margin of last sternite with a small emargination in middle.

Distribution: The *Helochares* beetles were collected from river Ganga at Brajghat, Garmukhteshwar, Narora, Ghatiaghat, Farrukhabad, Allahabad bypass, Ramnagar Road Varanasi, Mirzapur, Tarighat downstream, Ghazipur in Uttar Pradesh, Mahatma Gandhi Bridge right Bank, Patna in Bihar, Farakka, Raghunathganj, downstream Murshidabad, Katwa and Nabadwip in West Bengal. It was also collected from tributary of Ganga in River RamGanga, River Yamuna, River Tons and River Gomti in Uttar Pradesh during all seasons spanning from December, 2014 to May, 2015.

Habitat: The biological water quality preferred by *Helochares* was found to be in the range of slight to heavily polluted with water temperature ranging

from 10.5˚C-34˚C. The substratum composition was having 5% boulders, 2-50% sand, 5% silt, clay 5-85%, detritus 5-30% and 5-80% macrophytic vegetation.

3.2.2.6.7.3 Halochares larva (Plate 16, Figure 49, 50)

Characters:

- Abdomen with 8 complete segments.
- 9th and 10th abdominal segment reduced and usually forming a stigmatic atrium.
- Ocelli six separately.
- Ocelli with uniform size, interval broad.
- Maxilla with the stipes short and stout, femora without swimming hairs.
- Abdomen 9-segmented, without lateral gills, if projections present, not prominent.
- Frontal sutures not parallel.
- Epicranial suture present or not.
- Lingula present.
- Antennae longer.
- Epicranial suture present, but usually short.
- Legs fairly long,not reduced.
- Mandibles symmetrical, each with 2-3 teeth.
- Abdomen without prolegs.
- Clypeus with 6 distinct teeth, placed in 2 groups, 2 on the left and 4 on the right.

Distribution: The larva of beetle was collected from River Ganga at Ramnagar road in Varanasi, Uttar Pradesh during the month of March, 2015.

Habitat: The water temperature at the above mentioned site was found at 22˚C and biological water quality was categorized as moderately polluted at the time of sampling. The substratum composition at this site approximately was found as 15% sand, 30% silt, 10% clay and 45% detritus. The length of the *Helochares larva* was measured at 11mm and width was found 2mm.

3.2.2.6.7.4 Helochares larva (Plate 16, Figure 51, 52)

Characters:

- Pronotum without longitudinal furrows.
- Body contour evenly curved.

- First segment of meso- and metatarsi shorter than 2nd segment.
- Large or very large species (14-43 mm).
- Meso- and metasternum markedly raised medially to form a common sternal keel.
- Prosternum strongly elevated in the middle, hood like, with a narrow and deep posteromedian excavation.

Distribution: The *Hydrophilus* was collected from River Ganga at downstream of Mirzapur, at Tarighat downstream of Ghazipur in Uttar Pradesh and River Ganga downstream of Murshidabad and Jiaganj in West Bengal. It was also observed in tributaries of Ganga in River Kali at Kannauj and River East Kali before confluence to River Ganga. Beetles were collected during the months of December, 2014 to May, 2015.

Habitat: At all the above mentioned locations water temperature ranged between 17˚C-35˚C with moderately polluted biological water quality. The substratum composition in these water bodies ranged between 10-35% sand, 15-20% silt, 10-25% clay, 5-20% detritus and 20-25% Macrophytic vegetation. The length varied between 3-5mm and width between 1-3mm.

3.2.2.6.7.5 Berosus larva (Plate 16, Figure 53, 54)

Characters:

- Abdomen with 8 complete segments, 9^{th} 10^{th} segment reduced.
- Ocelli six separately, interval broad, with uniform size.
- Femora without swimming hairs.
- Abdomen 8 segmented first 7 segments with long lateral tracheal gills.

Distribution: *Berosus* larva was collected from different locations of River Ganga at Madhya Ganga Barrage, Bijnor, and Dhonighat downstream Kanpur in Uttar Pradesh and Nabadwip in West Bengal.

Habitat: The water temperature in water bodies where *Berosus* larva was found has ranged between 16.5˚C-34˚C. Biological water quality at this location was found to be moderately polluted. This organism prefers substratum composed of 5-70% sand, 5-25% silt, 5-15% clay and 5-75% of macrophytic vegetation. Animal was collected during December 2014, January 2015 to May 2015. The length of the animals were recorded and found to be varying between 5-10 mm and width 2 mm.

3.2.2.6.7.6 Berosus (Plate 16, Figure 55, 56, 57, 58)

Characters:

- Pronotum without longitudinal furrows.
- Body contour evenly curved, only occasionally feebly interrupted between pronotum and elytra.
- First segment of meso- and metatarsi shorter than 2nd segment.
- Maxillary palp normally as long as, or longer than, antenna.
- Much smaller species (not exceeding 10mm).
- Meso and meta-sternum often markedly raised medially, but not forming a common sternal keel.
- Meso and metatibiae with conspicuous fringes of long swimming hairs.
- Scutellum distinctly longer than wide.
- Antennae 7-segmented.
- Eyes large, strongly convex and protruding.
- Abdomen with 5 sternites, or with a 6th retractable sternite exposed.

Distribution: *Berosus* was collected from river Ganga at Garmukhteshwar, Narora, Kachlaghat-Badaun,Ghatiaghat Farrukabad, Varanasi SH-98, Tarighat downstream Ghazipur, Mirzapur downstream. It was also collected from tributaries like Saloni River at Sukartal Ghat, River Ram Ganga, River Tons, River Varuna, River Gomti in Uttar Pradesh and Nalla at Patna in Bihar. The animals were collected during December, 2014 and January – April, 2015.

Habitat: *Berosus* was found to show preference for biological water quality of moderate to heavy pollution ranging with water temperature from 11˚C-26˚C at different locations. The substratum of different habitat was found composed of 5-50% sand, 4-30% silt, 2-80% clay, 4-45% detritus and 10-80% macrophytic vegetation. The body size of the collected individuals was measured and found of a length varied between 6-10 mm and width 2-5 mm.

3.2.2.6.7.7 Amphiops (Plate 16, Figure 59, 60)

Characters:

- Pronotum without longitudinal furrows.
- Body contour evenly curved, only occasionally feebly

interrupted between pronotum and elytra.

- First segment of meso- and metatarsi shorter than 2nd segment.
- Maxillary palp normally as long as, or longer than, antenna.
- Much smaller species (not exceeding 10mm).
- Meso and meta-sternum often markedly raised medially, but not forming a common sternal keel.
- Tibiae without fringes of long swimming hairs.
- Scutellum about as long as wide.
- Abdomen with basal two sternites covered by a bilobed hyaline mass supported by a fringe of long stiff yellowish setae.
- Very small (1.3-3.7mm) semiglobular species, with antennal club rather compact.

Distribution: The insect was observed only once in River Ganga at downstream of Mirzapur after the confluence of two drains to River Ganga.

Habitat: The biological water quality was moderately polluted and water temperature was 22˚C. Substratum composition was found having 35% sand, 20% silt, 10% detritus and 35% macrophytic vegetation in the month of March 2015. The length of the animal observed was found in the range of 5-6 mm and width was 4 mm.

3.2.2.6.8 Family Noteridae

- Head sunk in thorax.
- Eyes are touching the anterior margin of the neck shield.
- Eyes not protruding.
- The abdominal sternite of the middle thoracic segment sprouts out backwards among the hind coxa and forms a triangular cavity.
- Scutulum completely invisible, covered by the neck shield, carapace dotted.
- Pro- and medium tarsi segmented, with a curved spine at the apex of the fore tibiae for digging into the soil.
- Adults have to come to the surface for respiration.

3.2.2.6.8.1 Neohydrocoptus (Plate 16, Figure 61, 62)

Characters:

- Body elongate and tapering at apex, or oval, egg shaped.
- Foretibia at fore margin with strong spines, but these not strongly curved or hooked spur.

- Prosternal process apically pointed.
- Metacoxal process without hairs.
- Beetle larger than 2 mm.
- Shapes in dorsal view distinctly oval, egg shaped.

Distribution: The small beetle *Neohydrocoptus* was collected from River Saloni at Sukartal Ghat in Uttar Pradesh during the month of December, 2014.

Habitat: *Neohydrocoptus* was found to be living in the river with moderately polluted biological water quality. The water temperature of water body (River Saloni) was recorded at 19˚C and substratum composition was found to contain 40% sand, 4% silt, 2% clay, 4% detritus and 50% of macrophytic vegetation. It was collected in the month of December, 2014. The length of the beetle was measured as 2mm.

3.2.2.6.8.2 Noterus (Plate 16, Figure 63, 64)

Characters:

- Anterior tibiae with curved spur on the apex.
- Prosternal process rounded behind.
- Hind femur without angular cilia. (if present short and appressed).

Distribution: This insect of family *Coleopteran* was collected from River Yamuna, near Rajapur in Uttar Pradesh in the month of February, 2015.

Habitat: The above mentioned sites were found to have 18˚C of water temperature and moderately polluted biological water quality during the time of collection. The substratum of the river habitat on location consisted of 5% sand, 10% silt, 60% clay, 5% detritus and 20% macrophytic vegetation. The length of the beetle was found varying between 4-26 mm and width 2-15 mm.

3.2.2.6.8.3 Hydrocoptus (Plate 16, Figure 65, 66)

Characters:

- Anterior tibiae without curved spur.

Distribution: *Hydrocoptus* insect was collected from river Ganga at Garmukhteshwar, Varanasi SH-9 at Mirzapur downstream, Tarighat downstream Ghazipur in Uttar Pradesh, and Mahatma Gandhi Bridge at Patna in Bihar and downstream of Nabadwip in West Bengal. *Hydrocoptus* specimens were collected during the months of December, 2014 to February - May, 2015.

Habitat: The substratum composition of this site was having 10-40% sand, 5-30% silt, 5-70% clay, 5-15% detritus and 20-45% macrophytic vegetation. Biological water quality was observed to be moderately polluted with water temperature ranging between 18˚C - 34˚C. Its length varied from 3 - 4mm and width from 1 - 2 mm.

3.2.2.6.9 Family Eulichadidae

- Legs present with 3-6 well defined segments in larvae of this family.
- Legs with a single claw.
- Labrum free not fused to clypeus.
- Abdominal segments without pairs of articulated finger-like lobes on the dorsal surface.
- Abdomen with 9 segments, articulated cerci lacking.
- Antennae short and inconspicuous, consisting of 2-or 3 segments only.
- Body more or less cylindrical or fusiform. Head and legs visible when viewed from above.
- Abdominal segment 9 lacks a vertical operculum but ventral gill tufts are present on segment 1-8.

3.2.2.6.9.1 Eulichas larva (Plate 16, Figure 67, 68)

Characters:

- Abdominal segment 1-8 with tufts of finger like gills ventro-laterally.

Distribution: The larva of this beetle was collected from River Yamuna near Rajapur in Uttar Pradesh in the month of February, 2015.

Habitat: *Eulichas* larva was found in river habitat with moderately polluted biological water quality having 18˚C water temperature. Substratum composition includes 5% sand, 10% silt, 60% clay, 5% detritus and 20% macophytic vegetation. The length measured was 14mm and width was 3mm.

3.2.2.6.10 Family Histeridae

- Maxillary palp shorter than antennae.
- Antennae otherwise, where clubbed, the segment before the club is not laterally cup-shaped.
- Head without a median longitudinal line.
- Elytra covering entire abdomen or exposing only one tergite.
- Tarsal formula 4-4-4.
- Tarsi 4-or 5 segmented, 4th segment clearly visible.
- Abdomen with 5 or 6 visible segments.
- Antennae elbowed, with 2nd segment attached medially on elongated 1st segment.
- Antennal club consisting of several compactly fused segments.
- Small to large species (1-16mm).
- Occur in a variety of habitats.
- Commonly found in carrion, dung, decaying matter fungi, or under bark of dead or dying trees.

3.2.2.6.10.1 Hister (Plate 16, Figure 69, 70, 71, 72)

Characters:

- Adult is small to medium-sized (1-8mm).
- The body is broadly oval, or flattened, with compact form.
- Usually shining black in color.
- The head is deeply sunk into the thorax.
- The antennae are geniculate and each has a pronounced club.
- The elytra are truncated behind leaving one or two apical segment of abdomen exposed.
- When alarmed, they simulate death and closely retract the antennae and legs beneath the body, snugly into shallow grooves on the ventral side of the body that is often difficult to see them, even with considerable magnification.

Distribution: The small insect *Hister* was collected from River Ganga at Mirzapur downstream and tarighat downstream of Ghazipur in Uttar Pradesh and Raghunathganj, West Bengal in March and May 2015.

Habitat: It was observed that organism preferred biological water quality between slight to moderate pollution with temperature range 22˚C-31˚C. The substratum composition was having 10-35% sand, 20-25% silt, 10-20% clay, 5-10% detritus and 35-45% macrophytic vegetation. Its length varied

between 3-12mm and width 2-5mm.

3.2.2.6.11 Family Curculionidae

- Maxillary palp shorter than antennae.
- Antennae otherwise, where clubbed, the segment before the club is not laterally cup-shaped.
- Head without a median longitudinal line.
- Elytra covering entire abdomen or exposing only one tergite.
- Tarsal formula 5-5-5 or 4-4-4.
- Tarsi 5-segmented but 4th segment very small and concealed by the lobes of the 3rd, 1st ,to 3rd with adhesive lobes beneath.
- Head more or less produced in to rostrum.
- Antennae usually geniculate and clubbed, 1st segment retractable into a groove.
- Antennae nearly always geniculate.
- Trochanters very elongate.
- Ventral surface of mentum with a projecting seta or tuft of bristles.

3.2.2.6.11.1 Echinocnemus (Plate 16, Figure 73, 74, 75, 76)

Characters:

- Rostrum received in prosternum in repose.
- Upper surface of the body very often uneven.
- Procoxae contiguous.
- Mesoepisternum not visible from dorsal view.
- Last segment of tarsus projecting beyond lobes of 3rd segment.
- Tibiae without strong apical claw, or only with small process at inner apical angle.
- Third tarsal segment deeply emarginated
- Rostrum with the antennal cavities sloped downwards.
- The ventral portion between it narrowed posteriorly.
- Upper surface of body densely covered with oval scales.

Distribution: *Echinocnemus* insect was commonly observed in River Ganga in West Bengal stretch at Farakka downstream of FTPS, upstream of Jiaganj and Tribeni during the month of May, 2015.

Habitat: The water temperature on the location of collection of animals was recorded in the range of 30˚C-35˚C with biological water quality observed to

be in the range of slight to heavy pollution. Substratum of this site was found composed of a range in 10-15% sand, 15% silt, 20-35% clay, 5% detritus and 35-45% macrophytic vegetation. The recorded length of the collected specimen varied from 4 - 6 mm and width 2 - 3mm.

3.2.2.7 Order Diptera

Figure 25 : Classification of Order Diptera

Figure 26 : Classification of Sub-Order Nematocera

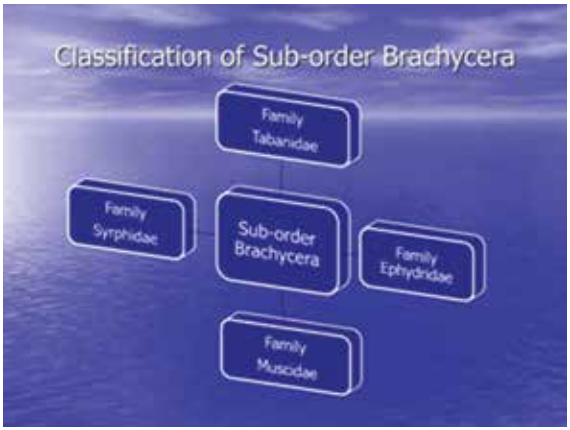

Figure 27 : Classification of Sub-Order Brachycera

3.2.2.7 Order Diptera

❖ Animal is a larvae or pupae without jointed thoracic legs.

3.2.2.7.1 Nematocera

- Head capsule usually well developed, complete and fully exposed.
- Mandibles usually toothed and moving in horizontal or oblique plane.

3.2.2.7.2 Brachycera

➢ Head capsule absent or reduced posteriorly, partially or almost completely retracted within thorax, with retracted portion consisting of a few slander rods.

➢ Mandibles usually hook-or sickle shaped and moving in vertical plane.

3.2.2.7.1.1 **Family Simulidae**

- Head prominent and non-retractable.
- At least one pair of prolegs present.
- Larvae dumbbell shaped.
- Abdominal segment 5 to 8 swollen; posterior segment terminating in a ring of numerous radiating rows of minute hooks or setae.
- Head capsule usually with pair of conspicuous dorso-lateral fans on the labrum (upper jaw).

- Larvae are attached to the substrate with the help of the hooks and a sticky substance secreted by salivary glands.
- Pupae are enveloped in a silken cocoon.

3.2.2.7.1.1.1 *Simulium (Plate 17, Figure 1)*

Characters:

- Labral fans present.
- Anal sclerite 4-branched (X-shaped) or somewhat rectangular.
- Cervical sclerite free
- Antenna with basal two articles at least slightly pigmented, not strongly contrasting with distal article.
- Abdomen simple or with two ventral tubercles anterior to anal proleg.
- Postgenal cleft not extending to hypostoma, but if so, then with short, dark setae covering abdomen.
- Hypostomal middle and lateral teeth usually large.

Distribution: The larva was collected from River Alaknanda after confluence with River Mandakini at downstream of Rudraprayag in Uttarakhand state during the month of July, 2014.

Habitat: The water temperature preference was 17.2°C and substratum requirement of the genus was found to 60% boulders, 35% cobbles and 5% pebbles with a clean biological water quality (Class-A). The length of specimen was 3.7 mm and width 0.561 mm.

3.2.2.7.1.2 **Family Tipulidae**

- A pair of cylindrical false legs on the abdominal segment 3-7 each ends in a circlet of hooks.
- Respiratory disc with 6 appendages.

3.2.2.7.1.2.1 *Antocha (Plate 17, Figure 2)*

Characters:

- Spiracles absent.
- Tracheal system closed.
- Dorsal and lateral lobes of ninth abdominal segment I (spiracular disc) absent or extremely reduced
- Ventral lobes elongate, slightly divergent.
- Dorsal and ventral creeping wells on abdominal segments 2-7.
- Larvae in silken tubes on stones in swift, well oxygenated streams

Distribution: The larvae were collected from River Ganga at upstream of Rishikesh at Luxmanjhula and Barrage at Rishikesh in Uttarakhand state collected in the month of June, 2014.

Habitat: The larvae were found to prefer water with biological water quality ranging from clean to moderate pollution with the water temperature at locations ranging from 18.6°C to 19.3°C. The substratum composition of the habitat under observation was found to range between boulders 10 – 70%, cobbles at 20 – 90%, pebbles at 2% and gravel at 8%. Length of the animal ranged from 6.0 – 7.78 mm and width 0.934 – 1.0 mm.

3.2.2.7.1.3 **Family Chironomidae**

- No adhesive disc at posterior end.
- Body more or less cylindrical or dorso-lateral somewhat flattened, never with swollen abdominal segments.(When the larvae are ready for pupation, a swollen thorax can be present).
- The ring of radiating rows of minute hooks at the end of the abdominal segment is lacking.
- Pseudopodia are present at the end of abdomen.
- No dorso-lateral fans on head capsule.
- Abdominal pseudopodia paired. Mouth at anterior side of the head capsule.
- No stigmata.

3.2.2.7.1.3.1 Subfamily Tanypodinae (Plate 17, Figure 3)

Characters:

- Antennae retractile into head capsule.
- Prementum with lingual strongly and distinctively developed.
- Mentum weakly developed.

Distribution: This larvae is very common in water quality contaminated by organic pollution. It was collected from River Ganga at Madhya Ganga Barrage, Narora, Dhoni Ghat downstream of Kanpur and at Varanasi observed in almost all season during the months spanning December, 2014 to March, 2015.

Habitat: This Chironomus larva was observed to inhabit water substratum with moderate polluted biological water quality and water temperature at locations were found to be in the range of 16.5°C – 26°C. The substratum composition at these locations ranged between 5 – 70% of sand, 5 – 15% silt, 5- 10% of clay, detritus in the range of 5 – 15% and macrophytic vegetation at about 5 to 75%. The length of the larvae has ranged between 4.0 to 8.0 mm.

3.2.2.7.1.3.2 Subfamily Chironominae (Plate 17, Figure 4)

Characters:

- Ventral part of mentum expanded laterally to form ventromental plates which are usually striated.

Distribution: The larvae of this Subfamily - *Chironominae* was more commonly abundant in River Ganga in Uttar Pradesh, Bihar and West Bengal. In Uttar Pradesh its abundance was localized to Barawali, Madhya Ganga barrage, Sukartal ghat, Garhmukteshwar, Narora, Ghatiaghat at Farrukhabad, upstream and downstream of Kanpur, Fatehpur, Allahabad, Dengurpur and Varanasi in Uttar Pradesh of River Ganga. In Bihar it was observed in a Nalla in Patna and in River Ganga right bank Mahatama Gandhi Bridge. In West Bengal, it was observed at few location like Farakka, Raghunathganj, and Jiaganj. Collection of this benthic animal was carried out at the above mentioned locations in all seasons from December, 2014 to May, 2015. Its presence was also noted in tributaries of River Ganga in Uttar Pradesh specially in River RamGanga, River Yamuna, River Tons and River Varuna.

Habitat: This *Chironomus* was found to prefer locations with biological water quality in the category of slight pollution to heavy and water temperature ranging between 10.5°C to 35°C. Its average size is in the range of 5 to 10 mm.

3.2.2.7.1.3.3 Subfamily Orthocladiinae (Plate 17, Figure 5)

Characters:

- Prementum never with median brush.
- Premendible usually longer and narrower.
- Antennae usually with more than 4-segments.

Distribution: This Sub-family of *Chironomous* was observed at only one location on the entire stretch of River Ganga at Jiaganj in West Bengal. Its presence was also recorded in Saloni River, a tributary of River Ganga, at Sukartal Ghat in Bijnor District of Uttar Pradesh. The animals were collected during the months from December, 2014 to May, 2015.

Habitat: Animals of *Orthocladiinae* were found to have a wide range of water temperature tolerance between 19°C to 35°C with a substratum composition 15 – 40% of sand, 4- 15% of silt, 2- 20% of clay, 4 – 5% of detritus material and 45 – 50% of macrophytic vegetation cover at their habitat. These animals were observed in places with biological water quality falling in moderately polluted category. The length of this Chironomus was maximum and varied from 6 – 11 mm.

3.2.2.7.2.1 **Family Musidae**

- Posterior spiracular plates distinctly separated, may or may not be at apex of telescopic siphon.
- Anterior spiracles either absent or bearing 2 or more short or branched papillae;
- Posterior spiracles with openings usually arranged in parallel or in radiating pattern.
- Body variable, if covered with short fine hairs, then a respiratory siphon present, or each spiracle on a short tubular projection on terminal segment.
- Cephalo-pharyngeal skeleton without a ventral arch.
- Abdominal segments without lateral projections, but if present, slender, anterior spiracles usually present.
- Last abdominal segment rather truncate, and/or with setae on only intersegmental areas;
- Tubercles, if present, on only last abdominal segment.
- Posterior abdominal segment without tubercles surrounding spiracles,
- Anterior spiracle if present, fan-shaped and usually with fewer than 10 papillae.
- Accessory oral sclerite below mouth hooks.

3.2.2.7.2.1.1 *Musca domestica larva (Plate 17, Figure 6)*

Characters:

- The larvae are largely terrestrial but they are also common in phytotelmata, mud, aquatic mosses, and detritus along stream and lake margins.
- They have been recorded to feed on detritus, dung, living and dead animals, fungi and plants (often diseased plant parts).
- Aquatic larvae are typically predators on other benthic invertebrates such as diptera and oligochaeta.

Distribution: Larvae of *Musca domestica* (common house fly) were observed in River Ganga at Madhya Ganga Barrage and at downstream of Moradabad city, collected during the month of December, 2014.

Habitat: It was found surviving in a water temperature range of 11°C – 18°C within a substratum composed of 5 – 50% sand, 5% silt, 5% clay, 10 – 20% detritus and 20 – 75% of macrophytic vegetation in moderately polluted biological water quality. The body size of the collected animals varied between 6 to 7 mm in length.

3.2.2.7.1.4 **Family Culicidae**

- Body not transparent.
- Mouth brushes present.
- Found in ponds, puddles, pools including standing and polluted waters, outdoors privies, cisterns, open air drainage.

3.2.2.7.1.4.1 *Mansonia larva (Plate 17, Figure 7)*

Characters:

- Respiratory siphon present.
- Abdominal segments without palmate hairs.
- Antenna with hairs2-A and 3-A distad of 1-A.
- Comb present.
- Pecten present or absent.
- Siphon with one pair of subventral hairs 1-S,
- Accessary hairs 1a-S present or absent.
- Siphon valve sclerotized with saw teeth, modified for piercing plant tissues.

Distribution: *Mansonia* is a mosquito larva and was observed in River Ganga at upstream of Narora in Uttar Pradesh in the month of January, 2015.

Habitat: It was found preferring moderately polluted biological water quality in River Ganga at a water temperature of 18°C. It was found in a habitat with substrate composition containing 5% of sand and silt, 10% clay and detritus material and a maximum coverage 70% of macrophytic vegetation. The body length of the animals varied between 7 – 10 mm.

3.2.2.7.1.4.2 *Anopheles larva (Plate 17, Figure 8)*

Characters:

- Respiratory siphon absent.
- Palmate hairs present on most abdominal segments.

Distribution: The larvae of *Anopheles* mosquito, a vector of Malarial parasites were collected from River Ganga at Kanpur NH25, Fatehpur, Allahabad bypass, Varanasi in Uttar Pradesh and downstream of Nabadwip in West Bengal. The larvae were also observed thriving in River Yamuna at NH-27, River Tons near Panasa and Sirsa. The larvae were collected in the time spanning December, 2014 to May, 2015.

Habitat: The biological water quality at the location where the larvae were found was observed to be moderately polluted and a water temperature ranging between 16°C - 34°C. The substratum composition of the habitat in the river was found to vary between 2 – 10% of sand, 2 – 30% of silt,

10 – 85% of clay, 3 – 10% detritus and 5 – 45% of macrophytic vegetation at different locations. The maximum length of the larva was measured at 6.0 mm.

3.2.2.7.1.4.3 *Culex pupa (Plate 17, Figure 9, 10, 11)*

Characters:

- Trumpets with well-developed tracheation.
- Paddles without accessory hair 2-P, if present, arising level with and lateral of the apical hair 1-P.
- Anal segment without hair.
- Abdominal hair 9-VIII arising well cephalad of the posterior border of the segment

Distribution: Pupae of the *Culex* mosquito were observed in River Ganga at upstream of Narora during the month of January, 2015.

Habitat: The water temperature at the location where the pupae were found was recorded at 18°C with the biological water quality in the category of moderately polluted. The substratum was found to contain 5% of sand & silt, 10% of clay & detritus and 70% coverage of macrophytic vegetation. The pupal size was recorded at 6.0 mm.

3.2.2.7.1.4.4 *Culex larva (Plate 17, Figure 12)*

Characters:

- Respiratory siphon present.
- Abdominal segments without palmate hairs.
- Antenna with hairs2-A and 3-A distad of 1-A.
- Comb present.
- Pecten present or absent.
- Siphon with at least 3 pairs of subventral hairs 1-S.

Distribution: The larvae of *Culex* species were collected from River Ganga at Bithur in Kanpur in the month of March, 2015.

Habitat: The water temperature at the location was recorded at 19°C with a substratum composition of 5% sand & silt, 80% of clay and 10% of detritus material. The biological water quality at the location was moderately polluted. Length of the larvae collected were found in the range of 6 to 8 mm.

3.2.2.7.1.4.5 *Malaya larva (Plate 17, Figure 13)*

Characters:

- Respiratory siphon present.
- Abdominal segments without palmate hairs.

- Antenna with hairs2-A and 3-A distad of 1-A.
- Comb present.
- Pecten present or absent.
- Ventral brush (4-X) with a single pair of hairs (one or more small supplementary hairs present in some individuals.
- Antennae without articulated apical segment.
- Siphon with two or more subdorsal and ventral or subventral hairs.
- Thoracic hairs 5, 6-P large and fan-shaped, arising from a common tubercle.
- Abdominal segments without stellate hairs.
- Maxillae never with horns.
- Siphon at most about 4 times as long as saddle.

Distribution: This species of mosquito larva was found in River Varuna, a tributary of Ganga at Varanasi in Uttar Pradesh in the month of March, 2015.

Habitat: The biological water quality at the site of sampling in Varuna River was categorized at heavily polluted with water temperature measured at 27°C. The substratum of the River Varuna at the location was approximately composed of 30% sand, 10% silt, 20% clay and 40% of macrophytic vegetation. The body length of the larva was 13.0 mm and width was found at 2.0 mm.

3.2.2.7.1.5 **Family Nymphomyiidae**

- Head capsule usually fully exposed, complete without longitudinal incisions.
- Respiratory system like posterior spiracles not bordered by fringed lobes.
- Head and thorax distinctly separated by a constriction. A pair of elongate, crochet –tipped prolegs on each of first seven abdominal segments. Body compressed laterally, prolegs ventral, head capsule enclosed ventrally, antennae short, simple.

3.2.2.7.1.5.1 Nymphomyia (Plate 17, Figure 14, 15, 16)

Characters:

- The larva is compressed laterally.
- 1-2 mm in length (fourth instar).

- The head capsule is complete and well-sclerotized, with a complete postgenal bridge.
- The larval eye (stemmata) is small, on the posterolateral part of the head.
- The antenna is one –segmented, elongate, and about five times longer than broad, with four apical sensilla.
- The thorax is cylindrical, mostly glabrous, with three distinct segments but without appendages.
- Abdomen is apparently nine-segmented, mostly glabrous, with segment I-VII and IX each bearing paired, elongate, eversible, crochet-tipped, ventral prolegs (pseudopods).
- Crochets dimorphic (multi-toothed and simple) on segment I-VII, monomorphic (multi-toothed) on segment IX.
- Anal division with four thick, exsertile, digitiform anal papillae.
- Spiracles are absent.

Distribution: The larvae of this Diptera was collected from River Ganga at Ghatiaghat, Farrukhabad in Uttar Pradesh in the month of January, 2015.

Habitat: The *Nymphomia* larvae were found in moderately polluted water as per the biological water quality indices, with recorded water temperature at the location at 11°C. The river bed was found approximately composed of 35% sand, 20% silt, 30% of clay and 15% detritus material. The body size of the collected larvae was found to have a length of 10.0 mm and width of 2.0 mm.

3.2.2.7.2.2 **Family Sratiomyidae**

- Head capsule absent or variously reduced posteriorly, partially or almost completely retracted within thorax, with retracted portion consisting of a few slender rods;
- Mandibles usually hook-or sickle – shaped and moving in vertical plane.
- External sclerotized portions of head capsule present but sometimes greatly reduced, in which case slender tentorial and metacephalic rods prominent internally.
- Body dorso-ventrally compressed;
- Head permanently exposed, capable of only slight independent movement.
- Calcarious deposits form numerous, small articulately arranged facets.

3.2.2.7.2.2.1 *Nemotelus (Plate 17, Figure 17)*

Characters:

- Last abdominal segment rounded posteriorly, without apical cornet of plumose hairs.
- Last abdominal segment bipartite in dorsal view, bilobed posteriorly.
- Each lobe with long subapical seta.

Distribution: *Nemotelus* was collected from River Ganga at Ghatia ghat, Farrukhabad in Uttar Pradesh in the month of January, 2015 showing a habitat preference similar to *Nymphomia* larvae.

Habitat: The biological water quality at the site was found falling in moderately polluted category with a water temperature of 11°C at the location. Its substrate preference in River Ganga was 35% of sand, 20% of silt, clay at 30% and 15% detritus material. Its length varied from 9.0 to 32.0 mm and width in the range of 1- 3 mm.

3.2.2.7.2.3 **Family Tabanidae**

- Head capsule absent or variously reduced posteriorly, partially or almost completely retracted within thorax, with retracted portion consisting of a few slender rods.
- Mandibles usually hook-or sickle-shaped and moving in vertical plane.
- External sclerotized portions of head capsule present but sometimes greatly reduced, in which case slender tentorial and metacephalic rods prominent internally.
- Body not conspicuously compressed.
- Head capsule well- developed dorsally, closed ventrally by a submental plate.
- Tentorial arms solidly fused with anterior sclerites of head capsule.
- A brush of backwardly curved spines usually present above and near base of each mandible.
- Posterior spiracles present, at apex of short respiratory siphon or a slightly domed area on terminal segment.
- First 7 abdominal segments encircled by 3 or 4 pairs of fleshy welts or prolegs, each sometimes bearing apical spines

3.2.2.7.2.3.1 *Tabanus/Atylotus (Plate 17, Figure 18, 19, 20)*

Characters:

- Head capsule long, but completely retractable, includes a pair of curved mandibles.

- They can pierce human skin and, owing to poison glands, can lead to a painful sensation.
- Terminal fissure of last segment vertical.
- Body soft, cylindrical in form, usually white, yellowish, greenish or some shades of brown in color, often patterned or marked with darker bands.
- A short respiratory siphon is present at the tip of the anal segment.
- Locomotion is achieved through 3 or 4 pairs of pseudopods per abdominal segments.
- Mature larvae 20-25 mm long, some species reach 60mm.
- Pseudopods arranged in belts, may be considerably extended in species that occur in fast flowing streams.

Distribution: *Tabanus* larvae were collected from River Ganga at Anupsahar, Ghatia ghat, Farrukhabad and in River RamGanga at downstream of Moradabad in Uttar Pradesh. Its presence was also observed in River Ganga at Farakka in West Bengal. The animals were collected from different locations in the months spanning from December, 2014 to May, 2015.

Habitat: The larvae preferred moderate pollution biological water quality with the water temperature ranging from 11°C -31°C, with substratum composition varying from 15 – 90% sand, 4 – 20% silt, 2 – 30% clay, 4 -20% detritus and 20 – 55% of macrophytic coverage in water body at different locations. The body length was found to be ~25 mm.

3.2.2.7.2.4 **Family Syrphidae**

- Head capsule absent or variously reduced posteriorly, partially or almost completely retracted within thorax, with retracted portion consisting of a few slender rods.
- Mandibles usually hook-or sickle-shaped and moving in vertical plane.
- External sclerotized portions of head capsule absent.
- Head reduced to an internal cephalo-pharyngeal skeleton.
- Posterior spiracular plates fused or closely approximated, usually at apex of telescopic siphon.
- Anterior spiracles, if present, with openings near apex of a simple stalk.
- Cephalo - pharyngeal skeleton without mouth hooks, replaced by ribbed filter chamber.

3.2.2.7.2.4.1 *Eristalis sp. (Plate 17, Figure 21)*

Characters:

- The larvae vary in appearance from maggot-like or flattened to more or less leech-like.
- They are usually attenuated toward the head, with distinct mouth hooks and short posterior spiracular process.
- The aquatic larvae of Eristalinae usually possess a long posterior respiratory tube (so called rat-tailed maggots)

Distribution: The larva of Eristalis was collected from River Ganga at Tarighat located downstream of Ghazipur in Uttar Pradesh bordering Bihar in the month of March, 2015.

Habitat: The water temperature at the location was measured at 25°C, with biological water quality as moderately polluted at the site location. Substratum of the River habitat at the point of collection was found composed of 20% sand, 25% silt, 10% clay, 5% detritus and 40% of macrophytic vegetation with the body length of the larva at 4.0 mm.

3.2.2.7.2.5 **Family Ephydridae**

- Head capsule absent or variously reduced posteriorly, partially or almost completely retracted within thorax, with retracted portion consisting of a few slender rods.
- Mandibles usually hook-or sickle-shaped and moving in vertical plane.
- External sclerotized portions of head capsule absent.
- Head reduced to an internal cephalo-pharyngeal skeleton.
- Posterior spiracular plates distinctly separated, may or may not be at apex of telescopic siphon.
- Anterior spiracles either absent or bearing 2 or more short or branched papillae.
- Posterior spiracles with opening usually arranged in parallel or in radiating pattern.
- Body variable, if covered with short, fine hairs, than a respiratory siphon present, or each spiracle on a short tubular projection on terminal segment.
- Cephalo-pharyngeal skeleton without a ventral arch.
- Abdominal segments usually without lateral projections, but if present, slender.
- Anterior spiracle usually present.

- Last abdominal segments somewhat tapered, sometimes ending in a retractable respiratory siphon.
- Posterior abdominal segments covered with setae, spines or setae –bearing tubercles.

3.2.2.7.2.5.1 Ephydra pupa (Plate 17, Figure 22)

Characters:

- Posterior abdominal segment somewhat tapered, sometimes ending in a retractile respiratory tube.
- Integument of posterior abdominal segments covered with setae or spinules, or with setaceous (bristle-bearing) tubercles on some segments.
- Posterior spiracles may be extended on spines or at the apices of branches diverging from a common base.
- Both thoracic and abdominal segments rather short.

Distribution: The pupa of Dipteran species *Ephydra* was collected from River Ganga at Tribeni in West Bengal in the month of May, 2015.

Habitat: The biological water quality of the location was found as heavily polluted with water temperature at the time of collection recorded at 33°C. The river bed substratum was found composed of 10% sand, 15% silt, 30% clay, 5% detritus and 40% of macrophytic vegetation. Length of the collected pupa was measured at 10 mm and body width (diameter) at 2.0 mm.

3.2.2.7.2.6 **Family Psychodidae**

- Head capsule usually well-developed, complete and fully exposed without longitudinal incisions.
- Mandibles usually toothed and moving in horizontal or oblique planes.
- Posterior spiracles if present usually not bordered by fringed lobes.
- Head and thorax distinctly separated by a constriction.
- Suctorial disc usually absent.
- Prolegs usually absent, but if present, on no more than 3 abdominal segments.
- Thoracic segments usually individually distinguishable, about as wide or not as wide as abdomen.
- Prolegs absent.
- Body segments secondarily divided into 2 or 3 subdivisions, often indicated by narrow, transverse sclerotized plates.

- Respiratory system amphipneustic.
- Posterior spiracles usually at apex of short, conical siphon.

3.2.2.7.2.6.1 *Psychoda (Plate 17, Figure 22, 23, 24, 25, 26)*

Characters:

- The whitish larvae with a series of dark tergite plates only near the end of the abdomen.
- Pointed triangular head.

Distribution: The Dipteran species *Psychoda* was collected from River Ganga at transmission tower upstream of Tribeni in West Bengal in the month of May, 2015. It was also collected from River Ganga D/s Haridwar JSTP during October, 2015.

Habitat: The biological water quality of the habitat of this larva was found to be moderately polluted at water temperature of 18 - 32°C. The river bed substratum was found composed of 40% boulder, 45% cobles, 10% pebbles, 5% gravel in River Ganga at downstream Haridwar JSTP in Uttarakhand and 10% sand, 15% silt, 35% clay, 5% detritus and 35% of macrophytic vegetation in River Ganga of West Bengal stretch. Length of the collected larva was measured at 10 – 12.30 mm and body width at 0.953 - 2.0 mm.

3.2.2.8 Order Lepidoptera

Figure 28 : Classification of Order Lepidoptera

3.2.2.8 Order Lepidoptera

- Animal is a larvae with jointed thoracic legs, and many have gills.

- The three thoracic segments each bear a pair of five segmented legs with apical claw.
- Larvae have a fully developed head capsule with appasable mandibles, three thoracic segments and 10 abdominal segments.
- A semicircle of upto 6 stemmata (ocelli) on each side of the head.
- Presence of adfrontal sclerites laterad of the frons.
- A protruding spinneret on the labium.
- Prolegs with crochets (hooks) on A3-A6 and A10.
- Spiracles may occur on T1 and A1 to A8, but are often inconspicuous or absent in Nymphulinae

3.2.2.8.1 Family Pyralidae, Sub family Nymphulinae

I. Larvae with gills.

II. Larvae without gills.

- The head directed downward (hypognathous) or forward (prognathous).
- Leaf mining or stem boring larvae are usually prognathous.
- The epicranial suture is in the shape of an inverted Y with narrow adfrontal sclerite on each side of the frons.
- The clypeus and labrum are anterior to the frons.
- The labrum is notched anteriorly and bears six pair of setae, of which one or two may be modified into scale-like structures.
- The antennae are three segmented with apical sensilla.
- An elongate, protruding spinneret is located on the labium.
- There are six stemmata on each side of the head.
- There may be fewer and some stemmata are present only as dark spots.
- Tracheal gills may be present on T2 through T3 and in a few species on T1.
- The abdomen consists of 10 segments with prolegs present on A3 through A6 and A10.
- The prolegs may be long and well formed, or may consist of only crochets on the ventral surface of these segments.
- The dorsam of A10 bears more or less well defined anal plate.
- Tracheal gills if present are on all the segments or absent only on A9 and A10.

- Tracheal gills are present in most of the Nymphulinae larvae.
- First instar larvae are usually without gills.
- The gills usually occur on T2 and T3 and A1 through A10.
- This group of gills may occupy position similar to those of the setae and often certain setae are surrounded by gills. Ventral gills are not usually present. Gills of most larvae are unbranched but the gills of Paraponyx larvae are branched.

3.2.2.8.1.1 Paraponyx diminutalis (Plate 18, Figure 1)

Characters:

- Larvae with gills.
- Gills branched.

Distribution: The larvae were collected from River Ganga downstream of Nabadwip and Palta water intake in West Bengal river stretch. The larvae were also collected from tributary River Gomti at Rajwari in Uttar Pradesh during March-May 2015.

Habitat: These larvae preferred moderate pollution in biological water quality of waterbodies at a water temperature range of 26-34°C and a substratum composition of river bed consisted of 10-20% sand, 15-25% silt, 10-25% clay, 5% detritus and 40-45% of macrophytic vegetation. The length of preserved specimen was 8-16 mm and width of 2.0 mm.

3.2.2.8.1.2 Nymphula (Plate 18, Figure 2)

Characters:

- Larvae without gills.
- SD1 seta on prothoracic shield on anterior margin.

Distribution: This larvae of Lepidoptera was collected from River Ganga at Mahatma Gandhi bridge on right bank in Patna, Bihar state during the month of May 2015.

Habitat: *Nymphula* preferred moderate pollution in biological water quality of its habitat at a water temperature of 27.5°C and substratum composition of 20% sand, 25% silt, 15% clay,5% detritus and macrophyic vegetation cover of 35% in water body. The length of preserved specimen of *Nymphula* was 6.0 mm and width 1.0 mm

3.2.2.8.1.3 Elophila (Plate 18, Figure 3)

Characters:

- Larvae without gills.
- SD1 seta on prothoracic shield not on anterior margin.

- Anal shield with 4 pairs of setae.
- Larvae in portable cases made of leaves or leaf pieces

3.2.2.8.1.4 Eoophyla

Characters

- Larvae with gills.
- Gills unbranched.
- Gills abundant with more than 10 on each abdominal segment.
- Body flattened.
- Gills on cupola-shaped lateral expansion.
- Larvae under silk web on rocks.

3.3 Phylum Annelida

- Body without jointed limbs, soft and worm- like with more than 15 visible segments.
- Macro invertebrate body divided by constrictions into a usually large number of segments.
- Either with bristles on the segments or a sucker both at front and hind end.

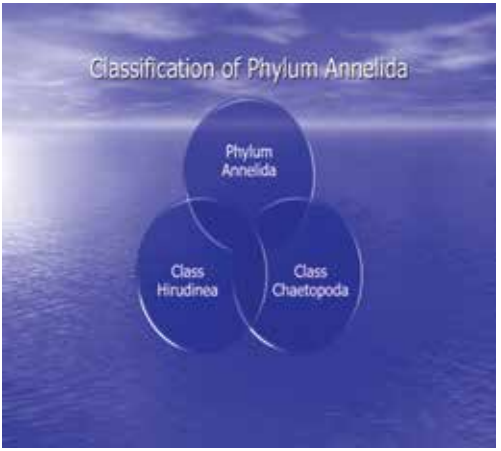

Figure 29 : Classification of Phylum Annelida

3.3.1 Class Hirudinea

- With a sucker at both ends.
- Never with setae (hairs). All leaches have suckers, body divided into 34 segments each segment is sub-divided into three median line of dark dots.

- The body of a typical euhirudinid consists of 2 preoral, non – metameric segments and 32 postoral somites (Metameres) labelled 1 throughXXXIV.
- Each somite is externally divided into 2-16 annuli.
- The number of annuli and how the annuli are subdivided can be diagnostic for a genus or species.
- It is assumed that the plesiomorphic number of annuli is 3 with the annulus numbering based on the 3 primary annuli a1, a2 and a3.
- Counting from anterior, with the neural annulus (containing the nerve cord ganglion and externally delineated by a transverse row of papillae or sensilla) labelled a2.
- The loss or repeated bisection of the primary annuli into additional annuli gives more complex annulation patters in some genera and species.
- They have a number of sensory structures including eyes and oculiform spots, papillae and sensilla.
- The position and arrangement of these structures can be important in identifying genera and species.
- The eyes are typically arranged in the first few somites and can be found either around the margins of the head or near the midline.
- In some genera (particularly in Glossiphonidas), the eyes are fused into lobed composite structures.
- Eyespots or occuliform spots can also occur on the lateral margins of the body and on the posterior sucker in some piscicolids.
- Papillae (small protrusible sense organs) and tubercles (large fleshy protrusions that include some of the dermal tissues and muscles) may be present and can be scattered or arranged in rows on the dorsal and ventral surfaces.

3.3.1.1 Family Glossiphoniidae

- Both suckers and at least the anterior sucker is not round.
- Usually three pairs of eyes.
- First pair may be small or un-pigmented.
- Anterior sucker not very distinct from rest of the body.
- Size up to 80cm.
- Flattened, stout cartilage-like body.

- Obvious rows of dorsal papillae.
- They are parasite on sluggish animals or attack only when the prey is inactive.
- So the suckers are only moderately developed.
- Parasites on gastropods, beetles, insect larvae, aquatic birds, fish and crabs.

3.3.1.1.1 Alboglossiphonia weberi (Plate 19, Figure 1)

Characters:

- Small ovate to elongate rounded reaching a maximum body length of 10-15 mm.
- Ground colour of dorsam pale yellow to pale light orange-grey.
- Dark black spots on every third papillae of the mid-dorsal line and along the lateral margin.
- Head region commonly bulbous.
- The species generally has 3 pairs of eyes.
- The eyes of the front pair very close together, while the eyes of the following two pairs are spaced farther apart and often fused.
- The somites are triannulate.
- The dorsal side has one median row of prominent papillae on each annulus.
- One pair of inner paramedian papillae on annulus a2.
- One pair of outer paramedian papillae on annulus a3.
- One pair of paramedian papillae on annulus a2.
- Additional and often numerous, minute, and irregularly arranged papillae also are observed.
- The leeches are either predators of small molluscs or they live as ectoparasites attached to shell of larger gastropods.

Distribution: These are the leeches collected from River Ganga at bridge Mahatma Gandhi right bank Patna in Bihar during April, 2015.

Habitat: These leeches were found in moderately polluted biological water quality of River Ganga at water temperature of 28°C and substratum composition of 25% sand, 35% silt, 15% clay, 5% detritus and 20% of macrophytic vegetation cover. The length of preserved specimen was 2.48 mm and width of 1.50 mm.

3.3.1.1.2 Hemiclapsis japonica (Plate 19, Figure 2)

Characters:

- Identified from the picture.

Distribution: This species of leech was collected from River Ganga at Narora Barrage in Uttar Pradesh during December 2014.

Habitat: The biological water quality preference of this leech was mostly moderate pollution in River Ganga at water temperature of 18°C. The substratum of river bed composed of 55% sand, silt, clay and detritus and 80% of macrophytic vegetation cover in water body. The length of preserved specimen was 0.5 cm and width 0.2 mm.

3.3.1.2 Family Salifidae

- Head with one, three to five pairs of eyes.
- Some are uniformly red to dark red-brown,, black, yellow brown and uniform light grey-yellow.
- Medium –sized, elongate with firm body consistence, body surface may be smooth or covered by papillae.
- Normally collected from lentic habitat.

3.3.1.2.1 Barbronia weberi (Plate 19, Figure 3)

Characters:

- Small to medium sized leeches reaching body length of 31 mm, width of 1.9 mm and 1.5 mm diameter of caudal sucker.
- Pharynx with three pairs of small needle shaped styli, showing in cranial direction.
- Head always with3 pairs of eyes.
- Clitellum easily visible in mature specimens, extending fromXb5 –XIII a2, the female on XIII b1.
- Body surface covered by minute papillae.
- Midbody somites composed of 5 annuli.
- It is uniform coloured, red to dark red-brown.
- Some individuals are nearly black appearance.
- The leeches have been collected from the subsurface of stones and shells of molluscs exclusively in zones rich in oligochaetes and polychaetes.
- *Barbraniaweberi* was observed feeding on small Naididae

Distribution: This species of leech was collected from River Ganga at transmission tower, upstream of Tribeni in West Bengal during May, 2015.

Habitat: Moderately polluted biological water quality was observed in this habitat of River Ganga at a water temperature of 32°C and a substratum composition of 10% sand, 15% silt, 35% clay, 5% detritus and 35% of macrophytic vegetation. The length of preserved specimen was 0.6 cm and width 0.1 cm.

3.3.2 Class Chaetopoda

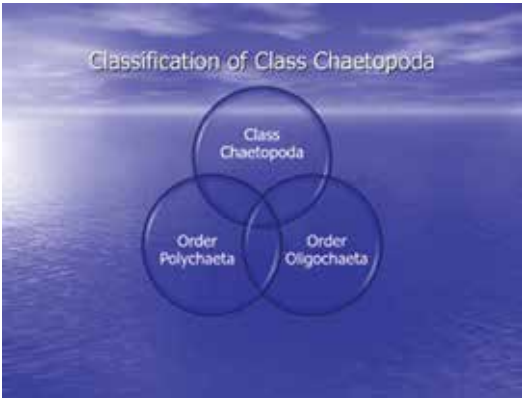

Figure 30 : Classification of Class Chaetopoda

Figure 31 : Classification of Order Oligochaeta

3.3.2 Class Chaetopoda

- True worms never with suckers.
- Usually with setae.

3.3.2.1 Order Polychaeta

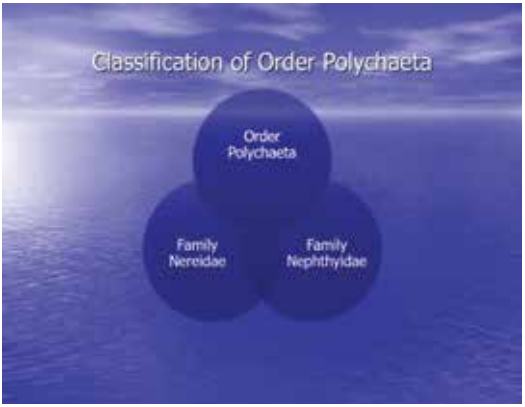

Figure 32 : Classification of Order Polychaeta

3.3.2 Class Chaetopoda

- True worms never with suckers.
- Usually with setae.

3.3.2.1 Order Polychaeta

- True worms of which the setae (hairs) are arranged in bundles on parapodia (false extremities).
- All polychaeta are of one sex with usually two bundles of numerous bristles or setae, sharply separated segments with one pair of parapodia.
- Large prostomium with pairs of antennae.

3.3.2.1.1 Family Nereididae

- Four prominent eyes located in the prostomium. Large crawling species. The posterior cirri are physiological gills, 4 pairs of antennae on head, length 10-15 cm.
- Most species are found in association with decaying wood and leaves (detritus), which may be an important source of food and provide protection from desiccation.

3.3.2.1.1.1 Namalycastis fauveli (Plate 20, Figure 1)

Characters:

- Medium –sized worms of 4 to 7 cm length.
- Living specimens have dark red-brown color.
- The posterior body bears gill-like cirri.

- The animals occur in the fresh water to brackish water tidal zone in mud and silt sediments.

Distribution: These polychaete worms were collected from River Ganga in Bihar stretch of mahatma Gandhi bridge at Patna and upstream and downstream locations and a nulla in Patna during April to May2015.

Habitat: These polychaetes preferred moderate pollution in biological water quality in a water temperature closely ranged from 27.5 – 28°C. The substratum of water bodies composed of 20-25% of sand, 25-35% silt, 15-20% clay, 5% detritus and 20-35% of macrophytic vegetation. The length of preserved specimen ranged from10-107 mm and width 1-3 mm.

3.3.2.1.1.2 Nemalycastis (Plate 20, Figure 2, 3, 4)

Characters:

- Four prominent eyes located in the prostomium. Large crawling species.
- The posterior cirri are physiological gills, 4 pairs of antennae on head, length 10-15 cm.
- Most species are found in association with decaying wood and leaves (detritus), which may be an important source of food and provide protection from desiccation.

Distribution: This polychaete was collected from West Bengal stretch of River Ganga at Ghat downstream of Srirampore during May, 2015.

Habitat: The biological water quality of River Ganga at Srirampore, was moderately polluted at a water temperature of 33°C. The substratum composition of water body at this location was, 5% sand, 15% silt, 35% clay, 5% detritus and 40% of macrophytic vegetation. The length of preserved specimen ranged from 35.67 mm and width 0.744 – 1.54 mm.

3.3.2.1.1.3 Namalycastis indica (Plate 20, Figure 5)

Characters:

- Worms are reaching a length of 10 to 15 cm with full extension.
- Living male specimens have yellow or reddish color while females are often greenish during reproduction period.
- The posterior part is usually darker reddish to brown.
- The posterior cirri are physiological gills (Branchiura sowberbyi, *Branchiodrilus* sps.).
- *Namalycastis indica* is very common worm of the Ganga River in mud, silt and sand substrate. The species prefers debris of the littoral.

- It is more abundant in pure fresh water than in brackish water, where it appears to be replaced by *Namalycastis fauveli*.
- *Namalycastis indica* can be regarded as shredder of leaf litter and as feeding on detritus.

Distribution: This species of Namalycastis was observed in River Ganga at transmission tower upstream of Tribeni in West Bengal during May 2015.

Habitat: *Namalycastis* preferred moderate pollution of biological water quality of River Ganga at Tribeni, at a water temperature of 32°C with a river bed substratum composed of 10% sand, 15% silt, 35%of macrophytic vegetation. The length of preserved specimen was 80 mm and width 1.0 mm.

3.3.2.1.1.4 Dendronereides heteropoda (Plate 20, Figure 6)

Characters:

- Small worms of 3cm length.
- Living specimens have light red color.
- The anterior mid-body has branched lateral gills from segment XIV to XXV
- Like *Namalycastis fauveli,* the specimens of *Dendronereides heteropoda* live in fresh water to brackish water tidal zone in mud and silt sediments, rich in detritus and organic material.

Distribution: The distribution of this polychaete worm was also restricted to West Bengal stretch of river Ganga mainly at Chinsura, Palta water intake and downstream Srirampore during May 2015.

Habitat: The habitat preference of this polychaete was moderate pollution in biological water quality, at a water temperature range from 29.9 – 33°C. The substratum preference range for sand 5%, silt 10-15%, clay 35%, detritus 5-10% and 40% of macrophytic vegetation. The length in preserved specimen varied from 20-52 mm and width 1-3 mm.

3.3.2.1.1.5 Nereis chilkaensis (Plate 20, Figure 7)

Characters:

- Medium-sized and comparatively thick worms of 3 to 5 cm length.
- Living specimens have notable dark olive greenish pinkish dorsal color.
- It has a very limited range due to preference of brackish waters.
- It lives in sand between gravel and stony banks.

Distribution: This species of polychaete were observed in River Ganga at Chinsura in West Bengal during May, 2015.

Habitat: The worm was observed in moderate pollution of biological water quality at a water temperature of 33°C in River Ganga at this location. The substratum of River Ganga at this location, composed of 5% sand, 10% silt, 35% clay, 10% detritus and 40% of macrophytic vegetation. The length of this preserved specimen of polychaete was 38 mm and width 3.0 mm.

3.3.2.1.2 Family Nephtyidae

- Prostomial sensory organs located between parapodial rami. Rigid crawling species.
- They have one pair of spiral-shaped lateral gills per segment. They prefer sand and mud sediments.

3.3.2.1.2.1 Nephthys polybranchia (Plate 20, Figure 8, 9, 10, 11)

Characters:

- Worms are reaching a length of 3 to 5 cm with full extension.
- Living specimens are very similar to *Nephthys oligobranchia* and have fleshy to light yellow color.
- It can be distinguished from *Nephthys oligobranchia* by the higher number of lateral gills.
- The gills are starting from segment v onwards usually until the posterior body.
- The species is principally found in similar habitats with *Nephthys oligobranchia*.
- It is less common in pure fresh water.
- It prefers more the lower river including its estuarine habitats.

Distribution: These polychaetes were collected from River Ganga stretch at SH 74 upstream of Varanasi, Vindhyachal ghat at Mirzapur upstream, Tarighat downstream Ghajipur in Uttar Pradesh and transmission tower upstream of Tribeni in West Bengal during May-March, 2015.

Habitat: Nephthys polybranchia preferred moderate pollution of water quality of River Ganga at water temperature range from 25-32°C. The substratum composition at this location consisted of 10-30% sand, 10-25% silt, 5-35% clay, 5% detritus and 35-60% of macrophytic vegetation cover. The length of preserved specimen varied from 20-29mm and width 1-3 mm.

3.3.2.1.2.2 Nephthys oligobranchia (Plate 20, Figure 12)

Characters:

- Worms are reaching a length of 3 to 5 cm with full extension.

- Living specimens have fleshy or light reddish color.
- They bear lateral gills from segment v to xxvi or xxxv, usually until segment xxxiii.
- Locally abundant worm of the silt and sand substrate.
- The species prefers the shallow lotic reaches of unpolluted stretches of the rivers.
- It is much less tolerant against organic load than other polychaetes.

Distribution: This species of Nephthys was observed in River Ganga at Raghunathganj in West Bengal during May 2015.

Habitat: *Nephthys oligobranchia* preferred only slight pollution in biological water quality at a water temperature of 31°C and substratum composition of river bed of 10% sand, 20% silt and clay, 5% detritus and 45% of macrophytic vegetation. The length of polychaete was 27°C and width 2.0 mm.

3.3.2.2 Order Oligochaeta

- True worms of which the setae are arranged segmentally but not on parapodia or which do not possess setae.
- All Oligochaeta are hermaphrodites with usually 4 bundles of setae, sharply separated segments without any parapodia, small prostomium without antennae.

3.3.2.3 Megadriles

- Large, firm and robust body.

3.3.2.3.1 Family Lumbricidae

- Length 21 mm, width-2.5 mm.
- Body behind clitellum is square like in cross section.
- Setae 4 pairs on each segment widely paired.

3.3.2.3.1.1 Dendrodrilus rubidus (Plate 21, Figure 1)

Characters:

- Medium-sized worms.
- Body length 31-40 mm, width 4mm. Colour on dorsal side brown-reddish being laterally reduced and absent on the clitellar segments, the ventral side is much lighter.
- Setae are lumbricine four pairs on each segment, widely paired.
- The clitellum extends over six segments from XXVII-XXXII.

Distribution: These worms were collected from River Ganga at Anupshahar in UttarPradesh and Mahatma Gandhi bridge, Patna in Bihar. It was also observed in tributary like River Saloni at Sukartal ghat in Bijnour during December 2015 and April, 2015.

Habitat: Presence of this oligochaete was observed in moderate pollution of biological water quality at water temperature range of 19-29°C. The substratum composition of water bodies at these locations ranged between 25-90% of sand, 4-35% of silt, 2-15% of clay, 4-5% of detritus and 20-50% of macrophytic vegetation. The length of preserved specimen ranged between 50-70 mm and width 3.0 mm.

3.3.2.3.1.2 Eiseniella teraedra tetraedra (Plate 21, Figure 2)

Characters:

- Medium-sized worms.
- Body length 21mm, width 2.5 mm.
- Body behind clitellum is square-like in cross section.
- Setae are lumbricine four pairs on each segment, widely paired.
- Color is yellowish brown ventrally and dark brown on the dorsal surface, being reduced on the clitellar segments.
- The clitellum extends over five segments from XXII-XXIV.
- Paired male pores are on XV.
- Cold- stenotherm species of fast running hill streams with mixed and stony sediments.

Distribution: The worm was collected from River Ganga at downstream of FTPS Farakka, Raghunathganj and downstream of Murshidabad in West Bengal during the month of May, 2015.

Habitat: The worms were observed in slight to moderate pollution in biological water quality at a water temperature varied from 30-31°C. The substratum composition of water bodies consisted of 10-15% sand, 15-20% silt, 20% clay, 5% detritus and macrophytic vegetation of 45%. Its length in preserved specimen was 50 mm and width 1-4 mm.

3.3.2.3.2 Family Lumbriculidae

1. No more than 8 chaetae per segment. If more, than chaetae arranged evenly around the segment, rarely with all chaetae absent.
2. Crotchet chaetae all simple-pointed or if bifid then with upper tooth rudimentary.
3. Hair chaetae absent.

4. Setae 4 pairs on each segment, widely paired.
5. Length up to 40 mm and width 2 mm.
6. Head with large and rounded prostomium.
7. Head with conical first segment.

3.3.2.3.2.1 Lumbriculus variegatus

Characters:

- Chaetae with rudimentary upper teeth.
- Anterior end usually greenish and posterior reddish when alive.
- Thrashes or swim with spiral undulations.
- Large and robust worms of dark reddish color.
- The length of preserved specimens reaches up to 40 mm and 2 mm width.
- The anterior body has dark brown pigment band which are transversally arranged on each segment mainly on the dorsal side.
- The head is bearing a very large rounded prostomium.
- The segment number is up to 150.
- Dorsal and ventral are four pairs of setae starting from segment II.
- S-shaped bifid needles with distal nodulus.

3.3.2.4 Microdriles

- They are usually smaller than 10 cm with thin body.

3.3.2.4.1 Family Naididae

- More than 8 chaetae on many segments (especially anteriorly).
- Always in discrete bundles (never arranged evenly around the segment)
- Crochet chaetae rarely all simple-pointed.
- Hair chaetae present or absent.
- Small to large worms (1 to >20mm)
- Hair chaetae absent ventrally.
- Ventral chaetae present in II.
- Ventral chaetae of XII usually not modified.
- Pharynx without a ventral mouth pouch.

- Body form variable but usually soft and coiled when preserved.
- Hair chaetae present or absent.
- Crochet chaetae rarely all simple-pointed.
- Ventral crochet chaetae sigmoid with a distinct nodulus.
- Proboscis and terminal filament absent.
- Ventral chaetae usually more than 2 per bundle.
- Usually all bifid..
- Dorsal chaetae present from II or from IV or more posteriorly.
- Dorsal crochet chaetae usually absent from a few anterior segments.
- Hair chaetae usually present.
- Crochet chaetae usually thinner, smaller and straighter than the ventral chaetae with variably shaped distal ends.
- Eye spot may be present on segment I or the prostomium may bear a proboscis.
- Terminal segment may have a branchial chamber (with or without gills) or gills may be present as dorsolateral filaments on anterior segments.
- Preserved worms usually 1-10 mm long.
- Prostomium can form a trunk like retractile proboscis.
- Size <20 mm in living and <10mm in preserved specimen.
- Most of the Naididae species can swim with spiral movement for short distance.

3.3.2.4.1.1 Aulophorus flabelliger

Characters:

- Worm with 'case' or tube.
- Length of worm 5mm.

Distribution: Small worms collected from River Kali at Kanpur-Farrukhabad road in UttarPradesh during January, 2015.

Habitat: The biological water quality of River Kali, was moderately polluted in the vicinity of these worms in a water temperature of 12.5°C and substratum composition of 70% sand, 10% silt, 15% clay and 5% of detritus material.

3.3.2.4.1.2 Aulophorus hymanae (Plate 21, figure 3)

Characters:

- Small to medium-sized worms.

- Deep red in color.
- Length of preserved specimens reaching up to 13 mm.
- Living individuals with full extension may exceed 20-35 mm.
- Segment number upto 93+ indifferent zone.
- Dorsal setae starting from V.
- 1 hair and 1 thick bifid needle per bundle.
- Ventral setae 4(-5) thin crotchets per bundle in II – V, 3 crotchets from segment VI onwards and 2 crotchets in the posterior body.
- Branchial organ wide and cup-shaped. With 3 pairs of large foliate gills and 1 pair of thin palps.
- It occurs in the detritus cover of muddy sediments near submerged vegetation.
- It was also collected from small, clear. Groundwater-flodded ponds with dense aquatic macrophytes that are exposed to the direct sunlight.

Distribution: The small worms were collected from River Ganga at Narora Barrage in UttarPradesh and downstream of Murshidabad in West Bengal during December, 2014 and May 2015.

Habitat: These worms preferred moderately polluted biological water quality at a water temperature of 18-31°C. The substratum composition of water bodies ranged 5-15% sand, 5-20% silt and clay, 5% detritus and 45-80% of macrophytic vegetation. The length of preserved specimen varied between 9-16 mm and width 1.5 mm.

3.3.2.4.1.3 Dero dorsalis

Characters:

- Small worms, light red in colour.
- Length of preserved specimens reaching 5-10 mm.
- Segment number up to 70+ indifferent zone.
- Dorsal setae starting from IV.
- 1 hair and 1 double-pronged needle per bundle.
- Ventral setae 3-5 crotchet per bundle.
- Branchial organ with 5-6 pairs of gills.
- Occasionally the worms were found in tubes made of various sized detritus and plant material.

- *Dero dorsalis* was found on submerged overhanging grasses and leaf litter at the confluence of a small drainage stream, a running water habitat with loam, sand and mud substratum.

Distribution: These small worms were collected from River Ganga at Mahatma Gandhi bridge, Patna in Bihar during April, 2015.

Habitat: These worms preferred moderate pollution in biological water quality of River Ganga having substratum composition of 255 sand, 35% silt, 15% clay, 5% detritus and 20% of macrophytic vegetation. The length of preserved specimen was 5-0mm.

3.3.2.4.2 Family Tubificidae

- More than 8 chaetae on many segments (especially anteriorly).
- Always in discrete bundles (never arranged evenly around the segment)
- Crochet chaetae rarely all simple-pointed.
- Hair chaetae present or absent.
- Small to large worms (1 to >20mm)
- Hair chaetae absent ventrally.
- Ventral chaetae present in II.
- Ventral chaetae of XII usually not modified.
- Pharynx without a ventral mouth pouch.
- Body form variable but usually soft and coiled when preserved.
- Hair chaetae present or absent.
- Crochet chaetae rarely all simple-pointed.
- Ventral crochet chaetae sigmoid with a distinct nodulus.
- Proboscis and terminal filament absent.
- Ventral chaetae usually more than 2 per bundle.
- Usually all bifid.
- Dorsal chaetae present from II or from IV or more posteriorly.
- Dorsal crochet chaetae normally present from II, with or without hair chaetae.
- Usually with crochet chaetae of similar size and shape to the ventral chaetae.
- Neither eyes nor proboscis present.
- Gills present as mid-dorsal and mid-ventral filaments on posterior segments of one species only.

- Preserved worms often >10mm long.
- 80-98 mm length, body cylindrical, segmental boarder.
- One pair of short dorso-ventral gills along the posterior segments.

3.3.2.4.2.1 Brachiura sowerbyi (Plate 21, figure 4, 5)

Characters:

- Medium-sized to large worms of dark red or pink brown colour.
- The length of preserved specimens reaches 15-100 mm, living worms up to 20 cm.
- One pair of short dorso-ventral gills along the posterior segments is always found.
- Dorsal setae starting from II. 3 hairs and 3-4 crochets, ventral setae 5 crochets per bundle.

Distribution: The worm was collected from River Ganga at Narora, Kachla ghat Badayun, SH98 at Varanasi in Uttar Pradesh. It was also observed in tributaries like River saloni at Sakurtal ghat in Bijnour, River RamGanga downstream of Muradabad, River Garra and River Kali in Uttar Pradesh during Decmber 2014 and January to May 2015.

Habitat: This worm could withstand moderate to heavy pollution in biological water quality at a water temperature range of 10.5 -19°C. The substratum composition at these water bodies consisted of 5-70% sand, 4-30% silt, 2-70% clay, 4-30% detritus and 5-80% of macrophytic vegetation. The length of preserved specimen ranged between 10-29 mm and width 0.5-2mm.

3.3.2.4.2.2 Branchiodrilus semperi (Plate 21, figure 6)

Characters:

- *Branchiodrilus semperi* is sometimes confused with *Branchiura sowberbyi*.

Distribution: The worm was collected from River Ganga at Narora Barrage and NH-25 at Kanpur in Uttar Pradesh during December 2014 to January 2015.

Habitat: The biological water quality in the habitat of this worm, was mostly moderately polluted at a water temperature ranging from 16-18°C. The substratum composition of water bodies consisted of 5% sand, 5-15% silt, 5-20% clay, 5-10% of detritus and 50-80% of macrophytic vegetation. The length of preserved specimen was 8.0 mm.

3.3.2.4.2.3 Limnodrilus hoffmienseri (Plate 21, figure 7)

Characters:

- Medium –sized worms of reddish orange or dark brownish variable colour.
- The length of preserved specimens reaches up to 30 mm, living worms up to 60 mm with full extension.
- The body is cylindrical with distinct segmental borders.
- The maximum body width is in segment XI.
- The head is bearing an elongate prostomium.
- Dorsal and ventral setae starting from II, 2-6 crochets per bundle.

Distribution: These true worms were collected from River Ganga at Tarighat downstream of Ghajipur in UttarPradesh. It was also observed in tributaries like River RamGanga downstream of Muradabad and River Kali at Kanpur-Farrukhabad road in Uttar Pradesh. In Bihar stretch of River Ganga, it was collected from a Nalla in Patna during December 2014 and January –April 2015.

Habitat: The biological water quality preference of this worm was moderate to heavy pollution where water temperature ranged from 10.5-to 25°C.The substratum preference of this worm ranged from 10-70% of sand, 10-30% of silt, 10-25% clay, 5-30% detritus and 5-40% of macrophytic vegetation. The length of preserved specimen ranged between 3-45 mm and width 1.0 mm.

3.3.2.4.2.4 Limnodrilus udekemianus (Plate 21, figure 8, 9, 10)

Characters:

- Small worms of Wine-reddish colour.
- The length of preserved specimens reaches 14 to 18 mm, living worms up to 30 mm with full extension.
- The body is cylindrical with distinct segmental borders.
- The dorsal and ventral setae starting from II, 5-8 crochets per bundle with upper tooth 2-times longer and thicker than lower (anterior body).
- Teeth becoming equal length in the posterior body.

Distribution: These worms were collected from River Ganga at upstream of Narora and Ghatia ghat at Farrukhabad in UttarPradesh. It was also observed in River Ramganaga downstream of Muradabad during December 2014 to January 2015.

Habitat: These worms survived the moderate pollution in biological water quality at a water temperature range from 11-18°C. The substratum of River

bed composed of 5-50% sand, 5-20% silt, 5-30% clay, 5-20% detritus and 20-70% of macrophytic vegetation. The length of preserved specimen ranged between 1-17 mm.

3.3.2.4.2.5 Bothrioneurum vejdovskyanum (Plate 21, figure 11)

Characters:

- Medium- sized worms of dark red color with dorsoventrally compressed clitellar region.
- The length of preserved specimen reaches 17-25 mm.
- Prostomium is bluntly conical with small sensory pit on the dorsal side.
- Segments number 114 or more.
- Dorsally there are 3 bifid needle setae per bundle in the preclitellar region.
- Ventral setae are 3-4 crotchets per bundle.
- From segment XII onwards, the mid-body and the posterior region bear only 2 setae.
- Dorsal and ventral of similar shape and size.
- Pollution sensitive and cold steno-therm species.
- It inhabits shallow pools with fine brown mud associated with gastropods and bivalves.

Distribution: These worms were collected from River Ganga at NH-2 Varanasi in UttarPradesh and from a nulla at Patna in Bihar during March-April 2015.

Habitat: This oligochaete preferred moderate pollution in biological water quality at a water temperature range from 21-25°C. The river bed substratum on these locations of waterbodies, composed of 10-20% sand, 25-30% of silt, 15-20% clay, 5% detritus and 30-40% of macrophytic vegetation. The length of preserved specimen ranged from 8-25mm and width 0.5mm.

3.4 Phylum Platyhelminthes

Figure 33 : Classification of Plylum Platyhelminthes

3.4 Phylum Platyhelminthes

- Body unsegmented.
- Without bristles, or suckers.
- Body dorso-ventrally flat and elongate.
- If a proboscis (head) is present, the gut opens at the end of it.
- There is only one opening to the gut.

3.4.1 Family Dugesiidae

- Two eyes, far away from each other.
- The distance between the eyes is more than the distance from the eyes to the lateral margins of the head.
- Waved body margin.

3.4.1.1 Dugesia sp. (Plate 22, Figure 1)

Characters:

- Many species of Dugesia can propagate in two ways, i.e., sexual reproduction by cocoon (egg capsule) formation usually occurs in early springs and asexually by means of fission.
- A cocoon contains several embryos.
- The cocoon is attached to aquatic plants or bottom stones by means of a thin stalk.
- After 2-3 weeks, young planarians hatch from the cocoon.
- They will be fully grown within several months after hatching.
- High water temperatures accelerate the degeneration and

impairs fission in them.

- The two fission pieces of a single specimen easily regenerate and grow into two normal individuals.
- No more than two alternations of sexual and asexual reproduction have been observed in a single specimen.
- This means, the average life span of sexual animals is less than 3 years.
- The largest living sexual specimen reach about 17-20mm long and 3 mm wide

Distribution: The identification of this animal in River Ganga in West Bengal, is doubtful, since it was found in the waters of River Yamuna at Yamunotri. The planarian species was collected frpm River Ganga at Diamond Harbour in West Bengal during the month of May, 2015.

Habitat: The biological water quality of this species preferred moderate pollution in water body at Diamond Harbour at a water temperature of 31°C and substratum composition of 5% sand, 10% silt, 355 clay, 10% detritus and 40% of macrophytic vegetation. The length of preserved specimen was 15 mm and width 5,0 mm.

Plate 1

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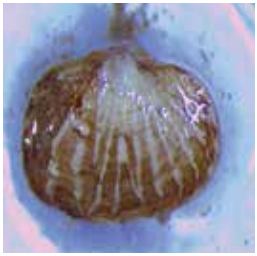

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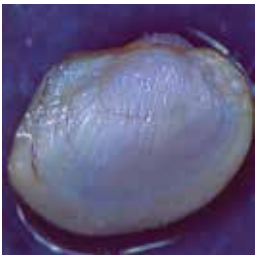

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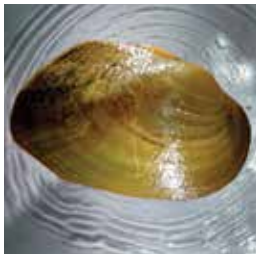

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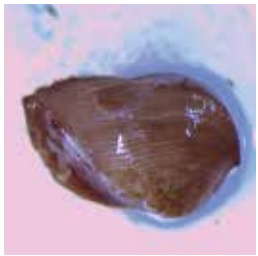

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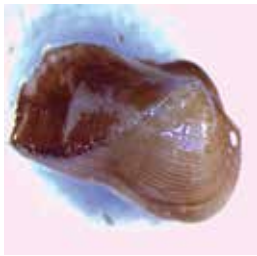

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Plate 1

1. *Corbicula assamensis,* Bridge at Buxar, Chausa Water Intake point,Bihar

Length 8.8 mm	Width 7.0 mm	Magnification 1.25x

2. *Corbicula assamensis,* Vindhyachal Ghat, Mirzapur upstream, Uttar Pradesh

Length 13.57 mm	Width 10.35 mm	Magnification 0.75x

3. *Corbicula striatella,* Vindhyachal Ghat, Mirzapur upstream, Uttar Pradesh

Length 8.79 mm	Width 7.23 mm	Magnification 1.25x

4. *Corbicula bensoni,* Tarighat,downstream Ghazipur, Uttar Pradesh

Length 12.06 mm	Width 9.56 mm	Magnification 0.75x

5. *Parreysia corrugate laevirostris juvenile,* Tarighat downstream Ghazipur, Uttar Pradesh

Length 5.83 mm	Width 3.62 mm	Magnification 1.6x

6. *Parreysia corrugate,* Bridge near Fatehpur, Uttar Pradesh

Length 11.73 mm	Width 8.71 mm	Magnification 0.75x

7. *Parreysia virudula,* Bridge near village Mahewa Kalan Kachhar, Dengurpur, downstream Allahabad, Uttar Pradesh

Length 34.95 mm	Width 23.1 mm

8. *Parreysia virudula,* Bridge near village Mahewa Kalan Kachhar, Dengurpur, downstream Allahabad,Uttar Pradesh

Length 34.95 mm	Width 23.1 mm

9. *Parreysia favidens favidens juvenile,* Barawali Railway & Road Bridge

Length 9.22 mm	Width 5.99 mm	Magnification 1.25x

10. *Parreysia favidens favidens,* River Gomti at Rajwari, Uttar Pradesh

Length 41.0 mm	Width 31.0 mm

11. *Parreysia triembolus,* River Gomti at Rajwari, Uttar Pradesh

Length 52.0 mm	Width 36.8 mm

12. *Parreysia triembolus,* River Gomti at Rajwari, Uttar Pradesh

Length 52.0 mm	Width 36.8 mm

13. *Parreysia triembolus,* River Gomti at Rajwari, Uttar Pradesh

Length 52.0 mm	Width 36.8 mm

14. *Radiatula pachysoma,* Bridge at River Garra, Uttar Pradesh

Length 45.87 mm	Width 23.74 mm

15. *Radiatula occata juvenile,* River Ramganga before confluence to River Ganga

Length 4.60 mm	Width 2.35 mm	Magnification 2.0 x

16. *Radiatula occata,* Barawali Railway & Road Bridge, Uttar Pradesh

Length 15.16 mm	Width 8.28 mm	Magnification 0.75x

17. *Radiatula occata,* Saloni River at Sakurtal Ghat, Uttar Pradesh

Length 13.14 mm	Width 7.44 mm	Magnification 0.75 x

18. *Radiatula caerulea,* Bridge on River Ghaghra near Manjhi, Bihar

Length 12.83 mm	Width 6.74 mm	Magnification 0.75x

19. *Radiatula olivaria,* Kachla Ghat Bridge, Badaun, Uttar Pradesh

Length 10.33 mm	Width 5.23 mm	Magnification 1.25x

20. *Lamellidens sp.,* juvenile Bathing Ghat-1, Varanasi, Uttar Pradesh

Length 18.49 mm	Width 9.16 mm	Magnification 0.75

21. *Lamellidens phenchooganjensis,* Tarighat downstream Ghazipur, Uttar Pradesh

Length 73.91 mm	Width 35.0 mm

22. *Lamellidens phenchooganjensis,* Tarighat downstream Ghazipur, Uttar Pradesh

Length 73.91 mm	Width 35.0 mm

23. *Lamellidens phenchooganjensis juvenile,* Bridge on River Ghaghra near Manjhi, Bihar

Length 29.81 mm	Width 17.13 mm

24. *Lamellidens lamellatus,* dorsal view, Saloni River at Sakurtal Ghat,

Length 64.9 mm	Width 34.6 mm

25. *Lamellidens lamellatus,* dorsal view, Saloni River at Sakurtal Ghat,

26. *Lamellidens rhadineus,* Saloni River at Sakurtal Ghat

Length 40.9 mm	Width 23.81 mm

27. *Lamellidens sp,* juvenile, Bridge near Fatehpur, Uttar Pradesh

Length 13.11 mm	Width 6.68 mm	Magnification 1.0x

28. *Lamellidens sp,* juvenile, Bridge near Fatehpur, Uttar Pradesh

Length 13.11 mm	Width 6.68 mm	Magnification 1.0x

29. *Lamellidens sp,* juvenile, Bridge on Allahabad Bypass, Uttar Pradesh

Length 13.89 mm	Width 6.96 mm	Magnification 0.75x

30. *Pisidium annandalei,* Bridge upstream of Narora, Uttar Pradesh

Length 3.76 mm	Width 3.01mm	Magnification 3.2x

31. *Musculium indicum,* Bridge Lord Curzen Allahabad right, Uttar Pradesh

Length 4.72 mm	Width 3.93 mm	Magnification 1.6x

32. *Scaphula celox,* dorsal view, River Ganga downstream of FTPS Farakka, West Bengal

Length 8.38 mm	Width 3.51 mm	Magnification 1.25x

33. *Scaphula celox,* ventral view, River Ganga downstream of FTPS Farakka, West Bengal

Length 8.38 mm	Width 3.51 mm	Magnification 1.25x

34. *Scaphula deltae,* dorsal view, River Ganga downstream of FTPS Farakka, West Bengal

Length 5.43 mm	Width 2.15 mm	Magnification 2.0x

35. *Novaculina gangetica,* Kastharni ghat, upstream Munger, Bihar

Length 49.0 mm	Width 17.5 mm	Height 13.7 mm	Magnification 1.0 x

36. *Novaculina gangetica* juvenile Kastharni ghat, upstream Munger, Bihar

Length 9.0 mm	Width 4.2 mm	Height 2.1 mm	Magnification 1.0x

37. *Novaculina gangetica mature,* Ferry ghat, (LCT ghat) downstream Sahibganj, Jharkhand

Length 27.0 mm	Width 10.3 mm	Height 6.8 mm	Magnification 1.0x

38. *Novaculina gangetica young,* Syedbazar ghat near Mangalhaat upstream Rajmahal, Jharkhand

Length 19.0 mm	Width 7.8 mm	Height 4.5 mm	Magnification 0.75x

39. *Lamellidens rhadineus* juvenile, River Ganga at Digha rail road bridge, upstream Patna, Bihar

Length 14.63 mm	Width 6.24 mm	Height 6.8 mm	Magnification 0.75x

40. *Novaculina gangetica* juvenile, River Ganga at Kastarnighat, upstream Munger, Bihar

Plate 2

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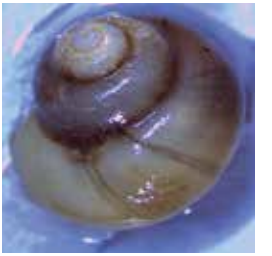

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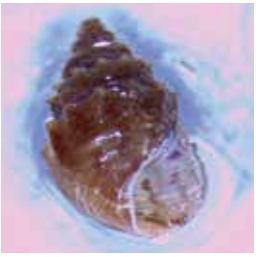

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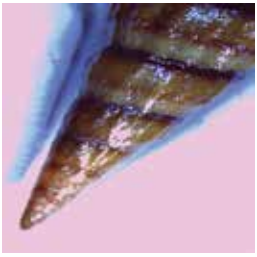

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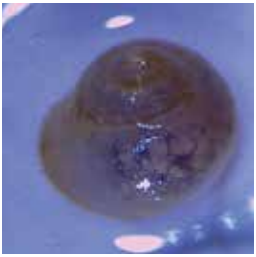

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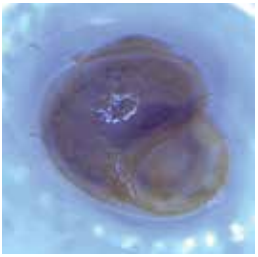

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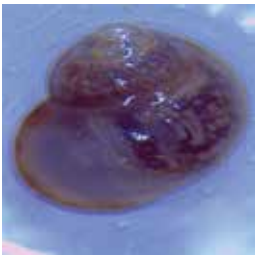

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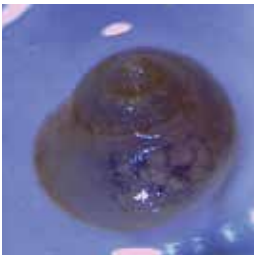

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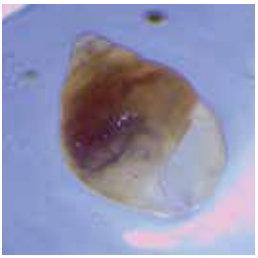

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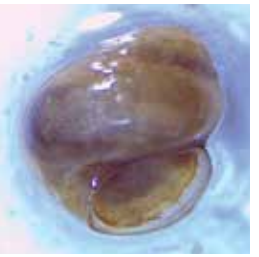

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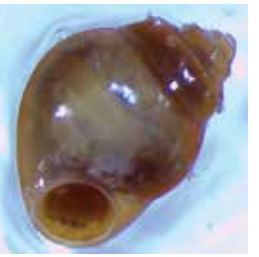

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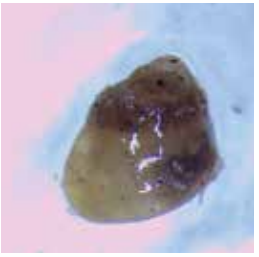

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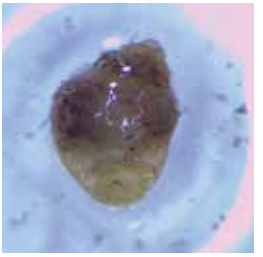

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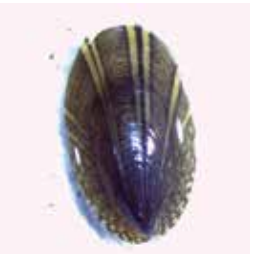

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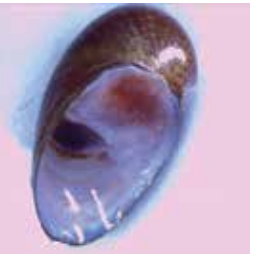

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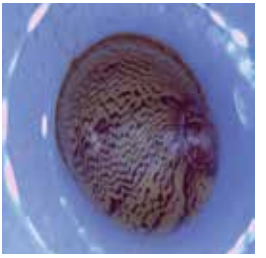

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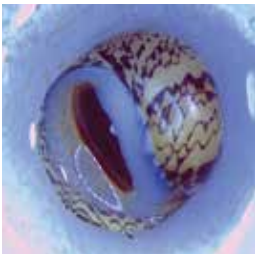

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Plate 2

1. *Bellamya bengalensis,* ventral view, River Ganga at Raghunathganj,West Bengal

Length 13.27 mm	Width 9.38 mm	Magnification 0.75x

2. *Bellamya bengalensis,* dorsal view, River Ganga at Raghunathganj, West Bengal

Length 13.27 mm	Width 9.38 mm	Magnification 0.75x

3. *Makongia crassa,* dorsal view, Farakka Barrage, West Bengal

Length 13.76 mm	Width 10.21 mm	Magnification 0.75x

4. *Makongia crassa,* ventral view, Farakka Barrage, West Bengal

Length 13.76 mm	Width 10.21 mm	Magnification 0.75x

5. *Idiopoma dissimilis,* River Ganga at Chinsura downstream of Tribeni, West Bengal

Length 7.84 mm	Width 4.60 mm	Magnification 1.25x

6. *Melanoides tuberculatus,* River Gandak on Bridge near Hajipur, Bihar

Length 40.91 mm	Width 12.43 mm

7. *Melanoides tuberculatus,* Barawali Railway & Road Bridge

Length 6.82 mm	Width 2.38 mm	Magnification 1.6x

8. *Melanoides pyramis,* Bridge on River Ghaghra near Manjhi

Length 14.52 mm	Width 4.64 mm	Magnification 0.75x

9. *Melanoides pyramis,* River Ganga at Chinsura downstream of Tribeni, West Bengal

Length 15.32 mm	Width 4.89 mm	Magnification 0.75x

10. *Thiara (Thiara) scabra,* Farakka Barrage, West Bengal

Length 7.69 mm	Width 4.13 mm	Magnification 1.25x

11. *Thiara (Thiara) scabra,* River Ganga downstream of Murshidabad (downstream Beharampur), West Bengal

Length 17.99 mm	Width 6.62 mm	Magnification 0.75x

12. *Thiara (Tarebia) lineata,* Bridge on River Ghaghra near Manjhi, Bihar

Length 17.77 mm	Width 7.11 mm	Magnification 0.75x

13. *Thiara (Tarebia) lineata* River Gandak on Bridge near Hajipur, Bihar

Length 18.60 mm	Width 6.52 mm	Magnification 0.75x

14. *Thiara (Sermyla) requeti,* Farakka Barrage, West Bengal

Length 27.2 mm	Width 10.1 mm

15. *Thiara (Sermyla) requeti,* Farakka Barrage, West Bengal

Length 27.2 mm	Width 10.1 mm

16. *Thiara (Sermyla) requeti,* Farakka Barrage, West Bengal

Length 27.2 mm	Width 10.1 mm

17. *Thiara (Sermyla) requeti,* River Ganga downstream of FTPS Farakka

Length 7.24 mm	Width 2.87 mm	Magnification 1.25x

18. *Brotia costula costula,* Bridge on River Ghaghra near Manjhi

Length 41.2 mm	Width 12.89 mm

19. *Assiminea francesiae,* Ghat downstream of Srirampore upstream of Kolkata, West Bengal

Length 19.15 mm	Width 6.08 mm	Magnification 0.75x

20. *Digoniostoma pulchella,* ventral view, Farakka Barrage, West Bengal

Length 5.14 mm	Width 3.78 mm	Magnification 1.6x

21. *Digoniostoma pulchella,* dorsal view, Farakka Barrage, West Bengal

Length 5.14 mm	Width 3.78 mm	Magnification 1.6x

22. *Digoniostoma lithoglyphoides,* dorsal view River Ganga D/S of Nabadwip

Length 5.29 mm	Width 3.39 mm	Magnification 2.0x

23. *Digoniostoma lithoglyphoides,* ventral view, River Ganga D/S of Nabadwip

Length 5.29 mm	Width 3.39 mm	Magnification 2.0x

24. *Gabbia stenothyroides,* ventral view, River Ganga upstream of Jiaganj, West Bengal

Length 3.32 mm	Width 2.22 mm	Magnification 2.5x

25. *Gabbia orcula,* dorsal view, River Ganga D/S of Nabadwip

Length 6.29 mm	Width 3.99 mm	Magnification 1.6x

26. *Gabbia orcula,* ventral view, River Ganga D/S of Nabadwip

Length 6.29 mm	Width 3.99 mm	Magnification 1.6x

27. *Stenothyra Ornate,* Farakka Barrage, West Bengal

Length 4.49 mm	Width 3.04 mm	Magnification 2.5x

28. *Stenothyra Ornate,* dorsal view, River Ganga at Chinsura downstream of Tribeni,West Bengal

Length 3.30 mm	Width 2.29 mm	Magnification 2.0x

29. *Stenothyra Ornate,* ventral view, River Ganga at Chinsura downstream of Tribeni, West Bengal

Length 3.30 mm	Width 2.29 mm	Magnification 2.0x

30. *Septaria tesselata,* dorsal view River Ganga at Chinsura D/s of Tribeni,West Bengal

Length 14.26 mm	Width 10.14 mm	Magnification 0.75x

31. *Septaria tesselata,* ventral view, River Ganga at Chinsura D/s of Tribeni,West Bengal

Length 14.26 mm	Width 10.14 mm	Magnification 0.75x

32. *Septaria sp.* dorsal view, River Ganga at Chinsura D/s of Tribeni, West Bengal,

Length 9.49 mm	Width 7.11 mm	Magnification 0.75x

33. *Septaria sp.* Ventral view, River Ganga at Chinsura D/s of Tribeni, West Bengal,

Length 9.49 mm	Width 7.11 mm	Magnification 0.75x

34. *Neritina (Dostia) violacea,* dorsal view River Ganga near Belgharia, West Bengal,

Length 13.60 mm	Width 9.33	Magnification 0.75x

35. *Neritina (Dostia) violacea,* ventral view River Ganga near Belgharia, West Bengal,

Length 13.60 mm	Width 9.33	Magnification 0.75x

36. *Neritina (Vittina) smithi,* dorsal view, River Ganga at Diamond Harbour, West Bengal.

Length 9.53 mm	Width 8.23 mm	Magnification 0.75x

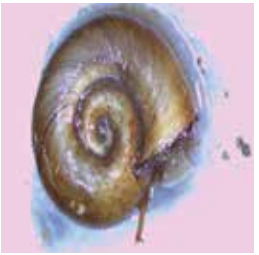
37. *Neritina (Vittina) smithi,* ventral view, River Ganga at Diamond Harbour, West Bengal.

Length 9.53 mm	Width 8.23 mm	Magnification 0.75x

38. *Melanoides pyramis,* Farakka Barrage, West Bengal

Length 14.58 mm	Width 4.66 mm	Magnification 0.75x

Plate 3



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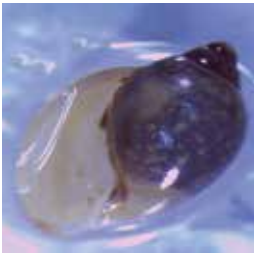

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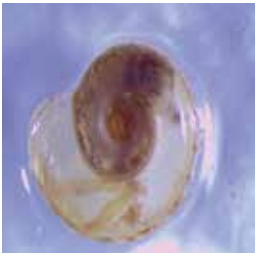

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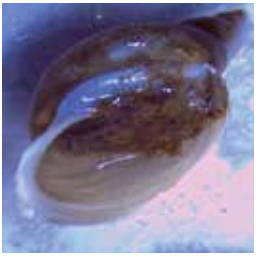

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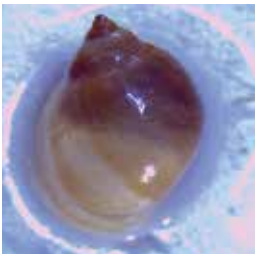

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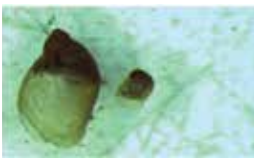

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Plate 3

1. *Indoplanorbis exustus,* River Ganga at Palta Water Intake downstream of Kolkatta, West Bengal

Length 3.85 mm	Width 10.57 mm	Magnification 0.75x

2. *Physa (Haitia) mexicana,* Mirzapur downstream, after confluence of two drains

Length 9.76 mm	Width 5.45 mm	Magnification 1.25x

3. *Gyraulus convexiusculus,* River Ganga downstream of FTPS Farakka, West Bengal

Length 1.0 mm	Width 4.28 mm	Magnification 2.0x

4. *Lymnaea accuminata,* Tarighat D/S Ghazipur, Uttar Pradesh

Length 18.40 mm	Width 8.97 mm	Magnification 0.75x

5. *Lymnaea accuminata,* River Gandak on Bridge near Hajipur, Bihar,

Length 10.76 mm	Width 6.08 mm	Magnification 1.0x

6. *Lymnaea andersoniana simulans,* ventral view, River Ganga downstream of Nabadwip, West Bengal

Length 13.44 mm	Width 7.90 mm	Magnification 0.75x

7. *Lymnaea andersoniana simulans,* dorsal view, River Ganga D/S of Nabadwip, West Bengal

Length 13.44 mm	Width 7.90 mm	Magnification 0.75x

8. *Onchidium typhae,* dorsal view, Palta-Falta, West Bengal

Length 35.0 mm	Width 23.5 mm

9. *Onchidium typhae,* ventral view, Palta-Falta, West Bengal

Length 35.0 mm	Width 23.5 mm

10. *Segmentine calathal,* Family Planorbiidae, River Ganga at Digha rail and road bridge, upstream Patna, Bihar

Length 6.08 mm	Width 4.37 mm	Magnification 0.75x

11. *Quickia sp./* Family Succineidae, River Ganga at Anupshahar downstream confluence of STP outlet at upstream of Mokshdham (Shavdahgrah), Uttar Pradesh

Length 4.67 mm	Width 2.47 mm	Magnification 2.0x

Plate 4

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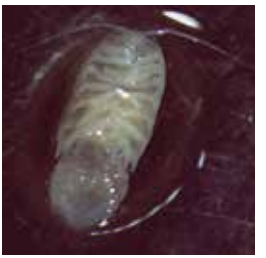

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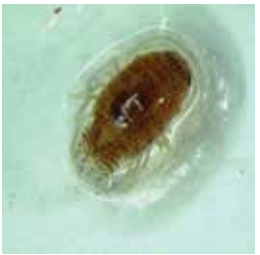

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Plate 4

1. *Cirolana parva* Dorsal view, River Ganga at transmission tower U/S of Tribeni, West Bengal

Length 8.39 mm	Width 3.77 mm	Magnification 1x

2. *Cirolana parva* Ventral view, River Ganga at transmission tower U/S of Tribeni, West Bengal

Length 8.39 mm	Width 3.77 mm	Magnification 1x

3. *Annina,* Dorsal view, River Ganga upstream of Tribeni, West Bengal

Length 5.84 mm	Width 2.57 mm	Magnification 1x

4. *Annina,* Ventral view, River Ganga upstream of Tribeni, West Bengal

Length 5.84 mm	Width 2.57 mm	Magnification 1x

5. *Annina kumari,* dorsal view, River Ganga downstream of Murshidabad (downstream Beharampur), West Bengal.

Length 8.27 mm	Width 2.75 mm	Magnification 1.25x

6. *Annina kumari,* ventral view, River Ganga downstream of Murshidabad (downstream Beharampur), West Bengal.

Length 8.27 mm	Width 2.75 mm	Magnification 1.25x

7. *Stenasellus,* dorsal view, River Ganga at transmission tower upstream of Tribeni, West Bengal

Length 4.07 mm	Width 3.89 mm	Magnification 1.25x

8. *Stenasellus,* ventral view, River Ganga at transmission tower upstream of Tribeni, West Bengal

Length 4.07 mm	Width 3.89 mm	Magnification 1.25x

9. *Stenasellus,* lateral view, River Ganga at Chinsura downstream of Tribeni, West Bengal

Lngth 3.58 mm	Width 4.19 mm	Magnification 1x

10. *Stenasellus,* ventral view, River Ganga at Chinsura downstream of Tribeni, West Bengal

Length 3.58 mm	Width 4.19 mm	Magnification 1x

11. *Nerocilia deprassa,* Dorsal view, River Ganga upstream of Tribeni, West Bengal

Length 5.15 mm	Width 2.53 mm	Magnification 1x

12. *Nerocilia deprassa,* Ventral view, River Ganga upstream of Tribeni, West Bengal

Length 5.15 mm	Width 2.53 mm	Magnification 1x

13. *Corallana grandienata,* ventral view, Ghat downstream of Srirampore (upstream of Kolkatta), West Bengal

Length 3.45 mm	Width 1.76 mm	Magnification 2x

14. *Corallana grandienata,* dorsal view, Ghat downstream of Srirampore (upstream of Kolkatta), West Bengal

Length 3.45 mm	Width 1.76 mm	Magnification 2x

15. *Corallana sp.,* dorsal view, River Ganga at Kahalgaon, Bihar

Length 3.45 mm	Width 1.76 mm	Magnification 2x

16. *Corallana sp.,* ventral view, River Ganga at Kahalgaon, Bihar

Length 3.45 mm	Width 1.76 mm	Magnification 2x

17. *Stygocyathura.* Dark field view, River Ganga at Diamond Harbour, West Bengal.

Length 9.68 mm	Width 1.46 mm	Magnification 1.0 x

18. *Stygocyathura.* Light field view, River Ganga at Diamond Harbour, West Bengal.

19. *Alitropus typus.* Dorsal view, First inlet stream (Falgu River) from west on NH-34, downstrem Farakka, West Bengal.

Length 3.88 mm	Width 1.62 mm	Magnification 1.6 x

Plate 5

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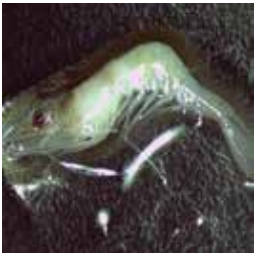

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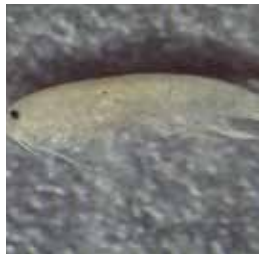

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Plate 5

1. *Macrobrachium idae,* River Ganga at Katwa, West Bengal

Length 14.14 mm	Width 2.33 mm	Magnification 0.75x

2. *Macrobrachium idae,* River Ganga at Katwa, West Bengal

Length 14.14 mm	Width 2.33 mm	Magnification 0.75x

3. *Macrobrachium callirrhoe,* Bridge upstream of Narora, Uttar Pradesh

Length 14.08 mm	Width 2.78 mm	Magnification 0.75x

4. *Macrobrachium lopopodus,* Anterior view, cephalo- thoracic region, River Ganga upstream of Jiaganj, West Bengal

Length 17.35 mm	Width 2.52 mm	Magnification 0.75x

5. *Macrobrachium lopopodus,* Posterior view, telson region, River Ganga upstream of Jiaganj, West Bengal

Length 17.35 mm	Width 2.52 mm	Magnification 0.75x

6. *Macrobrachium lopopodus,* Barawali Railway & Road Bridge, Uttar Pradesh

Length 15.90 mm	Width 2.33 mm	Magnification 0.75x

7. *Macrobrachium horstii,* Bridge Ghat Road Bridge NH-24, Garhmukteshwar, Uttar Pradesh

Length 14.19 mm	Width 2.74 mm	Magnification 0.75x

8. *Machrobrachium lanchasteri,* anterior view, Farakka Barrage, West Bengal

Length 20.47 mm	Width 3.16 mm	Magnification 0.75

9. *Machrobrachium lanchasteri,* Posterior view, Farakka Barrage, West Bengal

Length 20.47 mm	Width 3.16 mm	Magnification 0.75

10. *Macrobranchium niphanae,* River Ganga Bridge at Ramnagar Road near Varanasi, UttarPradesh

Length 20 mm	Width 3.28 mm	Magnificatin0.75x

11. *Macrobranchium niphanae,* River Ganga Bridge at Ramnagar Road near Varanasi, UttarPradesh

Length 20 mm	Width 3.28 mm	Magnificatin0.75x

12. *Macrobrachium mirabile,* River Ganga at Diamond Harbour, West Bengal

Length 11.20 mm	Width 1.63 mm	Magnification 0.75

13. *Macrobrachium mirabile,* River Ganga at Diamond Harbour, West Bengal

Length 11.20 mm	Width 1.63 mm	Magnification 0.75

14. *Platochestia platensis.* Dark field view, with eye, River Ganga at Falta, West Bengal.

Length 6.0 mm	Width 0.774 mm	Magnification 1.25 x

15. *Platochestia platensis.* Light field view, River Ganga at Falta, West Bengal.

16. *Neoniphargus indicus.* Dark field view, without eye, River Ganga at Diamond Harbour,West Bengal

Length 4.21 mm	Width 0.661 mm	Magnification 1.6 x

Plate 6

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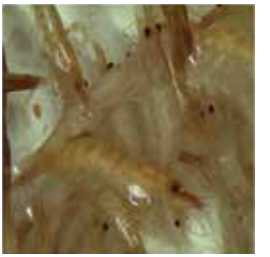

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Plate 6

1. *Caridina peninsularis,* River Ganga upstream of Tribeni

Length 7.47 mm	Width 1.17 mm	Magnificatio1.25x

2. *Caridina bruneiana,* River Ganga at transmission tower upstream of Tribeni, West Bengal

Length 5.59 mm	Width 1.07 mm	Magnification 1x

3. *Caridina bruneiana,* Madhya Ganga Barrage, Uttar Pradesh

Length 9.21 mm	Width 1.61 mm	Magnification 0.75x

4. *Caridina endehensis,* River Ganga at Chinsura downstream of Tribeni, West Bengal

Length 8 mm	Width 3.14 mm	Magnification 1x

5. *Cardina celebensis,* anterior view, Mirzapur downstream, after confluence of two drains, Uttar Pradesh

Length 18.71 mm	Width 6.02 mm	Magnification 0.75x

6. *Cardina celebensis,* posterior view, Mirzapur downstream, after confluence of two drains, Uttar Pradesh

Length 18.71 mm	Width 6.02 mm	Magnification 0.75x

7. *Caridina temasek,* River Ganga at Anupshahar downstream STP outlet confluence, Uttar Pradesh

Length 18.99 mm	Width 3.24 mm	Magnification 0.75x

8. *Caridina temasek,* Rostrum armed dorsaly, River Ganga at Anupshahar downstream STP outlet confluence, Uttar Pradesh
9. *Caridina elongapoda,* River Ganga at Anupshahar upstream, Uttar Pradesh

Length 15.47 mm	Width 1.72 mm	Magnification 0.75x

10. *Caridina elongapoda,* Shape of carapace, River Ganga at Anupshahar upstream, Uttar Pradesh
11. *Caridina elongapoda,* Appendix interna of endopod of first pleopod of male, River Ganga at Anupshahar upstream, Uttar Pradesh
12. *Caridina thambipilaii,* River Ganga at Naratpageora downstream barrage, Uttar Pradesh

Plate 7

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Plate 7

1. *Johara,* dorsal view, Ghat downstream of Srirampore (upstream of kolkata), West Bengal

Length 2.56 mm	Width 3.66 mm	Magnification 1.25x

2. *Johara,* ventral view, Ghat downstream of Srirampore (upstream of kolkata), West Bengal

Length 2.56 mm	Width 3.66 mm	Magnification 1.25x

3. *Isolapolaman,* dorsal view, River Ganga at Diamond Harbour, West Bengal

Length 4.64 mm	Width 6.26 mm	Magnification 0.75x

4. *Isolapolaman,* ventral view, River Ganga at Diamond Harbour, West Bengal

Length 4.64 mm	Width 6.26 mm	Magnification 0.75x

5. *Perithelphusa,* dorsal view, River Ganga at Chinsura downstream of Tribeni, West Bengal

Length 3.58 mm	Width 4.91 mm	Magnification1x

6. *Perithelphusa,* dorsal view, River Ganga at Chinsura downstream of Tribeni, West Bengal

Length 3.58 mm	Width 4.91 mm	Magnification1x

7. *Perithelphusa,* River Ganga at Raghunathganj, West Bengal

Length 5.97 mm	Width 7.41 mm	Magnification 1x

8. *Salangathelphusa,* dorsal view, River Ganga at Diamond Harbour, West Bengal

Length 5.0 mm	Width 5.76 mm	Magnification 1.0x

9. *Salangathelphusa,* ventral view, River Ganga at Diamond Harbour, West Bengal

Length 5.0 mm	Width 5.76 mm	Magnification 1.0x

10. *Neorhyncoplax nasalis,* dorsal view,River Ganga at Chinsura downstream of Tribeni, West Bengal

Length 2.54 mm	Width 2.85 mm	Magnification 1x

11. *Neorhyncoplax nasalis,* ventral view, River Ganga at Chinsura downstream of Tribeni, West Bengal

Length 2.54 mm	Width 2.85 mm	Magnification 1x

12. *Varuna yui,* ventral view, River Ganga at Diamond Harbour
13. *Varuna yui,* dorsal view, River Ganga at Diamond Harbour
14. *Varuna yui,* River Ganga upstream of Jiaganj, West Bengal

Length 3.25 mm	Width 3.51 mm	Magnification 1.6x

15. *Sesermoides,* dorsal view, River Ganga at Diamond Harbour, West Bengal

Length 7.95 mm	Width 10.41 mm	Magnification 0.75x

16. *Sesermoides,* ventral view, River Ganga at Diamond Harbour, West Bengal

Length 7.95 mm	Width 10.41 mm	Magnification 0.75x

17. *Geoseserma,* dorsal view, Ghat downstream of Srirampore (upstream of Kolkatta), West Bengal

Length 9.76 mm	Width 11.47 mm	Magnification 0.75x

18. *Geoseserma,* ventral view, Ghat downstream of Srirampore (upstream of Kolkatta), West Bengal

Length 9.76 mm	Width 11.47 mm	Magnification 0.75x

19. *Sesermops,* dorsal view, River Ganga at Diamond Harbour, West Bengal

Length 2.63 mm	Width 3.30 mm	Magnification 2x

20. *Sesermops,* ventral view, River Ganga at Diamond Harbour, West Bengal

Length 2.63 mm	Width 3.30 mm	Magnification 2x

21. *Pseudoseserma,* dorsal view, River Ganga at Diamond Harbour, West Bengal

Length 6.08 mm	Width 8.06 mm	Magnification 1x

22. *Pseudoseserma,* ventral view, River Ganga at Diamond Harbour, West Bengal

Length 6.08 mm	Width 8.06 mm	Magnification 1x

23. *Lepidothelphusa,* dorsal view, Ghat downstream of Srirampore (upstream of Kolkatta), West Bengal

Length 3.69 mm	Width 4.91 mm	Magnification 1x

24. *Lepidothelphusa,* ventral view, Ghat downstream of Srirampore (upstream of Kolkatta), West Bengal

Length 3.69 mm	Width 4.91 mm	Magnification 1x

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Plate 8

1. *Gangemysis assimilis,* Bridge near Danapur Patna 2, Bihar

Length 6.36 mm	Width 0.658 mm	Magnification 1.6x

2. *Gangemysis assimilis,* River Ganga at Brijghat, Bhagalpur, Bihar

Length 5.47 mm	Width 0.550 mm	Magnification 1.25x

Plate 9

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Plate 9

1. *Baetis,* Bridge SH-98 at Varanasi, Uttar Pradesh

Length 6.54 mm	Width 1.12 mm

2. *Baetis,* Bridge on River Varuna in Varanasi, Uttar Pradesh

Length 5.42 mm	Width 1.05 mm

3. *Pseudocloeon,* River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 4.29 mm	Width 0.602 mm	Magnification 1.6x

4. *Platybaetis,* dorsal view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 4.62 mm	Width 0.666 mm	Magnification 1.0x

5. *Platybaetis,* ventral view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 4.62 mm	Width 0.666 mm	Magnification 1.0x

6. *Caenis,* upstream Rishikesh, Luxmanjhula, Uttarakhand.

Length 9.93 mm	Width 1.53 mm	Magnification 0.75x

7. *Caenis,* Bridge downstream of River Tons near Sirsa, Uttar Pradesh

Length 3.39 mm	Width 0.923 mm

8. *Eatogenia,* Bridge at Bithoor, Uttar Pradesh

Total Length 27.49 mm	Total Width mm 4.85

9. *Eatogenia,* Head and Thoracic region, Bridge at Bithoor, Uttar Pradesh

Total Length 27.49 mm	Total Width mm 4.85

10. *Eatogenia* Abdominal region, Bridge at Bithoor, Uttar Pradesh

Total Length 27.49 mm	Total Width mm 4.85

11. *Eatogenia* tail region, Bridge at Bithoor, Uttar Pradesh

Total Length 27.49 mm	Total Width mm 4.85

12. *Ephemera Sp.,* River Gandak on Bridge near Hajipur, Bihar

Length 9.86 mm	Width 1.84 mm

13. *Ironodes,* in groups, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 7.6 mm	Width 1.8 mm	Magnification 0.75x

14. *Ironodes,* dorsal view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 13.81 mm	Width 3.38 mm	Magnification 1.25x

15. *Ironodes,* ventral view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 13.81 mm	Width 3.38 mm	Magnification 1.25x

16. *Epeorus Epeorus,* in groups, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

17. *Epeorus Epeorus,* dorsal view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 10.04 mm	Width 2.18 mm	Magnification 1.25X

18. *Epeorus Epeorus,* ventral view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 10.04 mm	Width 2.18 mm	Magnification 1.25X

19. *Afronurus*, dorsal view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 4.19 mm	Width 0.965 mm	Magnification2.5x

20. *Afronurus,* ventral view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 4.19 mm	Width 0.965 mm	Magnification2.5x

21. *Rhithrogena,* River Alaknanda after confluence River Mandakini, downstream Rudraprayag.

Length 4.0-6.59 mm	Width 0.6-1.16 mm	Magnification 1.0x

22. *Rhithrogena,* dorsal view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 6.96 mm	Width 1.51 mm	Magnification 0.75x

23. *Rhithrogena,* ventral view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 6.96 mm	Width 1.51 mm	Magnification 0.75x

24. *Cynigmina,* River Alaknanda after confluence River Mandakini, downstream Rudraprayag

Length 7.5-7.97 mm	Width 2.1-2.13 mm	Magnification 0.75x

25. *Cynigmina,* dorsal view, upstream Rishikesh, Luxmanjhula, Uttarakhand.

Length 4.13 mm	Width 0.661 mm	Magnification 1.25x

26. *Cynigmina,* dorsal view, upstream Rishikesh, Luxmanjhula, Uttarakhand.

Length 4.13 mm	Width 0.661 mm	Magnification 1.25x

27. *Ameletus,* River Alaknanda after confluence River Mandakini, downstream Rudraprayag

Length 7.33-8.15 mm	Width 1.06-1.43 mm	Magnification 1.0x

28. *Ameletus,* dorsal view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 4.63 mm	Width 0.719 mm	Magnification 2.0x

29. *Ameletus,* dorsal view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 4.63 mm	Width 0.719 mm	Magnification 2.0x

30. *Ephemerella Eurylophella,* dorsal view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 5.51 mm	Width 0.766 mm	Magnification 1.6x

31. *Ephemerella Eurylophella,* ventral view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 5.51 mm	Width 0.766 mm	Magnification 1.6x

32. *Ephemerella sp.,* dorsal view, upstream Rishikesh, Luxmanjhula, Uttarakhand.

Length 5.43 mm	Width 0.491 mm	Magnification 1.25x

33. *Ephemerella sp.,* ventral view, upstream Rishikesh, Luxmanjhula, Uttarakhand.

Length 5.43 mm	Width 0.491 mm	Magnification 1.25x

34. *Drunella*, dorsal view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 5.08 mm	Width 0.995 mm	Magnification 1.0x

35. *Drunella,* ventral view, River Alaknanda after confluence of River Mandakini downstream Rudraprayag, Uttarakhand.

Length 5.08 mm	Width 0.995 mm	Magnification 1.0x

36. *Neoephemeropsis,* River Ganga Barrage at Rishikesh (Nearby Park)

Length 3.01-3.22 mm	Width 0.987-1.11 mm	Magnification 2.0x

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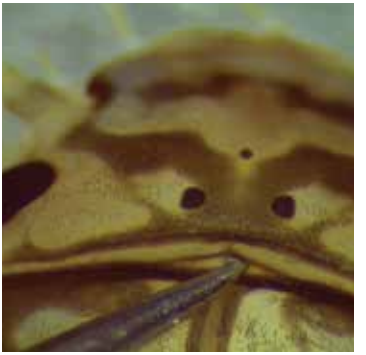

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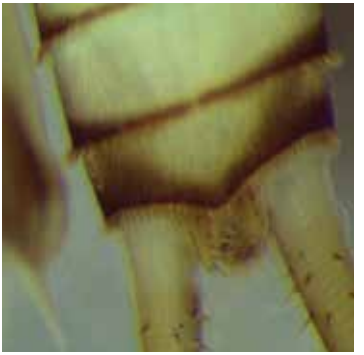

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Plate 10

1. *Tetropina,* Barrage at Rishikesh (Nearby Park), Uttarakhand

Length 9.37 mm	Width 1.42 mm

2. *Flevoperla,* dorsal view, River Ganga on barrage at Rishikesh, Uttarakhand.

Length 11.75-16.93mm	Width 2.29-3.10mm	Magnification0.75x

3. *Flevoperla,* ventral view, River Ganga on barrage at Rishikesh, Uttarakhand.

Length 11.75-16.93mm	Width 2.29-3.10mm	Magnification0.75x

4. *Flevoperla,* dorsal view, head showing ocelli and occipital ridge, River Ganga on barrage at Rishikesh, Uttarakhand.

Length 11.75-16.93mm	Width 2.29-3.10mm	Magnification0.75x

5. *Flevoperla,* ventral view, anal gills on last abdominal segment and two caudal filaments at tail region, River Ganga on barrage at Rishikesh, Uttarakhand.

Length 11.75-16.93mm	Width 2.29-3.10mm	Magnification0.75x

Plate 11

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Plate 11

1. *Hydropsychidae,* Barawali Railway & Road Bridge, Uttar Pradesh

Length 5.457 mm	Width 0.907 mm	Magnification 2x

2. *Cheumetopsyche,* Bridge at Bithoor, Uttar Pradesh

Length 10.10 mm	Width 2.18 mm	Magnification 0.75x

3. *Stenopsyche,* River Alaknanda after confluence to River Mandakini at Rudra Prayag in Uttarakhand.

Length 25.6 mm	Width 19.1mm	Magnification 0.75x

4. *Triaenodes,* Bridge at Bithoor, Uttar Pradesh

Length 9 mm	Width 0.915 mm	Magnification 1x

5. *Brachycentrus,* caddis larva inside case, River Alaknanda after confluence to River Mandakini at Rudra Prayag in Uttarakhand.
6. *Brachycentrus,* larva and case, River Alaknanda after confluence to River Mandakini at Rudra Prayag in Uttarakhand.

Length 2.86 mm	Width 0.736 mm	Magnification 2.0x

7. *Oxyethira,* dorsal view of larva inside case, River Ganga at Luxmanjhula, Rishikesh, Uttarakhand.

Length 0.4 mm	Width 0.1 mm	Magnification 2.5x

8. *Chimarra/* Family Philopotamidae, River Ganga at Barrage at Rishikesh, Singthali near Byasi, upstream Rishikesh, Uttarakhand

Length 26.73 mm	Width 3.04 mm	Magnification 1.25x

9. *Lype/* Family Psychomyiidae, River Ganga downstream JSTP, downstream Hardwar, Uttarakhand

Length 5.364 mm	Width 0.697 mm	Magnification 1.6x

10. *Incertae sedis/* Family Pseudoneuroclipsis, River Ganga at Hardwar Barrage, Uttarakhand

Length 6.48 mm	Width 1.24 mm	Magnification 1.6x

11. *Orthotrichia/* Family Hydroptilidae, River Ganga at Singthali near Byasi, upstream Rishikesh, Uttarakhand

Length 2.21 mm	Width 0.657 mm	Magnification 2.5x

12. *Triplectides,* River Ganga at Singthali near Byasi, upstream Rishikesh, Uttarakhand

Length 4.56 mm	Width 1.34 mm	Magnification 1.25x

13. *Agapetus/* Family Glossosomatidae, River Ganga at Singthali near Byasi, upstream Rishikesh, Uttarakhand

Length 8.17 mm	Width 2.78 mm	Magnification 1.0x

Plate 12

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Plate 12

1. *Sinictinogomphus,* River Ghagra near Manjhi, Bihar

Length 14.87 mm	Width 3.47 mm

2. *Sinictinogomphus,* Nalla in Patna 3b, Bihar

Length 7.24 mm	Width 2.20 mm

3. *Heliogomphus,* River saloni at Sukartal Ghat, Uttar Pradesh

Length 10.02 mm	Width 2.33 mm

4. *Orientogomphus,* River Gomti at Rajwari, Uttar Pradesh

Length 18.71mm	Width 5.68 mm

5. *Paragomphus,* Danapur Patna 2, near bridge, Bihar

Length 12.41 mm	Width 3.57 mm

6. *Nihanogomphus* BH 12 Downstream Mahatma Gandhi Bridge right bank, Patna, Bihar

Length 23 mm	Width 4.50 mm

7. *Heliogomphus,* River Ganga upstream Rishikesh at Luxman Jhula, Hardwar Barrage, Uttarakhand

8. *Heliogomphus.* Dorsal view, River Ganga at Luxmanjhula, Rishikesh, Uttarakhand.

Length 8.47 mm	Width 3.55 mm	Magnification 0.75x

9. *Stylurus.* Dorsal view, First inlet stream (Falgu River) from west on NH-34 downstrem Farakka, West Bengal.

Length 10.66 mm	Width 2.39 mm	Magnification 1.0x

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Plate 13

1. *Acisoma,* Barrage at Narora Uttar Pradesh

Length 10.34 mm	Width 3.48 mm

2. *Orthetrum albistylum speciosum,* Downstream of Nabadwip, West Bengal

Length 11.32 mm	Width 5.17 mm

3. *Sympetrum sp.* River Gomti at Rajwari, Uttar Pradesh

Length 8.97 mm	Width 3.74 mm

4. *Brachythemis* Downstream of FTPS, Farakka West Bengal

Length 7.31 mm	Width 2.48 mm

5. *Brachythemis,* Dhonighat downstream Kanpur 5, Uttar Pradesh

Length 16.36	Width 4.58

6. *Brachythemis* Downstream of FTPS, Farakka West Bengal

Length 7.31 mm	Width 2.48 mm

7. *Zyxomma,* Nalla in Patna 3b, Bihar

Length 10.37 mm	Width 4.26 mm

8. *Tholymis,* Ramnagar road near Varanasi, near Bridge, Uttar Pradesh

Length 15.31 mm	Width 5.24 mm

9. *Hydrobasileus,* Farakka Barrage, West Bengal

Length 10.42 mm	Width 4.26 mm

10. *Hydrobasileus,* Farakka Barrage, West Bengal

Length 13.85 mm	Width 5.23 mm

11. *Nannophya pygmea,* STPS, Farakka, West Bengal

Length 10.92 mm	Width 5.05 mm

12. *Nannophya pygmea,* Downstream of Nabadwip, West Bengal

Length 18.28 mm	Width 5.86 mm

13. *Rhyothemis,* Downstream of FTPS, Farakka in West Bengal

Length 12.31 mm	Width 5.23 mm

14. *Libellula* Raghunathganj in West Bengal

Length 12.69	Width 5.52

15. *Lyriothemis,* Downstream of Nabadwip in West Bengal

Length 14.04 mm	Width 5.02 mm

16. *Sympetrum speciosum speciosum,* Raghunathganj, West Bengal

Length 12.50 mm	Width 5.71 mm

17. *Macromedia,* River Tons near Panas, Uttar Pradesh

Length 8.95 mm	Width 4.32 mm

18. *Macromia,* Bathing ghat – 1, Varanasi, Uttar Pradesh

Length 17.34 mm	Width 7.42 mm

19. *Diplacodes,* River Ganga at Anupshahar downstream STP outlet confluence, Uttar Pradesh

Length 7.17 mm	Width 2.92 mm	Magnification 1.0 x

20. *Tramea,* River Ganga at Anupshahar downstream STP outlet confluence, Uttar Pradesh

Length 7.50 mm	Width 3.66 mm	Magnification 1.0 x

21. *Trithemis,* dorsal view showing hind femora, River Ganga at upstream Anupshahar, Uttar Pradesh
22. *Trithemis,* dorsal view showing lateral spines, River Ganga at upstream Anupshahar, Uttar Pradesh
23. *Trithemis,* premental setae, River Ganga at upstream Anupshahar, Uttar Pradesh
24. Trithemis. Dorsal view, River Ganga at upstream Anupshahar, Uttar Pradesh.

Length 9.32 mm	Width 3.22 mm	Magnification 0.75 x

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Plate 14

1. *Euphaea decorate,* dorsal view, River Alaknanda after confluence River Mandakini downstream Rudraprayag

Length 7.03 mm	Width 1.86 mm	1.6x Magnification

2. *Euphaea decorate,* ventral view showing abdominal gills,River Alaknanda after confluence River Mandakini downstream Rudraprayag

Length 7.03 mm	Width 1.86 mm	1.6x Magnification

3. *Euphaea decorate,* dorsal head, River Alaknanda after confluence River Mandakini downstream Rudraprayag

Length 7.03 mm	Width 1.86 mm	1.6x Magnification

4. *Euphaea decorate,* ventral head region, prementum at ventral side of head, River Alaknanda after confluence River Mandakini downstream Rudraprayag

Length 7.03 mm	Width 1.86 mm	1.6x Magnification

5. *Euphaea decorate,* prementum at ventral side of head, River Alaknanda after confluence River Mandakini downstream Rudraprayag

Length 7.03 mm	Width 1.86 mm	1.6x Magnification

6. *Euphaea decorate,* River Alaknanda after confluence River Mandakini downstream Rudraprayag

Length 7.03 mm	Width 1.86 mm	1.6x Magnification

7. *Prodasineura autumnalis,* Bridge Ghat Road Bridge NH-24, Garhmukteshwar, Uttar Pradesh

Length 17 mm	Width 1.2 mm

8. *Prodasineura autumnalis,* River Gomti at Rajwari, Uttar Pradesh

Length 24 mm	Width 2 mm

9. *Agriocnemis lacteola,* Farakka Barrage, West Bengal

Length 25 mm	Width 2mm

10. *Agriocnemis lacteola,* Varanasi, Bridge SH-98, Uttar Pradesh

11. *Megalestes,* Bridge on River Varuna in Varanasi, Uttar Pradesh

Length 17 mm	Width 2mm

12. *Matrona,* River Ganga at downstream Hardwar JSTP, Uttarakhand

Length 19.41 mm	Width 1.53 mm	0.75x Magnification

Plate 15

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Plate 15

1. *Lethoceros,* dorsal view, River Ganga at Ramnagar road near Varanasi

Length 63 mm	Width 23 mm

2. *Diplonychus rusticus,* dorsal view, River Ganga at Chinsura downstream of Tribeni, West Bengal

Length 4.63 mm	Width 2.88 mm	Magnification 2.0x

3. *Diplonychus rusticus,* ventral view, River Ganga at Chinsura downstream of Tribeni, West Bengal

Length 4.63 mm	Width 2.88 mm	Magnification 2.0x

4. *Ilyocoris,* dorsal view, Haridwar Barrage, Uttar Pradesh

Length 9.38 mm	Width 5.85 mm	Magnification 1.0x

5. *Ilyocoris,* ventral view, Haridwar Barrage, Uttar Pradesh

Length 9.38 mm	Width 5.85 mm	Magnification 1.0x

6. *Ilyocoris,* ventral view, Haridwar Barrage, Uttar Pradesh

Length 9.38 mm	Width 5.85 mm	Magnification 1.0x

7. *Aphelocheirus,* dorsal view, Dam Khoti on Ganga Nahar downstream Har ki poudi, Hardwar, Uttar Pradesh.

Length 3.0-6.32 mm	Width 2.5-2.84 mm	Magnification 1.25x

8. *Aphelocheirus,* ventral view, Dam Khoti on Ganga Nahar downstream Har ki poudi, Hardwar, Uttar Pradesh.

Length 3.0-6.32 mm	Width 2.5-2.84 mm	Magnification 1.25x

9. *Nepa,* dorsal view, Mirzapur downstream, after confluence of two drains

Length 5.85 mm	Width 3.01 mm	Magnification0.75x

10. *Laccotrephes pfepferiae,* dorsal view Saloni River at, Sakurtal Ghat, Uttar Pradesh

Length 16.78 mm	Width 5.07 mm	Magnification 0.75x

11. *Laccotrephes,* ventral view, River Ganga downstream of Nabadwip, West Bengal

Length 14.57 mm	Width 5.40 mm	Magnification 0.75x

12. *Laccotrephes,* dorsal view, River Ganga downstream of Nabadwip, West Bengal

Length 14.57 mm	Width 5.40 mm	Magnification 0.75x

13. *Laccotrephes,* ventral view, River Ganga D/S of Nabadwip, West Bengal

Length 14.57 mm	Width 5.40 mm	Magnification 0.75x

14. *Laccotrephes,* dorsal view, River Ganga D/S of Nabadwip, West Bengal

Length 14.57 mm	Width 5.40 mm	Magnification 0.75x

15. *Laccotrephes,* dorsal view, River Ganga D/S of Nabadwip, West Bengal

Length 14.57 mm	Width 5.40 mm	Magnification 0.75x

16. *Laccotrephes,* ventral view, River Ganga D/S of Nabadwip, West Bengal

Length 14.57 mm	Width 5.40 mm	Magnification 0.75x

17. *Agraptocorixa,* dorsal view, River Ganga at Raghunathganj, West Bengal

Length 2.05 mm	Width 1.07 mm	Magnification 2.0x

18. *Sigara,* dorsal view, Bridge on River Yamuna, MDR, 26B, near Rajapur, Uttar Pradesh

Length 6.78 mm	Width 2.53 mm	Magnification 1.25x

19. *Sigara,* ventral view, Bridge on River Yamuna, MDR, 26B, near Rajapur, Uttar Pradesh

Length 6.78 mm	Width 2.53 mm	Magnification 1.25x

20. *Sigara,* dorsal view, Bridge on River Yamuna, MDR, 26B, near Rajapur, Uttar Pradesh

Length 6.78 mm	Width 2.53 mm	Magnification 1.25x

21. *Corixa,* dorsal view, River Ganga downstream of FTPS Farakka, West Bengal

Length 4.55 mm	Width 2.11 mm	Magnification 1.6x

22. *Ranatra brevicolis,* dorsal view, Barrage at Narora, Uttar Pradesh

Length 19.54 mm	Width 1.70 mm	Magnification 0.75x

23. *Ranatra brevicolis,* ventral view, Barrage at Narora, Uttar Pradesh

Length 19.54 mm	Width 1.70 mm	Magnification 0.75x

24. *Ranatra brevicolis,* dorsal view, Barrage at Narora, Uttar Pradesh

Length 19.54 mm	Width 1.70 mm	Magnification 0.75x

25. *Ranatra brevicolis,* ventral view, Barrage at Narora, Uttar Pradesh

Length 19.54 mm	Width 1.70 mm	Magnification 0.75x

26. *Hebrus,* dorsal view, River Ganga downstream of Nabadwip, West Bengal

Length 3.72 mm	Width 1.56 mm	Magnification 2.0x

27. *Hyrcannus,* dorsal view, Mirzapur downstream, after confluence of two drains

Length 4.16 mm	Width 2.24 mm	Magnification 1.6x

28. *Hyrcannus,* ventral view, Mirzapur downstream, after confluence of two drains

Length 4.16 mm	Width 2.24 mm	Magnification 1.6x

29. *Rhagodotarsus,* dorsal view, Bridge Ghat Road Bridge NH-24, Garhmukteshwar, Uttar Pradesh

Length 3.07 mm	Width 0.840 mm	Magnification 2.0x

30. *Rhagodotarsus,* ventral view, Bridge Ghat Road Bridge NH-24, Garhmukteshwar, Uttar Pradesh

Length 3.07 mm	Width 0.840 mm	Magnification 2.0x

31. *Metrocoris,* dorsal view, Bridge Ghat Road Bridge NH-24, Garhmukteshwar, Uttar Pradesh

Length 1.80 mm	Width 0.739 mm	Magnification 2.0x

32. *Halobates,* River Ganga at Diamond Harbour, West Bengal

Length 4.41 mmm	Width 2.29 mm	Magnification 0.75x

33. *Anisops,* dorsal view, Bridge on NH-2 right

Length 5.46 mm	Width 1.70 mm	Magnification 1.25x

34. *Anisops,* ventral view, Bridge on NH-2 right

Length 5.46 mm	Width 1.70 mm	Magnification 1.25x

35. *Hydrometra latreille,* dorsal view, River Ganga downstream of FTPS Farakka, West Bengal

Length 11.08 mm	Width 0.440 mm	Magnification 2.0x

36. *Paraplea,* River Ganga at Anupshahar downstream of STP and upstream of Mastrammurdaghat, Uttar Pradesh

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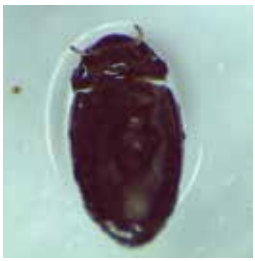

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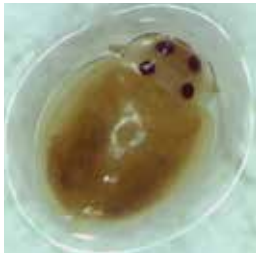

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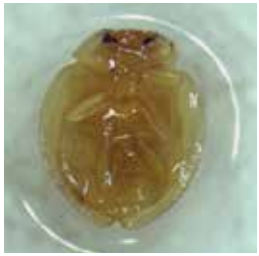

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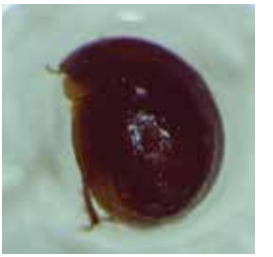

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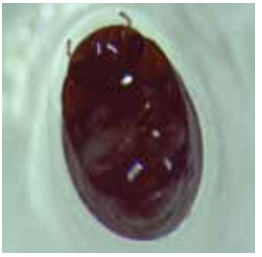

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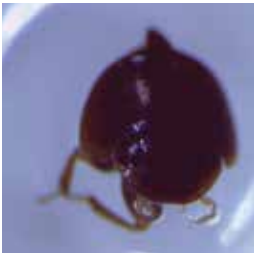

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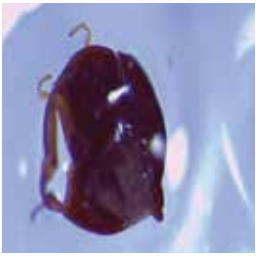

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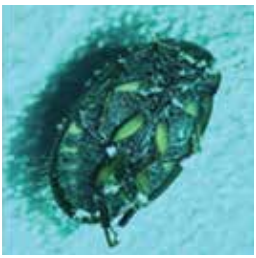

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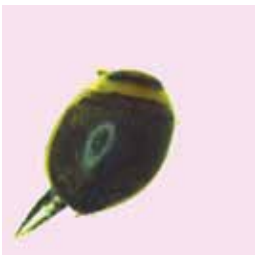

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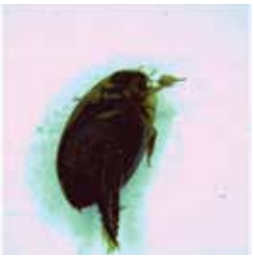

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Plate 16

1. *Stenelmis larva,* River Alaknanda after confluence River Mandakini, downstream Rudraprayag, Uttarakhand.

Length 5.87 mm	Width 1.04 mm	Magnification 1.25x

2. *Stenelmis larva,* River Alaknanda after confluence River Mandakini, downstream Rudraprayag, Uttarakhand.

Length 5.87 mm	Width 1.04 mm	Magnification 1.25x

3. *Stenelmis,* dorsal view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 4.83 mm	Width 2.30 mm	Magnification 1.6x

4. *Stenelmis,* ventral view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 4.83 mm	Width 2.30 mm	Magnification 1.6x

5. *Stenelmis,* ventral view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 4.83 mm	Width 2.30 mm	Magnification 1.6x

6. *Pseudomophilus,* dorsal view, Bridge Lord Curzen Allahabad right, Uttar Pradesh

Length 2.47 mm	Width 0.985 mm	Magnification 3.2x

7. *Pseudomophilus,* ventral view, Bridge Lord Curzen Allahabad right, Uttar Pradesh

Length 2.47 mm	Width 0.985 mm	Magnification 3.2x

8. *Prionocyphon,* ventral view, River Ganga at transmission tower upstream of Tribeni, West Bengal

Length 4.77 mm	Width 1.39 mm	Magnification 2.0x

9. *Prionocyphon,* dorsal view, River Ganga at transmission tower upstream of Tribeni, West Bengal

Length 4.77 mm	Width 1.39 mm	Magnification 2.0x

10. *Hyphydrus,* dorsal view, Dhonighat downstream Kanpur, Uttar Pradesh

Length 4.67 mm	Width 2.71 mm	Magnification 1.6x

11. *Hyphydrus,* ventral view, Dhonighat downstream Kanpur, Uttar Pradesh

Length 4.67 mm	Width 2.71 mm	Magnification 1.6x

12. *Nipponhydrous,* dorsal view, Mirzapur downstream, after confluence of two drains, Uttar Pradesh

Length 3.38 mm	Width 1.60 mm	Magnification 2.5x

13. *Nipponhydrous,* ventral view, Mirzapur downstream, after confluence of two drains, Uttar Pradesh

Length 3.38 mm	Width 1.60 mm	Magnification 2.5x

14. *Rhantus,* dorsal view, Bridge at Ghatiaghat, Farukhabad, Uttar Pradesh

Length 10.53 mm	Width 5.83 mm	Magnification 1.0x

15. *Rhantus,* ventral view, Bridge at Ghatiaghat, Farukhabad, Uttar Pradesh

Length 10.53 mm	Width 5.83 mm	Magnification 1.0x

16. *Rhantus,* ventral view, Bridge at Ghatiaghat, Farukhabad, Uttar Pradesh

Length 3.93 mm	Width 2.15 mm	Magnification 2.0x

17. *Rhantus,* dorsal view, Bridge at Ghatiaghat, Farukhabad, Uttar Pradesh

Length 3.93 mm	Width 2.15 mm	Magnification 2.0x

18. *Hydrovatus,* dorsal view, Barrage at Narora, Uttar Pradesh

Length 3.71 mm	Width 2.15 mm	Magnification 2.0x

19. *Hydrovatus,* ventral view, Barrage at Narora, Uttar Pradesh

Length 3.71 mm	Width 2.15 mm	Magnification 2.0x

20. *Oreodytes larva,* Barawali Railway & Road Bridge, Uttar Pradesh

Length 6.75 mm	Width 1.29 mm	Magnification 1.6x

21. *Oreodytes larva,* ventral view, Barawali Railway & Road Bridge, Uttar Pradesh

Length 6.75 mm	Width 1.29 mm	Magnification 1.6x

22. *Deronectes larva,* dorsal view, Bridge on Allahabad Bypass, Uttar Pradesh

Length 7.51 mm	Width 1.79 mm	Magnification 1.25x

23. *Deronectes larva,* ventral view, Bridge on Allahabad Bypass, Uttar Pradesh

Length 7.51 mm	Width 1.79 mm	Magnification 1.25x

24. *Deronectes larva,* dorsal view, Barrage at Narora, Uttar Pradesh

Length 8.36 mm	Width 1.39 mm	Magnification 1.25x

25. *Deronectes larva,* ventral view, Barrage at Narora, Uttar Pradesh

Length 8.36 mm	Width 1.39 mm	Magnification 1.25x

26. *Hydrovatus larva,* ventral view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 7.39 mm	Width 1.69 mm	Magnification 1.25x

27. *Hydrovatus larva,* dorsal view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 7.39 mm	Width 1.69 mm	Magnification 1.25x

28. *Cybister larva,* lateral view, River Gomti at Rajwari, Uttar Pradesh

Length 25.04 mm	Width 2.44 mm	Magnification 0.75

29. *Cybister larva,* anterior view, River Gomti at Rajwari, Uttar Pradesh

Length 25.04 mm	Width 2.44 mm	Magnification 0.75

30. *Cybister larva,* dorsal view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 14.66 mm	Width 1.33 mm	Magnification 0.75x

31. *Cybister larva,* ventral view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 14.66 mm	Width 1.33 mm	Magnification 0.75x

32. *Dytiscus,* antero-dorsal view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 26.1 mm	Width 13.9 mm

33. *Dytiscus,* antero- ventral view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 26.1 mm	Width 13.9 mm

34. *Dytiscus,* ventral view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 26.1 mm	Width 13.9 mm

35. *Dytiscus,* dorsal view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 26.1 mm	Width 13.9 mm

36. *Laccophilus,* dorsal view, Bridge at Ramnagar Road near Varanasi, Uttar Pradesh

Length 4.24 mm	Width 1.99 mm	Magnification 2.0x

37. *Laccophilus,* ventral view, Bridge at Ramnagar Road near Varanasi, Uttar Pradesh

Length 4.24 mm	Width 1.99 mm	Magnification 2.0x

38. *Orectochilus,* dorsal view, Bridge SH-98 at Varanasi, Uttar Pradesh

Length 9.21 mm	Width 3.33 mm	Magnification 1.25x

39. *Orectochilus,* ventral view, Bridge SH-98 at Varanasi, Uttar Pradesh

Length 9.21 mm	Width 3.33 mm	Magnification 1.25x

40. *Haliplus,* dorsal view, Barawali Railway & Road Bridge, Uttar Pradesh

Length 2.77 mm	Width 1.64 mm	Magnification 2.5x

41. *Haliplus,* ventral view, Barawali Railway & Road Bridge, Uttar Pradesh

Length 2.77 mm	Width 1.64 mm	Magnification 2.5x

42. *Haliplidae larva,* Tarighat downstream Ghazipur, Uttar Pradesh

Length 13.62 mm	Width 2.92 mm	Magnification a- 0.75x

43. *Haliplidae larva,* Tarighat downstream Ghazipur, Uttar Pradesh

Length 13.62 mm	Width 2.92 mm	Magnification b – 1.0x

44. *Haliplidae larva,* Tarighat downstream Ghazipur, Uttar Pradesh

Length 13.62 mm	Width 2.92 mm	Magnification c – 3.2x

45. *Helophorus,* River East Kali before confluence to River Ganga

Length 5.14 mm	Width 2.78 mm	Magnification 1.6x

46. *Helophorus,* River East Kali before confluence to River Ganga

Length 5.14 mm	Width 2.78 mm	Magnification 1.6x

47. *Helochares,* dorsal view, Dhonighat downstream Kanpur, Uttar Pradesh

Length 3.23 mm	Width 1.44 mm	Magnification 2.0x

48. *Helochares,* ventral view, Dhonighat downstream Kanpur, Uttar Pradesh

Length 3.23 mm	Width 1.44 mm	Magnification 2.0x

49. *Helochares larva,* ventral view, Bridge at Ramnagar Road near Varanasi, Uttar Pradesh

Length 10.16 mm	Width 2.29 mm	Magnification 1.25

50. *Helochares larva,* dorsal view, Bridge at Ramnagar Road near Varanasi, Uttar Pradesh

Length 10.16 mm	Width 2.29 mm	Magnification 1.25

51. *Hydrophilus* dorsal view, River East Kali B/C to River Ganga

Length 3.59 mm	Width 1.79 mm	Magnification 2.5x

52. *Hydrophilus* ventral view, River East Kali B/C to River Ganga

Length 3.59 mm	Width 1.79 mm	Magnification 2.5x

53. *Berosus larva,* dorsal view, Dhonighat downstream Kanpur, Uttar Pradesh

Length 6.77 mm	Width 1.84 mm	Magnification 1.25x

54. *Berosus larva,* ventral view, Dhonighat downstream Kanpur, Uttar Pradesh

Length 6.77 mm	Width 1.84 mm	Magnification 1.25x

55. *Berosus,* dorsal view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 8.72 mm	Width 4.67 mm	Magnification 1.0x

56. *Berosus,* ventral view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 8.72 mm	Width 4.67 mm	Magnification 1.0x

57. *Berosus,* dorsal view, Mirzapur downstream, after confluence of two drains, Uttar Pradesh

Length 8.67 mm	Width 4.58 mm	Magnification 0.75x

58. *Berosus,* ventral view, Mirzapur downstream, after confluence of two drains, Uttar Pradesh

Length 8.67 mm	Width 4.58 mm	Magnification 0.75x

59. *Amphiops,* (doubtful), dorsal view, Mirzapur downstream, after confluence of two drains, Uttar Pradesh

Length 5.44 mm	Width 4.03 mm	Magnification 1.6x

60. *Amphiop,* (doubtful), ventral view, Mirzapur downstream, after confluence of two drains, Uttar Pradesh

Length 5.44 mm	Width 4.03 mm	Magnification 1.6x

61. *Neohydrocoptus,* dorsal view, Saloni River at Sakurtal Ghat

Length 2.58 mm	Width 1.23 mm	Magnification 4.0x

62. *Neohydrocoptus,* ventral view, Saloni River at Sakurtal Ghat

Length 2.58 mm	Width 1.23 mm	Magnification 4.0x

63. *Noterus,* dorsal view, Bridge on River Yamuna, MDR, 26B, near Rajapur, Uttar Pradesh

Length 3.98 mm	Width 2.10 mm	Magnification 2.0x

64. *Noterus,* ventral view Bridge on River Yamuna, MDR, 26B, near Rajapur, Uttar Pradesh

Length 3.98 mm	Width 2.10 mm	Magnification 2.0x

65. *Hydrocoptus,* dorsal view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 3.79 mm	Width 1.98 mm	Magnification 2.5x

66. *Hydrocoptus,* ventral view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 3.79 mm	Width 1.98 mm	Magnification 2.5x

67. *Eulichadidae larva,* dorsal view, Bridge on River Yamuna, MDR, 26B, near Rajapur, Uttar Pradesh

Length 13.60 mm	Width 2.94 mm	Magnification 1.0x

68. *Eulichadidae larva,* ventral view, Bridge on River Yamuna, MDR, 26B, near Rajapur, Uttar Pradesh

Length 13.60 mm	Width 2.94 mm	Magnification 1.0x

69. *Hister,* dorsal view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 1.89 mm	Width 1.83 mm	Magnification 3.2x

70. *Hister,* ventral view, Tarighat downstream Ghazipur, Uttar Pradesh

Length 1.89 mm	Width 1.83 mm	Magnification 3.2x

71. *Hister,* dorsal view, Mirzapur downstream, after confluence of two drains, Uttar Pradesh

Length 3.09 mm	Width 2.34 mm	Magnification 2.0x

72. *Hister,* ventral view, Mirzapur downstream, after confluence of two drains, Uttar Pradesh

Length 3.09 mm	Width 2.34 mm	Magnification 2.0x

73. *Echinocnemus,* dorsal view, River Ganga downstream of FTPS Farakka, West Bengal

Length 4.08 mm	Width 2.11 mm	Magnification 1.6x

74. *Echinocnemus,* ventral view, River Ganga downstream of FTPS Farakka, West Bengal

Length 4.08 mm	Width 2.11 mm	Magnification 1.6x

75. *Echinocnemus,* dorsal view, River Ganga upstream of Jiaganj, West Bengal

Length 5.77 mm	Width 2.22 mm	Magnification 1.6x

76. *Berosus,* dorsal view, River Ganga at Anupshahar downstream confluence of STP outlet at upstream of Mokshdham shavdahgrah, Uttar Pradesh

77. *Berosus,* ventral view, keeled sternum, River Ganga at Anupshahar downstream confluence of STP outlet at upstream of Mokshdham shavdahgrah, Uttar Pradesh

Length 3.63 mm	Width 1.56 mm	Magnification 2.5x

78. *Hydaticus,* dorsal view, River Ganga at Anupshahar downstream confluence of STP outlet at upstream of Mokshdhamshavdahgrah, Uttar Pradesh

Length 10.03 mm	Width 4.99 mm	Magnification 1.0x

79. *Hydaticus,* ventral view, adhesion disc on tarsus of fore legs of male, River Ganga at Anupshahar downstream confluence of STP outlet at upstream of Mokshdhamshavdahgrah, Uttar Pradesh

80. *Hydaticus,* tarsus of fore leg of female, River Ganga at Anupshahar downstream confluence of STP outlet at upstream of Mokshdhamshavdahgrah, Uttar Pradesh

81. *Hydaticus,* male and female, River Ganga at Anupshahar downstream confluence of STP outlet at upstream of Mokshdhamshavdahgrah, Uttar Pradesh

82. *Halochares* larva, *R*iver Ganga at Anupshahar downstream confluence of STP outlet at upstream of Mokshdhamshavdahgrah, Uttar Pradesh

Length 3.13 mm	Width 1.61 mm	Magnification 2.5x

83. *Orectochillus,* ventral view, River Ganga at Kahalgaon and bridge on River Ghaghra near Manjhi, Bihar

Length 13.11 mm	Width 1.8 mm	Magnification 0.75x

84. *Orectochillus* larva, River Ganga at Kahalgaon and bridge on River Ghaghra near Manjhi, Bihar

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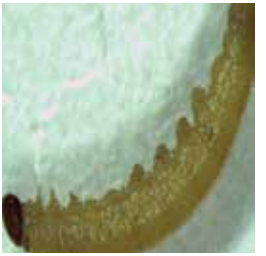

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Plate 17

1. *Simulium,* River Alaknanda after confluence River Mandakini downstream Rudraprayag, Uttarakhand.

Length 3.7 mm	Width 0.561 mm	Magnification 2.0x

2. *Antocha,* River Ganga at upstream Rishikesh, Luxmanjhula, Uttarakhand.

Length 6.0-7.78 mm	Width 0.934-1.0 mm	Magnification 1.25x

3. *Tanypodinae,* Madhya Ganga Barrage Uttar Pradesh

Width 4.87 mm	Length 0.523mm	Magnification 2.0x

4. *Chironominae,* Barawali Railway & Road Bridge, Uttar Pradesh

Length 10.08 mm	Width 0.781 mm	Magnification 1.6 x

5. *Orthocladiinae,* Saloni River at sukartal Ghat, Uttar Pradesh

Length 10.22 mm	Width 0.508 mm	Magnification 1.25x

6. *Musca domestica larva,* Madhya Ganga Barrage, Uttar Pradesh

Length 5.03 mm	Width 0.934 mm	Magnification 2.0x

7. *Mansonia larva,* Bridge Ghat Road Bridge NH-24, Garhmukteshwar, Uttar Pradesh

Length 5.60 mm	Width 0.840 mm	Magnification 1.6x

8. *Anopheles larva,* Bridge 2 at Kanpur-2 at NH-25, Uttar Pradesh

Length 6.66 mm	Width 0.646 mm	Magnification 1.25x

9. *Culex pupa,* River Ganga Bridge at Ghatiaghat, Farukhabad, Uttar Pradesh

Length 6.72 mm	Width 0.843 mm	Magnification 1.6x

10. *Culex pupa,* River Ganga Bridge at Ghatiaghat, Farukhabad, Uttar Pradesh

Length 6.72 mm	Width 0.843 mm	Magnification 1.6x

11. *Culex pupa,* River Ganga Bridge at Ghatiaghat, Farukhabad, Uttar Pradesh

Length 6.72 mm	Width 0.843 mm	Magnification 1.6x

12. *Culex larva,* Bridge Ghat Road Bridge NH-24, Garhmukteshwar, Uttar Pradesh

Length 5.63 mm	Width 0.843 mm	Magnification 1.6x

13. *Malaya larva,* Bridge on River Varuna in Varanasi, Uttar Pradesh

Length 5.41 mm	Width 0.890 mm	Magnification 1.25x

14. *Nymphomyia,* River Ramganga SH-29, Uttar Pradesh

Length 13 mm	Width 2.0 mm	Magnification 1.0x

15. *Nymphomyia,* River Ramganga SH-29, Uttar Pradesh

Length 13 mm	Width 2.0 mm	Magnification 1.0x

16. *Nymphomyia,* River Ramganga SH-29, Uttar Pradesh

Length 13 mm	Width 2.0 mm	Magnification 1.0x

17. *Nemotelus,* River Ramganga SH-29, Uttar Pradesh

Length 9.05 mm	Width 1.64 mm	Magnification 1.25x

18. *Tabanus,* Bridge at Anupshahar, Uttar Pradesh

Length 4.84 mm	Width 1.04 mm	Magnification 1.0x

19. *Tabanus,* Anterior view, Bridge at Anupshahar, Uttar Pradesh

Length 13.30 mm	Width 2.76 mm	Magnification 0.75x

20. *Tabanus,* Posterior view, Bridge at Anupshahar, Uttar Pradesh

Length 13.30 mm	Width 2.76 mm	Magnification 0.75x

21. *Eristalis sp.,* Tarighat downstream Ghazipur, Uttar Pradesh

Length 9.66 mm	Width 3.72 mm	Magnification 0.75x

22. *Ephydra pupa,* River Ganga upstream of Tribeni, West Bengal

Length 3.95 mm	Width 1.20 mm	Magnification 1.25x

23. *Psychoda,* River Ganga at transmission tower upstream of Tribeni, West Bengal

Length 8.63 mm	Width 2.95 mm	Magnification 1.25x

24. *Psychoda,* River Ganga downstream Haridwar JSTP, Uttarakhand

Length 12.30 mm	Width 0.953 mm	Magnification 1.0x

25. *Psychoda,* River Ganga downstream Haridwar JSTP, Uttarakhand

Length 12.30 mm	Width 0.953 mm	Magnification 1.0x

26. *Psychoda,* River Ganga downstream Haridwar JSTP, Uttarakhand

Length 12.30 mm	Width 0.953 mm	Magnification 1.0x

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Plate 18

1. *Paraponyx diminutalis,* River Gomti at Rajwari in Uttar Pradesh

Length 8 mm	Width 2 mm

2. *Nymphula,* Downstream Bridge Mahatma Gandhi right bank, Patna, Bihar

Length 15 mm	Width 3 mm

3. *Elophila,* River Ganga at Palta Water Intake (D/s of Kolkatta), West Bengal

Length 6 mm	Width 1 mm

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Plate 19

1. *Alboglossiphonia weberi,* Gandhi Ghat near NIT Patna,Bihar

Length 2.48 mm	Width 1.50 mm

2. *Hemiclapsis japonica,* Barrage at Narora, Uttar Pradesh

Length 2.45 mm	Width 1.33 mm

3. *Barbronia weberi,* River Ganga at transmission tower U/S of Tribeni, West Bengal

Length 6.92 mm	Width 1.63 mm

Plate 20

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Plate 20

1. *Namalycastis fauveli,* Chinsura in West Bengal

Length 35.67 mm	Width 0.744 mm

2. *Namalycastis sp.,* Ghat downstream of Srirampore (upstream of Kolkata), West Bengal.

Length 35.67-39.07 mm	Width 0.744-1.54 mm	Magnification 0.75x

3. *Namalycastis sp.,* Ghat downstream of Srirampore (upstream of Kolkatta), West Bengal.

Length 35.67-39.07 mm	Width 0.744-1.54 mm	Magnification 0.75x

4. *Namalycastis sp.,* Ghat downstream of Srirampore (upstream of Kolkatta), West Bengal.

Length 35.67-39.07 mm	Width 0.744-1.54 mm	Magnification0.75x

5. *Namalycastis indica,* River Ganga at transmission tower upstream of Tribeni, West Bengal

Length 8.06 mm	Width 1.09 mm

6. *Dendronereides heteropoda,* Chinsura in West Bengal

Length 20.13 mm	Width 1.09 mm

7. *Nerieis chilkaensis Chinsura* in West Bengal

Length 23.02 mm	Width 1.21 mm

8. *Nephthys polybranchia,* Tarighat downstream Ghazipur, Uttar Pradesh

Length 25 mm	Width 1.20 mm	Magnification 1.0x

9. *Nephthys polybranchia,* Tarighat downstream Ghazipur, Uttar Pradesh

Length 25 mm	Width 1.20 mm	Magnification 1.0x

10. *Nephthys polybranchia,* Tarighat downstream Ghazipur, Uttar Pradesh

Length 25 mm	Width 1.20 mm	Magnification 1.0x

11. *Nephthys polybranchia,* Tarighat downstream Ghazipur, Uttar Pradesh

Length 25 mm	Width 1.20 mm	Magnification 1.0x

12. *Nephthys oligobranchia,* Raghunathganj, West Bengal

Length 24.41 mm	Width 1.41 mm

13. *Manayunkia / Brandtika,* radiating crown on head, River Ganga at Kahalgaon, Kastarnighat upstream of Munger and Sultanganj upstream Bhagalpur, Bihar

14. *Namalycastis fauveli.* River Ganga downstream of Rajmahal, Jharkhand.

Length 31.18 mm	Width 1.35 mm	Magnification 0.75 x

15. *Manyunkia/Brandtika.* River Ganga at Kahalgaon, Bihar.

Length 14.39 mm	Width 1.75 mm	Magnification 1.0 x

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Plate 21

1. *Dendrodrilus rubidus,* River Saloni at Sukartal Ghat in Uttar Pradesh

Length 25.02 mm	Width 3.12 mm

2. *Eiseniella teraedra tetraedra* Downstream of FTPS Farakka in West Bengal.

Length 37.73 mm	Width 1.97 mm

3. *Aulophorus hymanae* Downstream of Murshidabad in West Bengal

Length 14.38 mm	Width 0.794 mm

4. *Brachiura sowerbyi* River Saloni at Sukartal Ghat in Uttar Pradesh

Length 25mm	Width 1.09 mm

5. *Brachiura sowerbyi* River Kali at Kanpur-Farrukhabad road, near bridge in Uttar Pradesh

Length 17.29 mm	Width 1.26 mm

6. *Branchiodrilus semperi* Kanpur 2 near bridge 2 on NH 25

Length 17.29 mm	Width 1.26 mm

7. *Limnodrilus hoffmienseri* Nalla in Patna 3b, Bihar

Length 20.38 mm	Width 0.599 mm

8. *Limnodrilus udekemianus* Upstream of Narora near bridge, Uttar Pradesh

Length 24.62 mm	Width 0.481 mm

9. *Limnodrilus udekemianus* River Ramganga SH-29, Moradabad, Uttar Pradesh

Length 19.12 mm	Width 0.365 mm

10. *Limnodrilus udekemianus* river Ramganga downstream of Moradabad, Uttar Pradesh

Length 32.58 mm	Width 0.738 mm

11. *Bothrioneurum vejdovskyanum* Varanasi, near bridge NH-2, Uttar Pradesh

Length 31.81 mm	Width 0.701 mm

12. *Lumbriculus variegatus,* live specimen, River Ganga at Narora barrage downstream, Narora, Uttar Pradesh

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Plate 22

1. *Dugesia sp.,* River Ganga at Diamond Harbor, West Bengal

Length 10.68 mm	Width 4.06 mm

Plate 1: BIVALVIA	
Family Corbiculidae	Periostracum : A proteinaceous thin pigmented layer of the shell in Molluscs. Striae: Thin, narrow grooves or channels, or a thin line or band especially if several of them are parallel or close together (in bivalve shell) Lotics: Running fast flowing water.
Family Amblemidae	Furcated pseudocardinal teeth: Teeth divided into two or more branches, located on anterior part of Bivalvia shell. Umbones: A knoblike protuberance arising from a surface as the prominence near the hinge of a bivalve shell.
Family Sphaeriidae	Midhill: mid-hills include deep river valleys well below 1000m, while the nearby ridge tops may rise to more than 3000m.

Plate 2,3: GASTROPODA	
Family Viviparidae	Operculum: A secreted plate like structure that close the aperture of a gastropod shell when the animal is retracted Horney: Horn like or calcareous matter. MSL: Mean Sea Level
Family Thiaridae	Brood pouch : A pouch in which eggs/embryo brood in the gastropod Turreted (long and narrow): Gastropod shell having the shape of a long spiral.
Family Assimineidae	Prosobranche: Gastropods having gills in front of the heart.
Family Septaridae	Lithal: Stick to stones and gravels.
Family Neritidae	Macrophytes: An aquatic plant growing in or near water and is either emergent, submerged or floating, provides cover for fish and substrate for aquatic invertebrates.

Family Planorbiidae	Carinate: Having a shape like keel or carina
Family Physidae	Synistral: When shell is held with spire pointing up and the aperture facing the viewer, then the aperture is on the left-hand side. Spiralled: Shell structure wounded in a continuous series of loops.
Family Onchidiidae	Hypopotamon: – Lower ranges of river with brackish water (except estuary). Biocoenotic: Interacting organisms living together in a habitat.

Plate 4,5,6,7,8 CRUSTACEA

CRUSTACEA	Antennule: First antennae situated on head, sensory organ. Antennae: Second antennae situated on head, sensory organ. Mandible: Chewing mouthpart situated on head, or jaws used for crushing or grinding intake food particles. Maxillae: One or two pairs of accessary jaws situated on head, used for chewing and shredding food particles. Maxilliped: Usually 0 to 3 pairs situated on thorax. Used for manipulating food particles. Pereopod: They are as many as five pairs of walking legs situated on thorax. Used for clinging. Pleopod: Situated on abdomen. Used for respiration, swimming, holding offspring Uropod: Known as tail fan. Situated on last abdominal segment (Telson). Used to escape and for protection.
Family Palaemonidae	Pereiopods: Anterior 5 pair of legs in a decapods crustacean used for walking, swimming, feeding and fighting. Appressed scales: Scales pressed closely against or lying flat against something. Glabrous: Free from hair or down; smooth.

	Telson: The posterior-most division of the body of a crustacean (Arthropod). Tuberculate: Having tubercles (Small mounds on surface) Spinules: Spinules are small spines or thorns part of body structure. Preanal carina: A rigid keel protruding from the ventral midline of the abdominal somite. Post antennular: Structure placed on anterior part of body, present after antennae
Family Atyidae	Scaphocerite : A flattened plate or scale like structure attached to the second joint of the antennae in many crustaceans. Stylocerite: A spine like structure arising from the lateral margin of the first segment of the antennular peduncle in shrimps. Antennular peduncle: Proximal segments of antennules from which flagella arise. Appendix interna,: Slender, rod like structure on mesial border of endopod of second through fifth pleopods of Atyidae. Endopod: The internal or principal branch of the locomotive appendages of Crustacea. Uropodal diaeresis: Transverse groove across outer branch of uropod (Posterior appendages). Dactylus: Terminal segment of a typically segmented appendage (Perepod). Flexor margin: The inner or shorter margin of a flexed appendage.
ORDER MYSIDACEA	Peripheral invaders: – Species which inhabit a river system as invaders (not native).
Family Mysidae	Hypopotamon: Lower ranges of river with brackish water (except estuary).
ORDER DECAPODA	Phytotelms: A habitat in water standing in a plant (e.g. Pitcher plants, macrophytes etc.)

Family Potamidae	Maxillipedes : An appendage modified for feeding, situated in pairs behind the maxillae. Merus: Fourth segment of a crustacean appendage (Thoracopod) from distal end from body, positioned between ischium and carpus, sometimes called arm of cheliped. Pterygostomial: Anteroventral region of carapace, bearing pterygostomial spine. Glabrous: Free from hair or down; smooth Pleopod: An appendage of any of the first five abdominal segments, serves as copulatory structure in male and egg-brooding structure in female. Pectinated: Having narrow ridges or projections aligned close together like the teeth of comb. Exopod: – Outer branch (ramus) of biramous (bifurcate) appendage. Striae: Type of vale structure, very fine grooves. Punctae: Small, circular pit-like depressions. Epi: Placed over or above a certain structure Gonopod: Typically refers to first or second pleopod of male modified for reproductive activity. Flagellum: – Distal of two divisions (peduncle, flagellum) of antennules or antenna. Typically paired in former and unpaired in the latter. Epigastric cristae: Folds of membranes/cuticle in epigastric region.
Family Parathelphusidae	Subcylindrical: A structure which is not a perfect cylinder but approximates a cylinder. Bilobed: Composed of two lobes Epistome: Relatively large, plate-like structure in front of mouth on underside of head. May be divided into more narrow anterior part extending between antennae and broader posterior portion (endostome). Branchial: Structure or conditions pertaining to gills
Family Varunidae	Squarish: Somewhat square in form or appearance. Dentiform: Tooth like structure. Anteroexternal: Situated in front and on the outer side.

Family Sesarmidae	Setose ridge : Hairy or bristles like ridges Basal antennular segment: The segment of antennae attached to head Chitinous: Made of chitin which is a resistant complex chemical compound, the chief constituent of exoskeleton or shell of crustaceans.
Family Gecarcinucidae	Undiscernible: Not perceptible, not distinguishable Subparallel: Diverging or converging slightly; almost parallel. Posterolateral: In decapod, relatively small region along each posterolateral margin of carapace.
Family Cirolanidae	Uropods: The paired biramous appendages of the isopod pleotelson, representing the appendages of the fused sixth pleonite. Anterolaterally: placed in front-side of a structure Anteroventrally: – Relates to the underside of the front of the head. Pleotelson: Structure formed by fusion of one or more abdominal somites with telson. Styliform: – A dactylar segment terminating to a narrow pointed apex. Exopod: – Outer branch (ramus) of biramous (bifurcate) appendage. Pleon: Abdominal body division, usually comprising five somites and often bearing biramous pleopods. Pleonites: A segment of the pleon (abdominal somite) Pereopods: A thoracic appendage used for movement, feeding, and defense. Tridentate: With three denticles (teeth).
Family Cymothoidae	Prehensile : Appendages (usually pereopods) adapted for holding or clinging Dactylus: Terminal segment of a typically segmented appendage (Perepod).
Family Corrallanidae	Ambulatory: Locomotory in use. Uni-or bidentate,: single or two denticles Articulating: Forming a joint with other structure

Plate 9: EPHEMEROPTERA

ORDER EPHEMEROPTERA	Nymph: The immature form of an insect which undergoes gradual metamorphosis before reaching its adult stages.
Family Baetidae	Hypognathous: Shape of head seahorse-like. Prognathus: Head with mouthparts projecting forward horizontally to a marked degree. Cerci (singular circus) : Paired appendages on the rear most segment of insect. Obovate gill : Gill shaped like an egg, with narrow end at the base. Lanceolate gill : Gill shaped like a lance head, i.e. Tapering to a point at the apex and at the base. Rheotropic: Denticles: A small tooth like projection. Palmate gill : Gill with filaments resembling a hand with fingers outspread. Mesal : Median plane of the body or part or towards the mid point or midline plane.
Family Leptophlebiidae	Paracercus: Terminal filament lying between a pair of cerci.
Family Caenidae	Operculate: Gill covered with hard body flap covering of Operculum: Hard bony flap covering and protecting the gill. Quadrate: Being square or approximately square. Vestigial:Relating to a body part that has become small and lost its use because of evolutionary change. Palpi : Each of a pair of elongated segmental appendages near the mouth of an arthropod, usually concerned with the senses of touch and taste.
Family Ephemeridae	Mandibles: A pair of appendages near the mouth of an insect used for chewing food. Maxilla: A pair of structures near the mandibles used for testing and manipulating food.

	Fossorial: Fossorial is a phrase used to describe the legs of some insects and other invertebrates that are modified for digging. The fore limbs are enlarged and powerful and well adopted for digging. Lanceolate: Shaped like a lance head, of a narrow oval shape tapering to a point at each end. Mesonotum: Mesonotum is the dorsam of the mesothorax, which is well developed and forms most of thorax in insecs. The mesonotum includes the scutum, notopleura, scutellum and post notum. Non-spuriferous: Without dense setae. Flagellae:A flellum is a whip-like structure that allows a cell to move. Flegella are used for locomotion. Mandibular tusk: Mandibular tusk are triangular in cross section and almost knife-like, a highly convex labrum and a markedly truncated frontal process on the head. The shape of mandibular tusks with tubercles and setae may be curved inword,with rather smooth inner edges. Tusks may be slender with setae and small tubercles, broad and flat tusk which are strongly toothed closed to the apex. Mandibular tusk is used to burrow and feed within the stream substrata using filtering setae.
Family Heptageniidae	Terga: These basically are the dorsal portion of body segment other than head. A turgum is the dorsal portion of an arthropod segment other than head. The anterior edge is called the base and posterior edge is called the apex or margin.
Family Siphlonuridae	Posterolateral:Situated on the side and toward the posterior aspect. Pectinate spines: Having the appearance of parallel teeth, comblike spines, comb of maxilla with 8-10 pectinate spines. Having projections resembling the teeth of a comb. Prognathus

Family Ephemerellidae	Semi-operculate:Operculate gill semi oval in shape. Posterio-median:Called also dorsal median.

Plate 10: PLECOPTERA

Family Perlidae/ Acroneuridae	Ocelli.: Simple eye or eye spot. Two distinct ocellus types exist: dorsal ocelli (or simply "ocelli"), found in most insects, and lateral ocelli (or stemmata), which are found in the larvae of some insect orders.

Plate 11: TRICHOPTERA

ORDER TRICHOPTERA	Sclerotization: A hard chitinous plate which makes up the exoskeleton of an arthropod. Pro-, meso- and meta- nota: The thorax consists of three segments known as the pro-, meso- and meta-thoracic segments. In most insects all three segments bear a pair of legs. Clypeus: The circular plate on the head above the labium and below the frons.
Family Hydropsychidae	Appressed: pressed closely against or fitting closely to something. the two cords can be closely appressed to one another. Ventrolateral: situated towards the junction of the ventral and lateral sides. Genae: Genae seperates the ventral apotome from the middle. Larvae with ventral apotome of head separating genae entirely or almost. Apotome: The ventral region of head. Yellow ventral apotome funnel-shaped with postgenal suture reaching approximately 29% of apotome length Ecdysal line: Antennae outside the Y shaped line, or antennae inside any Y shaped epicranial ecdysal line. Trochantin: The second segment of the leg, between the coxa and the femur. Sternum: The central portion of the segment is known as strernum. Prosternal: Prosternal (front chest) horn present, Prosternum: Prosternum with prosternal horn

	Frontoclypeus: Different shapes of cephalic capsule occupying most of the dorsal part of head. Anteromedial: Located in front and toward the middle.
Family Leptoceridae	Labrum. Structure extending between mouthparts. T-shaped and membranous. Mesal cavity: Anterior or mesal edge of eye or something. mesl excision: Mesal insertion Spinous: covered with or having spines; thorny, spinous pad present on fore coxae, claws on forelegs

Plate 12,13,14: ODONATA

ORDER ODONATA	Protrudable mask: modified lower lip used to catch the prey.
SUB ORDER Anisoptera	Epiproct: One middle single pointed extremities present at the end of abdomen. Paraproct: A pair of pointed extremities present behind paraproct. Bigger than paraproct. Cerci: A pair of pointed extrimities on the sides of paraproct. Smaller than paraproct.
Family Gomphidae	Mentum: The median basal structure of the labium called mentum. Median cleft: Mentum sometimes has a median cleft or indentation in the anterior margin of its prementum. Pre-mentum: The anterior part of the insect labium lying in front of the mentum and bearing a pair of lobes. Palpal lobe: Palpal lobes are mask- or bowl-shaped; setae usually occur on the mentum.
Family Libellulidae	Labium: A fused mouthpart which forms the floor of the mouth of an odonate. A diagnostic character for separating families. Labial palps: Labial palp is inserted at a base of anterolateral sides of the widest point of prementum.

	Movable hooks: At the anterior or anterolateral angle of the labial palp is a spine-like structure called the movable hook. A row of strong setae are usually located between this hook and the base of palp. Ligula: An anterior extension of the prementum called Lingula and a pair of extendable labial palp. Crenations: Any of the rounded teeth or the notches between them on a crenate structure.
Family Macromiidae	Metasternum: The ventral plate of the third or last segment of the thorax.
SUB ORDER Zygoptera	Caudal filaments: At the posterior end of the abdomen, are two or three caudal filaments, two cerci plus. A vestigial or well-developed median terminal filament.
Family Euphaeidae	Triquetral: Three dimensional structure. Saccoid: Ballon –shaped gills.
Family Ceonagrionidae	Subquardate: Nearly or approximately square; almost square. Subtruncate: Almost truncate i.e. square or broad at the end, as if cut off transversely.

Plate 15: HEMIPTERA

Family Belostomatidae	Metathoracic: The posterior division of the thorax of an insect, bearing the third pair of legs and the second pair of wings.
Family Naucoridae	Pronotum:The dorsal sclerite of the prothorax of an insect. Interocular: Being, or situated, between the eyes. Gula: The upper part of the throat or gullet. Tumid: Swollen, or affected with swelling, as a part of the body. Tectiform: Having the shape of a roof.
Family Nepidae	Scutulum :A small plate, scutum, or other shield like part, as on the thorax of insects. Para-sternites: Anterior margins of sternite 9 are well sclerotized and together forms parasternite. Subgenital: Posterior or interior to, or beneath the genitalia

	Spiracle :A breathing pore or aperture. Spiracles are paired, lateral holes in the plural (side) wall of insect body segments and are the means by which air enters the tracheal (respiratory) system.
Family Corixidae	Sulcate: having long, narrow grooves or channels Palae : Specialized front tarsi. Embolar : Groove/ Embolum is a narrow piece on the sostal margin of the corium of the wings of certain true bugs. Pruina : A specialized covering like frost which can be removed easily. Unicolorous : Having a single colour/ surface with uniform colour. Strigil: A curved structure at the apex of the fore tibia of many insects that functions as a scraper, a tibial comb orantenna cleaner Vermiculation- Resembling a worm, or having tracery simulating the tracks of a worm. Tarsomere: A subdivision or segment of the tarsus. Infuscated: Darkened with a fuscous or brownish tinge. Sinistral:of, relating to, or on the left side Dextral: of, relating to, or on the right side.
Family Ranatrinidae	Retractable: Able to be pulled backwords. Filiform: Thread or filament – like. Selenderly: Thinly, delicately, and slightly.
Family Hebridae	Carinae: A keel like part or ridge, especially a ridge of bone on the ventral side of the sternum.
Family Gerridae	Sternite:A sclerite of the sternum of an insect, especially a ventral sclerite of an abdominal segment. Metasternum: The ventral plate of the third or last segment of the thorax of insects. Mesosternum: The ventral piece of the middle segment of the thorax in insects. Metacetabula: Anterior part of ventral margin of anterior meta supra coxae.

Family Hydrometridae	Coxa (Coxae) : The basal segment of the insect leg, by means of which it is attached to the body. Coxae are paired, ventrolateral in position (i.e. attached to the side of the lower surface) and found on each thoracic segment. Medioptergites : A broad convex area on the posterior end of the insect thorax, between the subscutellum and the base of abdomen.

Plate 16: COLEOPTERA

Family Elmidae/ Elmididae/ Elminthidae	Pectinate: Having narrow parallel projections or divisions suggestive of the teeth of a comb. Coxae: The basal segment of the insect leg, by means of which it is attached to the body. Coxae are paired, ventrolateral in position (i.e. attached to the side of the lower surface) and found on each thoracic segment. Prosternum: The ventral sclerite of the prothorax of an insect. Hemicylindrical: Half of a cylinder divided lengthwise. Prothorax: the anterior division of the thorax of an insect, bearing the first pair of legs. Procoxal: the anterior division of the first pair of coxa. Pleuron (pl. Pleura) : The lateral region of any segment of the insect body, usually of the thoracic segments. Trochantin: The usually small second segment of the leg, between the coxa and femur. Striae: A slight or narrow furrow, ridge, stripe, or streak, especially one of a number in parallel arrangement. Pronotum,: The dorsal sclerite of the prothorax of an insect. Sublateral carinae: A keel like part or ridge, especially a ridge of bone towards lateral side on the ventral side of the sternum.

Family Scritidae	Maxillary palpi: Jointed, sensory structure found on the maxillae of an insect. Tergite: The dorsal plate or dorsal portion of the covering of a metameric segment of an arthropod; especially one on the abdomen. Sclerite: A hard chitinous plate which makes up the exoskeleton of an arthropod. Prosternum: The ventral sclerite of the prothorax of an insect. Bilobed: Consisting of or divided into two lobes. Hypopharynx,: Mouthpart. A tongue-like lobe on the floor of the mouth. Mesosternal: The ventral piece of the middle segment of the thorax in insects. Metasternal:The ventral plate of the third or last segment of the thorax of insects.
Family Dytiscidae	Scutulum: A small plate, scutum, or other shield like part, as on the thorax of insects. Assymetrical:Lacking symmetry between two or more like parts; not symmetrical. Emerginate: Nicked; with broken margin. Elytron: - One of the pair of hardened forewings of certain insects, as beetles, forming a protective covering for the posterior or flight wings. Subtriangular: Nearly, but not perfectly, triangular. Lingula:Relating to, or situated near the tongue or a tongue like organ. Fring: That part of the hair overhanging the forehead, Ciliae: Fine hairs along the edges of the wing
Family Gyrinidae	Sternite: A sclerite of the sternum of an insect, especially a ventral sclerite of an abdominal segment. Coaxal: The basal segment of the insect leg, by means of which it is attached to the body. Coxae are paired, ventrolateral in position (i.e. attached to the side of the lower surface) and found on each thoracic segment.

	Mesothorax: The second or middle thoracic segment which bears the middle legs and the anterior wings Episterna: The anterior portion of a Sternum. Epipleura: The anterior portion of a pleuron.
Family Haliplidae	Metacoxae: The coxa that is located on the hind leg. Metafemur: The hind part of the arthropod femur. Sutural : The junction or line of junction of contiguous parts. Stria: A slight or narrow furrow, ridge, stripe, or streak, especially one of a number in parallel arrangement. Epipleuron: The anterior portion of a pleuron. Metasternum: The ventral plate of the third or last segment of the thorax of insects. Unforked: Without fork-like branches.
Family Hydrophilidae	Acrched: An ordinary or partition line formed as a slight curve. Scavanger: An animal or other organism that feeds on dead organic matter. Mesosternum - The ventral piece of the middle segment of the thorax in insects. Metasternum- The ventral plate of the third or last segment of the thorax of insects. Posteromedian: In back and in the central line. Ocelli: The 'simple eye' of many adult insects which consists of a single bead-like lens. Insects may have a single ocellus or they may have a small group of ocelli (up to three). Ocelli may also be absent in some insects. Mesotibia- The middle part of the fourth segment of the leg, between the femur and tarsus. Metatibia- The posterior part of the fourth segment of the leg, between the femur and tarsus. Semiglobular: Possessing the form of half a globe; hemispheric.
Family Noteridae	Foretibia: The anterior part of the fourth segment of the leg, between the femur and tarsus.

	Prosternal: The ventral sclerite of the prothorax of an insect. Metacoxal: The coxa that is located on the hind leg. Appressed: Lying flat or pressed closely against something.
Family Eulichadidae	Ventro-lateral: Both ventral and lateral (that is, to the front and to the side).
Family Histeridae	Tergite: The dorsal plate or dorsal portion of the covering of a metameric segment of an arthropod; especially one on the abdomen
Family Curculionidae	Mentum: The medial plate of the labium in insects. Prosternum: The ventral sclerite of the prothorax of an insect. Procoxae: Laterally a pair of oblique anteriorly diverging ridges Mesoepisternum: The area of the mesopleuron anterior to the mesopleural suture; sometimes divided into an upper mesanepisternum and a lower meskatepisternum; the episternum of the mesothorax.

Plate 17: DIPTERA

Family Simulidae	Prolegs: Many fly larvae have "false legs" (prolegs or pseudopods) similar to those that support the fleshy abdomen of a caterpillar, can have prolegs around any body segment. Prolegs help the larvae crawl through narrow spaces or push through soil. Labral fans: black fly larvae found in fast-flowing (>1.0 m/s) seston-rich (>50 mg/L) water will tend to have strong fans with a porous ray structure, whereas larvae found in slow-flowing (<0.5 m/s) seston-poor (<10 mg/L) water will tend to have weak fans with a complex structure. Different black fly species have different labral fan structures allowing them to use habitats with different current velocities Sclerite: A hard chitinous plate which makes up the exoskeleton of an arthropod. Postgenal cleft: Situated on the posterior side on ventral region of head capsule. Post genal cleft may be narrow, semi rounded.

	Hypostoma: Hypostoma joined to postgenal cleft by postgenal bridge which is as long as hypostoma on the ventral side of head capsule. Hypostoma is strongly pigmented on the anterior margin with nine apical teeth. Hypostomal groove: Hypostoma with1+1 line of five lateral setae and 1+1 short setae parallel to lateral margin and 1+1 or 2+2 short setae in posterior margin of hypostoma near hypostomal groove.
Family Tipulidae	Spiracular disc: Abdominal segment of larvae of diptera are marked with ventral creeping welts, the anal pad, anus, papillae and posterior spiracles. Posterior spiracles are modified from round spiracular discs.
Family Chironomidae	Mentum: The medial plate of the labium in insects, posterior to the mouthparts of larval chironomidae head is a plate which is usually toothed. Ventromental: The lower and more proximal of the two transverse subdivisions of the mentum. The two component of mentum is a double walled plate. A median ventral wall known as ventromedian and a dorsal wall known as dorsomedian that extends more laterally and curved dorsally behind the ventromentum. Premendible: Morphology of head structure includes, antennae, mandibles, mentum, pectin epipharyngis, ventromental plate and premandibles. Premandibles are simple, slightly curved, labial plate or labrum with a pair of bifid spines, with a rounded median and six pair of laterals,median tooth wide and obtuse.
Family Musidae	Spiracular: Any of several tracheal openings in the exoskeleton of an insect or a breathing hole, an opening by which a confined space has communication with air, air hole. Cephalo-pharyngeal: The framework of the pharynx is composed of the cephalo-pharyngeal apineurosis and the petro-pharyngeal aponeurosis. The cephalo-pharyngael of the pharynx arises from the lower surface of the basilar (near the base)process. It descends along the sides of the pharynx and split into bundles.

	intersegmental sclerite: The thoracic terga consisted of three simple segmental plate (nota) between which lay small intersegmental sclerite. Phytotelmata: Phytotelmata are small water bodies within plants that exist as aquatic refugia within a much larger terrestrial ecosystem for example; tree holes, bamboo internodes, pitcher plants and water retaining plant axils.
Family Culicidae	Distad: In a direction away from the body. Relates to the distance like slightly distad to the middle. Comb: Comb may be consisting of scales long and more or less spine –like and some short apically fringed. A group of spines on the leg of an insect used for cleaning other parts of the insect"s body. Pecten: A comb – like structure found at the base of the antenna in some insects. Siphon: A tube –like eighth abdominal segment with external respiratory or breathing apparatus with delicate transparent outline with several sub-dorsal hair tufts. Subventral: A little distad from well below ventral side. Tracheation: Having a tracheal respiratory system. Tacheation and venation of the wing. Cephalad: Towards the anterior part or head end of the body. Subdorsal: A little distad from well above dorsal side.
Family Nymphomyiidae	Postgenal: A sclerite on the posterior lateral surface on ventral region of head capsule. Posterolateral: Posterior side near the base towards lateral side. Sensilla : A simple epithelial sense organ of an invertebrate (as an insect) usually in the form of a spine, plate, rod, cone, or peg that is composed of one or a few cells with a nerve connection Sensilla may be situated on the antenna, maxillary palps and proboscis.

	Glabrous: Having a surface without hairs or projection. Exsertile: Capable of being exerted or produced. Digitiform: Like a finger. Anal papillae: A skin tag that projects up from the junction between the skin and inside the lining of the anus.
Family Stratiomyidae	Tentorial rods: Thin sclerite present in front of eye. Metacephalic rods: An elongate sclerite which extends from the head into the prothorax. Calcarious: Of, containing, or like calcium carbonate, chalky. Bilobed:Consisting of or divided into two lobes. Subapical seta: Preapical scutellar bristle.
Family Tabanidae	Tentorial rods: Thin sclerite present in front of eye. Metacephalic rods: An elongate sclerite which extends from the head into the prothorax. Submental plate: A laminate extension on the surface or one of the margins of submentum.
Family Syrphidae	Spiracular plates: Flattened tip of each tube that bears the posterior spiracles of Syrphidae larvae.
Family Ephydridae	Spinules: Little spines.
Family Psychodidae	Suctorial disc Following types of Trachael spiracles or breathing apparatus can be distinguished. Apneustic: With absence of stigmas (spiracles). Metapneustic : With only one pair of stigma. These are on the abdomen. Amphipneustic: With two pairs of stigmas. One pair on the prothorax, one pair on the abdomen. Holopneustic: With two pairs of thoracic stigmas and eight abdominal pairs.

Plate 18: LEPIDOPTERA

ORDER LEPIDOPTERA	Appasable mandibles: the jaw or a jawbone, especially the lower jawbone in mammals and fishes. Stemmata (ocelli): A simple eye present in certain insect larvae. Adfrontal: Areas from the epicranium. Sclerites laterad: A Chitinous or calcareous plate or similar part of an invertebrate towards the side, especially one of the hard outer plates forming part of the exoskeleton of an arthropod. Frons: The forehead or equivalent part of an animal, especially the middle part of an insect's face between the eyes and above the clypeus.
Sub family Nymphulinae	SD1 seta: Situated on Prothorax of larva. Epicranial suture: The epicranial suture is part of the cranium. The epicranial suture is part of the anatomical system that forms the covering layer of the animal. Adfrontal sclerite: Or adfrontal areas also called adfrontal plates, a pair of narrow oblique plates on the head of Lepidoptera larvae, extending upward from the base of the antennae and meeting medially above. Labrum: a structure corresponding to a lip, especially the upper border of the mouthparts of a crustacean or insect. Sensilla.: simple sense organ of an arthropod or other invertebrate that consists of one cell or a few cells and may take the form of a hair or bristle. Dorsam: Dorsal part of an organism Cupola-shaped: Dome shaped

Plate 19: HIRUDINEA

CLASS HIRUDINEA	Euhirudinid: European Hirudinid Somites: Any of longitudinal series of segments. Preoral: Situated in front of or anterior to the mouth. Non – metameric : absence of several similar segments or somites

	Postoral somites: Situated behind the mouth. Annuli: An eye like spot Plesiomorphic: Applied to a character state that is based on features shared by different groups of biological organisms and inherited from a common ancestor. Papillae: The small projection of tissue at the base of a hair, tooth, or feather Sensilla: sense organ in insects, typically consisting of a receptor organ in the integument connected to sensory neurons. Oculiform spots: Resembling an eye Somites: A number of body segments containing the same internal structures, clearly visible in invertebrates. Piscicolids: Leeches of family Piscicolidae.
Family Glossiphoniidae	Dorsam: The back, The posterior part of animal from the neck to the end. Triannulate: Consisting of three annuli, as certain segments of the body in some species of earthworms. Paramedian: Situated adjacent to the midline Ectoparasite: A parasite, such as a flea, that lives on the outside of its host.
Family Salifidae	Lentic habitat: Stationary or relatively still water, from the Latin lentus, which means sluggish. Midbody somites: A number of body segments containing the same internal structures present in the middle region of the body of organism.

Plate 20: POLYCHAETA

ORDER POLYCHAETA	Parapodia: In Polychaeta worm, each of a number of paired muscular bristle-bearing appendages used in locomotion, sensation, or respiration. Prostomium: The prostomium (sometimes also called the acron) is the first body segment in an annelid worm's body in the anterior end. The portion of the head of an annelid worm (as an earthworm) that is situated in front of the mouth.

Family Nereididae	Posterior cirri: Physiological gills
Family Nephtyidae	Prostomial sensory organs : The prostomium also has appendages such as palps and tentacles or cirri. Some Polychaetes prostomia have a posterior extension called a caruncle. Another sensory organ, called the nuchal organ is a ciliated pit or groove at the posterior end of the prostomium. Parapodial rami: A structure in an invertebrate that has the form of a projecting arm, typically one of two or more that are conjoined or adjacent.

Plate 21: OLIGOCHAETA

CLASS OLIGOCHAETA	Parapodia: Each of a number of paired muscular bristle-bearing appendages used in locomotion, sensation, or respiration. Prostomium: The portion of the head of an annelid worm (as an earthworm) that is situated in front of the mouth.
Family Lumbricidae	Clitellar: A ring or saddle-shaped region of glandular tissue in the body wall of certain annelids, as earthworms and some leeches, that after copulation secretes a cocoon in which the eggs and sperm are deposited for fertilization and development. Lumbricine: An earthworm in the suborder Lumbricina
Family Lumbriculidae	Nodulus: Intermediate swelling along the shaft. Short mostly S-shaped (sigmoid) chaetae or crotchets are characterized by a more or less median swelling. Chaetae: A chaeta is a chitinous bristle or seta found in annelid worms. In annilids, parapodia are paired un-jointed lateral outgrowths that bear the chaetae.
Family Naididae	Branchial Gills: Branchial gills are a series of bony loops which support the gills. Branchial organ: Accessory breathing organ.

	Crotchet: Shorter aciculate setae are often called crotchets. The most obvious character useful in the identification of oligochaetes is setal morphology. Setae may be divided into two basic forms: hairs and crotchets. Hairs are elongate, slender and terminate in a distally acute point and lack a nodulus, crotchets may be either bifid with an upper (distal) and lower (proximal) tooth, with or without intermediate teeth between the two main laterals, or they may be simple-pointed.
Family Tubificidae	Preclitellar: Part of body of earthworms which is a glandular swelling of the epidermis of certain annelid worms, such as earthworms, that secretes a viscous fluid to form a cocoon in which the eggs are deposited. Steno-therm: Cold –water temperature loving (1.50C).

Plate 22: PLATYHELMINTHES

PHYLUM PLATYHELMINTHES	Unsegmented: Body that is not divided in to segments.
Family Dugesiidae	Cocoon: A pupal casing made by moth caterpillars and other insect larvae. Fission: A process of regeneration or reproduction asexually through a process of fission.

CENTRAL POLLUTION CONTROL BOARD
Parivesh Bhawan, East Arjun Nagar, Delhi-110032
BIO-SCIENCE LABORATORY
Field protocol number
Field Protocol for Bio- Monitoring of River Ganga

SAMPLING EVENT DETAILS	:	
Water body	:	
Location	:	
Data of sampling	:	
Staring time of sampling	:	
Ending time of sampling	:	
Sampling team	:	

LOCATION DETAILS :	1	2	3	4	5	6	7	8	9	10	d
Avg. Depth (m) or feet (Approx depth can be measured from Height of cattles wading, from bathing activities, length of lron rope of artificial substratum in water body or any other measuring device)											

Approx. width (m or feet)	:	
Approx. main stream flow (m/s)	:	

Description of water	:	Pool
		Slack
		Riffle
		Run
		Depositing
		Eroding
		Turbulent
		Canalized

Substrate composition of Natural or Manmade water body/wetland :

>256 mm	Boulders	0	%
255-64 mm	Cobbles	0	%
63-16 mm	Pebbles	0	%
15-2 mm	Gravel	0	%
0.0625 mm	Sand	0	%
0.002 mm	Silt	0	%
<0.002 mm	Clay	0	%
	Detritus	0	%
	Macrophytic vegetation	0	%
	Artificial substratum	0	%

Human influences	:	Melon farming	
		Cattle wading	
		Dredging	
		Sand recovery	
		Other	

Wet land plants	:			
Macrophyte cover/ Name	:			
Birds /wild life habitation /Name	:			
Surrounding land use	:	Urban		
		Arable		
		Grazing		
		Forest		
		Other		

Sun's intensity	:	Nil	
		Moderate	
		Heavy	

Approx altitude (m)	:	
Discharges	:	
Confluences	:	

Make a detailed drawing or photograph of the local situation, and indicate sampling station and other peculiarities:

Check list for Bio- Monitoring

1. Sieve with 0.6 mm mesh size
2. Hand net
3. Shovel
4. Scrapper
5. Depth measurement device- Folding stick etc.
6. Plastic ball, measuring tape & stop watch for flow measurement
7. Gum boots and hand gloves
8. pH strips, DO bottles & reagents
9. Thermometer
10. White enamel trays
11. Small plastic bucket & rope
12. Wide mouth bottle
13. Forceps, needles & convex hand lens
14. Formalin (4%) or Alcohol (70%)
15. Stickers & marking pen
16. Artificial substratum & its accessories for lined canals etc.
17. First aid box, soap disinfectant & towel
18. Field protocols
19. Camera for site photograph if required, caps etc
20. One big box/crate to accommodate artificial substratum for bio-monitoring of benthic macro-invertebrate.

21. Water proof file /bag for placing the field protocols
22. Life Jacket
23. APP for Biomonitoring

Check List for Sample Collection:

Sample Type	Bottle	Volume	Preservation	Tick Mark The Sample Collected From The Site

Water Samples for Chemical Analysis

Physico-chemical Composition	PE Carboy	5 L	Cooled in ice	
Ammonia	G NM	1 L	2 ml H_2SO_4	
Heavy metals	PE NM	250ml	1 ml HNO_3	
Mercury	G NM	250ml	1 ml HNO_3 + 5ml $K_2 Cr_2 O_7$	
Pesticides	G NM (brown)	1 L	-	
PAH+ PCB + etc.	G NM (brown)	1 L	-	
Oil and grease	G NM (brown)	1 L	Cooled in ice	
Phenol	G NM	1 L	Cooled in ice	
Chlorophyll	G NM (brown)	1 L	-	
	G NM GS (Sterilized)	300 ml	Cooled in ice	

Water samples for Bacteriological Analysis

Total Coliform and Fecal Coliform	Sterilized Glass Bottle	125ml	Cooled in ice	

Sediment Samples for Chemical Analysis

Heavy metals	PE WM	1 L	Cooled in ice	
Pesticides + PAH + PCB + etc.	G WM	1 L	Cooled in ice	

Biological Samples for Chemical Analysis (Fish, Mussels, Water Hyacinth, etc)

Heavy metals	PE bag		Deep frozen	
Pesticides + PCB + etc.	G WM	1 L	Deep frozen	

Biological Samples for Bio- Assessment

Benthic Macro-Invertebrates	PE WM	0.1-0.5L	Alcohol 70%or Formalin (4%)	

Others

Effluent toxicity	PE Carboy	25 L	None	
Up-stream dilution water	PE Carboy	25 L	None	

G-Glass, GS – Glass stoppered, PE- Polythene, NM- Narrow Mouth, WM –wide Month

FIELD MEASUREMENTS:

Reference Thermometer Code:

Time	Date	Water temperature (°C)			Air temperature (°C)			DO Titration (mg/1)	pH strip
		Temp Observed	Correction factor	Actual Temp	Temp Observed	Correction factor	Actual Temp		
AM		°C		°C	°C		°C	mg/l	

Sampling of Biological Organisms

PROCEDURE: - Different procedures can be employed for sampling of biological parameters. Sampling should be conducted during availability of ample amount or sunlight in the field. Find out the nature of river bed and select the procedure. Always approach the sampling area starting from downstream to upstream. Avoid bio- monitoring at places of acute air quality problems.

I. Stoney River Bed:

- Pick up stones randomly from the fast flowing shallow stream and remove the organisms by brush or soft forceps pins into a white tray.
- Place the sampling net firmly on to the stream bed.

- Brush off the large stones or rocks lying under water and placed adjacent to the mouth of net for collecting animals.

II. Smaller Stones and sandy Bed:

- Place the net or sieve firmly on the stream bed against the flow. Stand before the net or sieve and kick up the stream bed by foot and collect the animals into the net or sieve. Wash the animals into white tray.

III. Mud and Silty bed:

- Pick up 5 grab samples of the river bed by the shovel. Wash the sample in the sieve by river water pick up the animals by hand or brush or soft forcep pins into white tray.

IV. Water plants / floating lands:

- Uproot the water plants present near the sampling area. Wash and collect the animals either directly into the net or into white tray.
- Collect the benthic macro –invertebrates from floating land by scrubbing the sieve or net under or sides of the floating land.
- Identify the indicator animals belonging to various taxa from the given identification char and the characters, mote sown the abundance of each animals identified. Compare the results from the water quality Evaluation system of BWQC and define the water quality class to the investigated water body.

Saprobic [Biological Monitoring Workiing Party (BMWP) Score:

Ample care should be taken to ensure that all indicator families of Benthic Macro- invertebrates, which are present, are actually encountered. This can be accomplished by sub- sampling al different (micro) habitats in a sizeable stretch of the river /water body. The monthly inventory fieldwork can be restricted to a biologically mature period of the year (October-May), excluding monsoon and periods, Use identification key at page 12 for preliminary identification of Benthic Macro –invertebrates Taxa.

This method involves a quantitative inventory of the presence of macro – invertebrate benthic fauna up to family/genus level of taxonomic precision. All possible families having saprobic indicator value are classified on a score scale of 1 to 10 according to their preference for saprobic water quality. The families which are most sensitive to pollution are on the top of the list (Table 1) and are getting a score of 10 while the most pollution tolerant families are

getting a scope of 1 and 2. The other intermediately sensitive families are placed in between the scoping scale of 10 to 1.

ENTER DIFFERENT SPECIES WITHIN ONE FAMILY SEPARATEY, AND INDICATE ABUNDANCY AS:

Abundance scale: **A** = single (one individual0
B = scarce (2-10 individuals)
C = common (10-50 individuals)
D = abundant (50-100 individuals)
E = excessive (more than 100 individuals or only one species)

TABLE-1

TAXONOMICAL GROUP	TAXONOMICAL FAMILIES	MARK ENCOUNTERED FAMILIES AND IF POSSIBLE GENUS/ SPECEIES WITHHIN FAMILIES. ALSO MARK ABUNDANCY AS 1A,1B,1C,1D,1E,	TOAL FAMILIES/ GENUS/SPECIES ENCOUNTERED	BMWP SCORE	MULTI-PLIED SCORE
Ephemeroptera	Siphlonuridae				
	Heptageniidae				
	Leptophlebiidae				
	Ephemerelidae				
	Potaminthidae				
	Ephemeridae				
	Prosopistomatidae				
	Neoephemeridae				
Plecoptera	Taeniopterygidae				
	Leuctridae				
	Capniidae				
	Perlodidae				
	Perlidae				
Hemiptera	Aphelocheiridae				
Trichoptera	Leptoceridae				
	Pseudoneuroclipsis				
	Glossosomatidae				
	Goeridae				
	Lepidostomatidae				
	Brachycentridae				
	Sericostomatidae				
TOTAL FAMILIES ENCOUNTERED & TOTAL MULTIPLIED SCORE				**X 10**	

Signature of Team Leader

TAXONOMICAL GROUP	TAXONOMICAL FAMILIES	MARK ENCOUNTERED FAMILIES AND IF POSSIBLE GENUS/ SPECEIES WITHHIN FAMILIES. ALSO MARK ABUNDANCY AS 1A,1B,1C,1D,1E,	TOAL FAMILIES GENUS/SPECIES ENCOUNTERED	BMWP SCORE	MULTI-PLIED SCORE
Odonata	Euphaeidae				
	Protoneuridae				
	Platycnemididae				
	Gomphidae				
	Cordullegastridae				
	Aeshnidae				
	Corduliidae				
	Libellulidae				
	Macromidae				
	Chlorolestidae				
Trichoptera	Psychomyiidae				
	Philopotamidae				
TOTAL FAMILIES ENCOUNTERED & TOTAL MUTIPLIED SCROE				**X8**	
Ephemeroptera	Caenidae				
Plecoptera	Nemouridae				
Trichoptera	Rhyacophilidae				
	Stenopsychidae				
	Polycentropodidae				
	Limnephilidae				
TOTAL FAMILIES ENCOUNTERED & TOTAL MULTIPLIED SCORE				X7	
Mollusca	Neritidae				
	Septariidae				
	Assimineidae				
	Viviparidae				
	Ampullaridae				
	Thiaridae				
	Pleuroceridae				
	Bithyniidae				
	Amblemidae				
	Ancylidae				
	Solecurtidae				
	Stenothyridae				
	Unionidae				
	Arcidae				
	Succineidae				
Trichoptera	Hydroptilidae				
Crustacean	Atyidae				
	Gammaridae				
	Anthuridae				
	Niphargidae				
	Talitridae				
	Mysidae				
	Palaeamonidae				
	Potamidae				
	Parathelphusidae				
	Hymenosomatidae				
	Varunidae				
	Sesarmidae				
	Gecarcinucidae				

Polychaeta	Nereididae				
	Nereillidae				
	Sabellidae				
	Pisionidae				
	Histriobdellidae				
	Nephtyidae				
Odonata	Calopterygidae				
	Coenagrionidae				
TOTAL FAMILIES ENCOUNTERED & TOTAL MULTIPLIED SCORE				**X6**	

Signature of Team Leader

TAXONOMICAL GROUP	**TAXONOMICAL FAMILIES**	**MARK ENCOUNTERED FAMILIES AND IF POSSIBLE GENUS/ SPECEIES WITHHIN FAMILIES. ALSO MARK ABUNDANCY AS 1A,1B,1C,1D,1E,**	**TOAL FAMILIES GENUS/SPECIES ENCOUNTERED**	**BMWP SCORE**	**MULTI-PLIED SCORE**
Hemiptera	Mesovelidae				
	Hydrometridae				
	Gerridae				
	Nepidae				
	Ranatrinidae				
	Naucoridae				
	Notonectidae				
	Pleidae				
	Veliidae				
	Hebridae				
	Belostomatidae				
	Corixidae				
Coleoptera	Heteroceridae				
	Hygrobidae				
	Dytiscidae				
	Gyrinidae				
	Hydrophilidae				
	Dryopidae				
	Elminthidae				
	Elmididae				
	Noteridae				
	Psephenidae				
	Scirtidae				
	Eulichadidae				
	Histeridae				
	Curculionidae				
Trichoptera	Hydropsychidae				
	Ecnomidae				
Diptera	Tipulidae				
	Tabanidae				
	Culicidae				
	Blepharoceridae				
	Simulidae				
	Nymphomyidae				
	Sarcophagidae				
	Stratiomyiidae				
	Ceratopogonidae				

Lepidoptera	Pyralidae				
Planaria	Planariidae				
	Dendrocoelidae				
TOTAL FAMILIES ENCOUNTERED & TOTAL MULTIPLIED SCORE				**X5**	
Ephemeroptera	Baetidae				
Megaloptera	Sialidae				
	Corydalidae				
Hirudinea	Piscicolidae				
	Hirudinidae				
TOTAL FAMILIES ENCOUNTERED & TOTAL MULTIPLIED SCORE				**X4**	

Signature of Team Leader

TAXONOMICAL GROUP	TAXONOMICAL FAMILIES	MARK ENCOUNTERED FAMILIES AND IF POSSIBLE GENUS/ SPECEIES WITHHIN FAMILIES. ALSO MARK ABUNDANCY AS 1A,1B,1C,1D,1E,	TOAL FAMILIES/ GENUS/SPECIES ENCOUNTERED	BMWP SCORE	MULTI-PLIED SCORE
Mollusca	Lymnaeidae				
	Physidae				
	Planorbidae				
	Sphaeriidae				
	Corbiculidae				
	Onchididae				
Hirudinea	Glossiphoniidae				
	Hirudidae				
	Erpobdellidae				
	Haemadipsidae				
	Salifidae				
Planaria	Dugesiidae				
Crustacea	Asellidae				
	Aegidae				
	Cirolanidae				
	Stenasellidae				
	Cymothoidae				
	Corallaniidae				
TOTAL FAMILIES ENCOUNTERED & TOTAL MULTIPLIED SCORE				**X3**	
Diptera	Syrphidae				
	Chironomidae				
	Ephydridae				
	Muscidae				
	Psychodidae				
TOTAL FAMILIES ENCOUNTERED & TOTAL MULTIPLIED SCORE				**X2**	

Oligochaeta	Tubificidae				
	Naididae				
	Octochaetidae				
	Lumbricidae				
	Lumbriculidae				
TOTAL FAMILIES ENCOUNTERED & TOTAL MULTIPLIED SCORE				**X1**	
GRAND TOTAL FAMILIES ENCOUNTERED & GRAND TOTAL MULTIPLIED SCORE					

Saprobic score: $\frac{\text{GRAND TOTAL MULTIPLIED SCORE}}{\text{GRAND TOTAL NUMBER OF FAMILIES ENCOUNTERED}}$

SAPROBIC SCORE:

REMARKS: **Signature of Team Leader**

DIVERSITY SCORE (SEQUENTIAL COMPARISION)

The evaluation of the benthic fauna diversity leval can easily be done utilizing: the same animals collected for estimating the saprobic score. Take photograph of the living animals in the field for evidence.

Since the method only involves a pair –wise comparison of sequentially encountered individuals and the differences of two specimens can easily be observed up to the genus/species level, no taxonomic skill is required.

First observed animals is always different and scored as 1 run. When the next observed animal is different from the last, a new run starts. The encounter of an individual which cannot be discerned for the last does not increment the number of runs. Size differences only do NOT change the run.

SAME RUN IS 0 (organism is the same as the previous)

NEXT RUN IS 1 (organism is different from the previous)

When a row is full, continue on next row. Enter the number of runs over all rows (sum of1's)

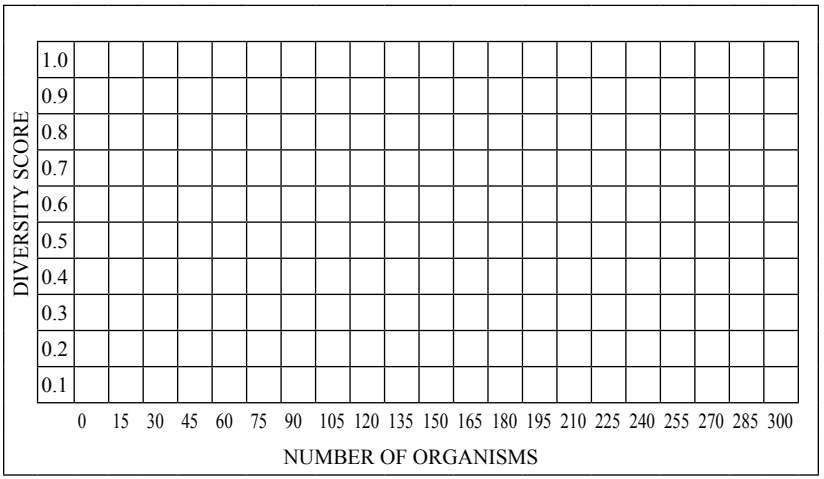
No	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total Runs	Total Org.	Diversity Score
1	**1**																15	
2																	30	
3																	45	
4																	60	
5																	75	
6																	78	
7																	105	
8																	120	
9																	135	
10																	150	
11																	165	
12																	180	
13																	195	
14																	210	
15																	225	
16																	240	
17																	255	
18																	270	
19																	285	
20																	300	

DIVERSITY SCORE: $\frac{\text{Number of Run}}{\text{Number of Organisms}}$

DIVERSITY SCORE: _____

Signature of Team Leader

Make a graph of Diversity score Vs Number of Organisms for selection of appropriate Diversity score at a linear range.



Note: If, there is no linearity in the graph, then take the average value of Diversity Score.

BIOLOGICAL WATER QUALITY CRITERIA (BWQC)

To assess the actual health of water bodies, CPCB has derived a Biological Water Quality Criteria (BWQC) for water quality evaluation. This system is based on the range of saprobic values and diversity of the benthic macro-invertebrate families with respect to water quality. The system has been developed after extensive field trials and calibration on the saprobic and diversity information of different taxonomic groups of benthic animals collected from artificial substratum and natural substratum of various water bodies. To indicate changes in water quality to different grades of pollution .level, the entire taxonomic groups, with their range of saprobic score from 1 to 10, in combination with the range of diversity score from 0 to 1 has been classified into five different classes of water quality (Table 2) The abnormal combination of saprobic score and diversity score indicates sudden change in environmental conditions.

Table-2

Range of Saprobic Score (0-10)	Range of Diversity Score (0-1)	Water Quality	Biological Water Quality Class	Indicator colour
7 and more	0.2-1.0	Clean	A	Blue
6-7	0.5-1.0	Slight Pollution	B	Light Blue
3-6	0.3-0.9	Moderate pollution	C	Green

2-5	**0.4-less**	**Heavy pollution**	**D**	**Orange**
0-2	**0-0.2**	**Severe Pollution**	**E**	**Red**

CRITERIA FOR BIOLOGICAL WATER QUALITY EVALUATION

The biological water quality evaluation using benthic fauna can easily be done by combining the observed saprobic score and diversity score and the biological water quality class can be determined through comparing the results with the ranges of Saprobic and diversity score prescribed in Biological Water Quality Criteria (BWQC).

Results:	**Range of Saprobic Score (0-10)**	**Range of Diversity Score (0-1)**	**Biological Water Quality**	**Biological Water Quality Class**	**Indicator Colour**

Signature of Team Leader

Appendix 2:
References of Literature

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3. Class Polychaeta, ASSESS-HKH: Materials to the Taxonomy Workshop, Kathmandu University, Dhulikhel, Kavre, Nepal, August 20 to September 7, 2006 Hasko Nesemann & Subodh Sharma.
4. Key to Diptera (Two- winged flies) by Berthold Janecek: Regional Capacity Building Workshop on Macro-invertebrates, Taxonomy & Systematics for Evaluating the Ecological Status of Rivers in the Hindu Kush – Himalayan (HKH) Region. Kathmandu University, Dhulikhel, Kavre, Nepal. August 20 to September 7, 2006,
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