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INTRODUCTION

FOREWORD TO MONGOLIAN GUIDE

This new taxonomic key will permit identification of macroinvertebrates to the family level and is intended for use by students, teachers, other volunteers, or anyone who requires that level of identification. Illustrations have been developed to highlight distinguishing characteristics that will increase accuracy and consistency. It is designed to help volunteers strengthen their identification skills and, in conjunction with a well-designed monitoring program and proper field protocols, will improve the quality of biological data that can be used for decision-making.

Biological communities serve as good indicators of overall stream health. Macroinvertebrates may spend years maturing in the stream. Thus, the size and diversity of their population reflect an integration of all the stream conditions that occur during their life cycles, such as water chemistry, habitat characteristics, pollutant loading, and changes in water flow, temperature, or velocity. Certain species are intolerant of pollution and will be absent from streams with degraded water quality or habitat. Biological monitoring adds a significant component to the overall assessment of stream health, but it requires training in proper sampling and identification, specialized equipment, access to a microscope, and appropriate interpretation of biological indices.

Many volunteers and local organizers prefer to monitor biological communities because volunteers may find it more engaging than other types of monitoring. Volunteers can augment limited agency resources and expand ambient water quality records, adding to the length or completeness of the data record by supplementing agency monitoring, or by sampling additional sites. By monitoring macroinvertebrates at a site where professionals sample water chemistry, volunteers add significantly to the knowledge base about that site. They often broaden the scope and context of agency monitoring because they know a great deal about the land use in the watershed and the history of their stream. Volunteers can help identify areas of concern and changes or trends that should be investigated. Volunteers also increase public awareness of water resources; they can motivate action and bring attention to under-appreciated natural resources.

The information volunteers collect is helping state and local governments, natural resource professionals, and local decision makers gain a better understanding of the health of our water resources. At the same time, volunteers learn for themselves how human uses affect the rivers and streams in their communities. Students learn scientific methods and gain life skills, as well as understanding more about natural systems. Organizations can follow up on problems and use the data they collect to undertake stewardship actions to improve the health or habitat of their streams.

Whatever your reasons for getting involved, there are monitoring options that will match your goals, skill level, and available resources. This guide will help get you started assessing the biological characteristics of streams, lakes, and other water resources.

CHAPTER 1

INTRODUCTION
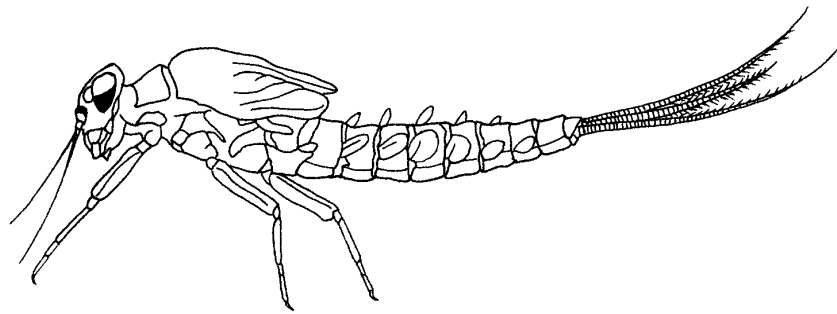
Draft
June 17, 2009

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INTRODUCTION

This guide has been developed for the identification of common aquatic invertebrates found in Mongolia. Most aquatic and semiaquatic organisms collected from a variety of water body types (*e.g.*, streams, rivers, lakes, wetlands, seeps, etc.) will key out in this guide. However, invertebrate samples often include semiaquatic and terrestrial invertebrates that are not dealt with in this guide. Additionally, the characters in this guide are based on mature larvae or adults, so some immature larvae may not key out properly because of their small size and lack of well-developed characteristics. Finally, not all aquatic taxa occurring in Mongolia will key out in this guide is probably incomplete because more families likely remain to be discovered in this country. In addition, this guide is largely based on North American and to a lesser extent, European taxa. As a result additional modifications and refinement may be necessary to make this guide fully accurate to the Mongolia fauna.

In this guide, dichotomous keys are provided to identify most insects to the family level and non-insects to the family or higher level (*e.g.*, order, class, etc.). The keys are divided into several chapters and placed into hierarchical order. The first key (Chapter 2: Aquatic Invertebrates) deals with all aquatic invertebrates and is designed to separate insects from other invertebrates and to identify non-insect invertebrates to the family or higher level. If your organism is identified as an insect, the second key (Chapter 3: Class Insecta) can be used to identify insects to the order level. Finally, each insect order has its own key (Chapters 4 through 13) for family-level identifications.

The keys in this guide are modified from a number of sources including Merritt and Cummins (1996), Hilsenhoff (1995), McCafferty (1981), Brigham et al. (1982), Pescador and Harris (1995), Pennak (1989), Nilsson (1997), Nilsson (1996), Stehr (1987), Stehr (1991), and Thorp and Covich (2001) (see Appendix E for a full list of references). Illustrations in this guide are modified and redrawn from a variety of sources. A complete list of illustration acknowledgements is included in Appendix F at the end of the guide.

How to use this key

Before you begin to key out specimens, take time to page through this guide to familiarize yourself with the diversity of form and structure of aquatic invertebrates. You should also spend some time learning the terms for structures and orientations. You can do this by examining the labeled figures at the beginning of many of the chapters. In addition, you should read through the orientation descriptions in Appendix B. If you have problems with terms, you can reference the glossary provided at the end of the guide in Appendix D. These exercises will improve your ability to use the keys provided in this guide.

Using dichotomous couplets

This guide uses dichotomous keys to identify aquatic invertebrates. A dichotomous key consists of a series of couplets or pairs of characters that are used to narrow down and eventually to determine an organism's identity (Figure 1). To help visualize the structure of a dichotomous key you can

compare it to that of a tree. You start at the bottom of the tree trunk and each time the tree branches you must decide which character or characters match your specimen to determine which branch to follow. As you move up the tree you will continue to narrow down the identity of your specimen until you reach the end of a branch and the name of your organism.

To begin, start with the first couplet in the key and read both options. The first half of a couplet is designated by the couplet number (*e.g.*, 1.) whereas the second half is designated by the couplet number followed by an apostrophe (*e.g.*, 1'.) (see Figure 1.1). In addition, in all couplets except the first, the couplet number for the first half of a couplet is followed by a number in parentheses (*e.g.*, 2(1).). This is the number of the previous couplet and allows you trace your steps back if you make a mistake. The apostrophe included with the second half of a couplet helps you determine which characters you selected when backtracking trough the key. It is important to read both options completely in order to insure correct identification. Choose the character or characters that match the specimen you are keying out. Illustrations are provided with most character descriptions to help with identification.

Once you have decided what character or characters match your specimen, the number following the character description will direct you to the next couplet. Go to the couplet that is given and again find the character or characters that match your specimen and proceed to the next couplet. Eventually you will reach the name of an organism, which means you have identified the specimen.

If you can identify the specimen further, a chapter number will follow the name. If a chapter number is given, go to this chapter and begin the new key following the same steps described above. If you reach a couplet and neither character or set of characters matches your specimen, you may have made an error. If this occurs, you may need to backtrack and determine where the mistake was made.

Once you have arrived at a determination, follow the page number given after the organism's name. This will take you to a more detailed description of the organism as well as an illustration of a characteristic member from that group. Use the description to double check your identification. If you are unsure of your identification, reference other entomological texts (see Appendix E) or consult with someone experienced with identifying aquatic invertebrates. Keep in mind, the more practice you have, the easier it becomes to identify aquatic invertebrates. The illustration included with the organism description and in the keys are examples of a species form the group. As a result the species or genus of the illustrated taxon does not necessarily correspond to your organism. This guide does not go beyond the genus or species level and other resources would need to be consulted for this level of identification. One final note: it is possible that some families that occur in Mongolia are not in this guide. It is also possible that the organism you are trying to identify is not aquatic and is not included in this guide. Therefore it is possible that specimens that are collected in Mongolia will not key out using this guide.

Description of character(s) for the first part of couplet #2

Figure number for the illustration of the character in this couplet

Next couplet (if your organism matches the description, go to couplet 3)

Couplet #2 – part 1

Illustration of character(s) for the first part of couplet #2

Couplet #2 – part 2 (the apostrophe indicates this is the second part of the couplet)

Figure number and description of illustration

This is couplet #3; the number in parentheses tells you the previous couplet and helps you trace you steps if you need to backtrack.

Name of organism keyed out

Arrow pointing to character described in couplet

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2(1). Fully developed wings present - *the fore wings are often hardened so you will often have to lift up the fore wings to see the well-developed membranous hind wings* (Figs. 3.12, 3.13) 3

Figure 3.12: *Sigara mckinstryi* (Corixidae) adult, Dorsal View.

Figure 3.13: *Hydrobiomorpha* sp. (Hydrophilidae) adult, Dorsal View.

2'. Fully developed membranous wings absent - *although wing pads may be present in some taxa* (Figs. 3.14, 3.15)..4

wing pad

wing pad

Figure 3.14: *Leuctra* sp. (Leuctridae) larva, Dorsal View.

Figure 3.15: *Calopteryx maculata* (Calopterygidae), larva, Dorsal View.

3(2). Sucking mouthparts present (beak-like) (Fig. 3.16); only a portion of fore wing hardened (Fig. 3.17) ....**Hemiptera - adults [in part] (True Bugs)** *p. 87*

hardened portion of wing

membranous portion of wing

Figure 3.16: Head of Notonectidae adult, Lateral View.

Figure 3.17 *Sigara mckinstryi* (Corixidae) larva, Dorsal View.

3'. Sucking mouthparts absent (Fig. 3.18); entire fore wing hardened (Fig. 3.19) ....**Coleoptera – adults (Beetles)** *p. 141*

hardened wing (elytra)

Figure 3.18: Head of *Laccophilus* sp. (Dytiscidae) adult, Lateral View.

Figure 3.19: *Hydrobiomorpha* sp. (Hydrophilidae) adult, Dorsal View.

Chapter 3 | INSECTA   41
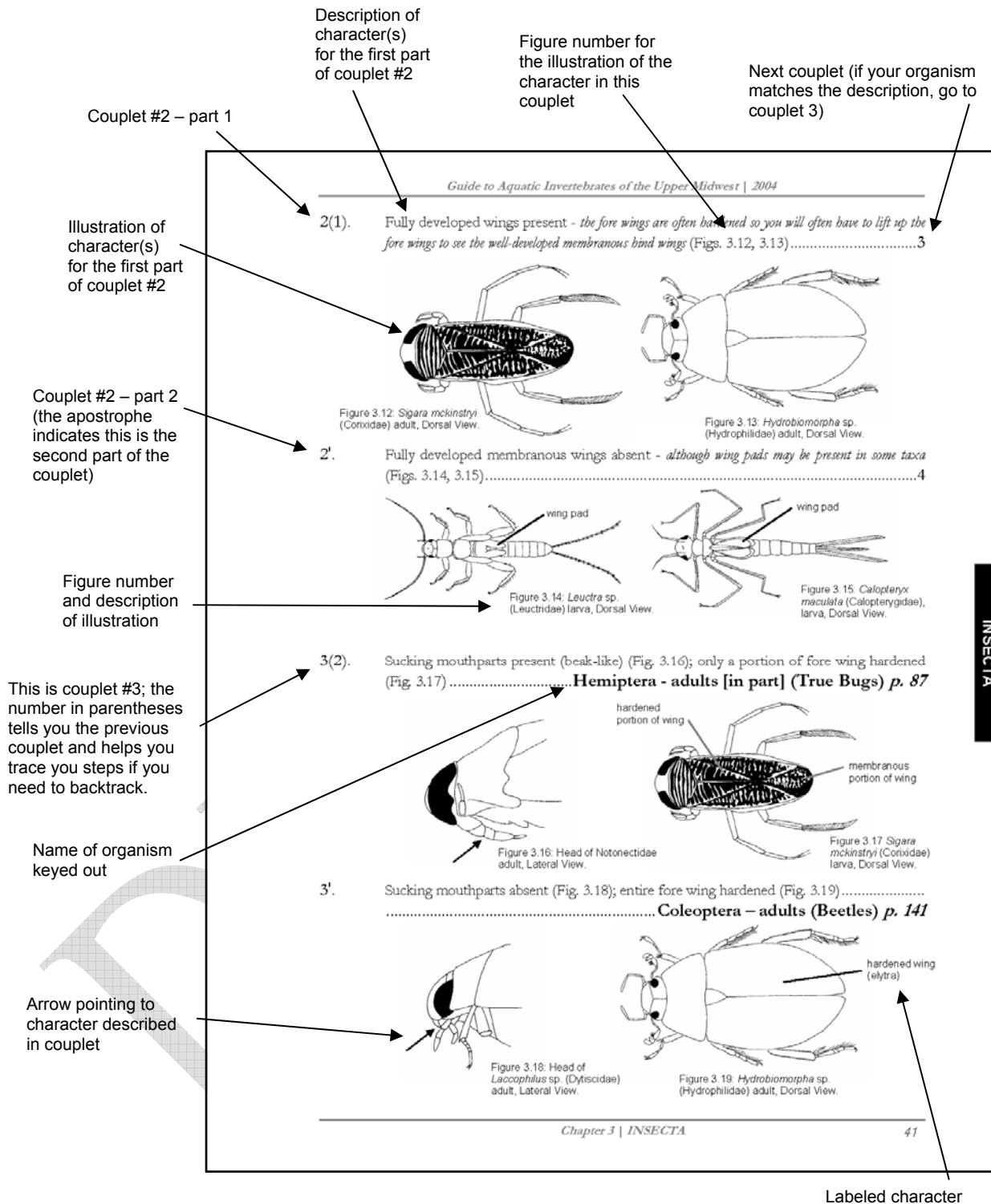
INSECTA

Labeled character

Figure 1.1: Dichotomous key layout example.

Layout of Descriptions for Families and Groups

A description of each insect order is provided before each order key. This information includes a description of the biology of the group and a description of the major characters used to identify the group and families within that group. An illustration of a generalized specimen for each order with labeled structures is also provided to aid with orientation and identification of structures used in the key. In addition, a description of each taxon is provided at the end of each key. Each scientific name at the top of the taxon description is a family name (these names end in "idae"). For taxa that are not families, the classification level (*e.g.,* class, order) follows the taxonomic name in parentheses. The information for each taxon is organized into the following categories:

English Common Name: Organisms are designated a single scientific name following rules of the International Code of Zoological Nomenclature, but many organisms also have one or many common names. In this guide, common names for the groups are provided. Due to the variability of common names, some invertebrates may have additional common names or a common name may be applied to multiple groups. If you want to be sure you are applying the correct name to an organism it is best to use the scientific name.

Feeding Group: Another way to classify organisms is to place them in categories according to their feeding behavior or habit. The most common feeding habit is given for each taxon. In some cases several feeding habits are listed for a single taxon because many families contain numerous species using variety of feeding strategies. In addition, a single organism may change its feeding habits as it matures, as it passes through different life stages, or as food availabilities change. Be aware that your organism may not match the feeding habit given for the group because there are often unusual species or exceptions in a family. A complete description of feeding habits provided in Appendix C.

Tolerance Value: Invertebrates used to evaluate water quality are often given a number to represent their tolerance or intolerance to pollution. Higher numbers represent increased tolerance while lower numbers represent intolerance. In this guide, values of 0 through 3 are considered indicative of a low tolerance to stress, values of 4 through 6 a moderate tolerance, and values of 7 through 10 a high tolerance. Similar to feeding habits, the pollution tolerance can vary among species within a family or group. Additionally, many pollution tolerance values are based on only one or a few types of stressors. For example, the pollution tolerance values given in this key are mainly for organic pollution and may not accurately reflect an organism's tolerance to heavy metals or toxic chemicals. Most of the tolerance values giving in this key are from Hilsenhoff (1988). Tolerance values for taxa not included in Hilsenhoff (1988) are taken from Barbour *et al.* (1999). For example, tolerance values for many Hemiptera and Coleoptera are not included in Hilsenhoff (1988). In addition, tolerance values have not been determined for many taxa and are listed as undetermined or unknown in this guide. These tolerance values are based on North American taxa and although many should be similar for Mongolian taxa, there may be differences. Future work in Mongolia should be able to refine the tolerance values to make them more applicable in Mongolia.

Habitat: The habitat section provides information on the type of water body and habitat in which an invertebrate can be found. Again, this information is based on the habitats of the majority of the species or the most common species within the family or group, but there are almost always exceptions. A complete description is provided in Appendix C.

Length: The range of lengths provided are for mature larvae and adults. Lengths do not include antennae and cerci when they are present.

Characteristics: This section lists a number of the more important diagnostic characters for the group. Unique characters used in the key are listed here along with additional characters not unique to the group. These additional non-unique characters can sometimes be helpful when you have a difficult specimen. After you key out an organism, check the characteristics listed under the group description in order to double check your identification.
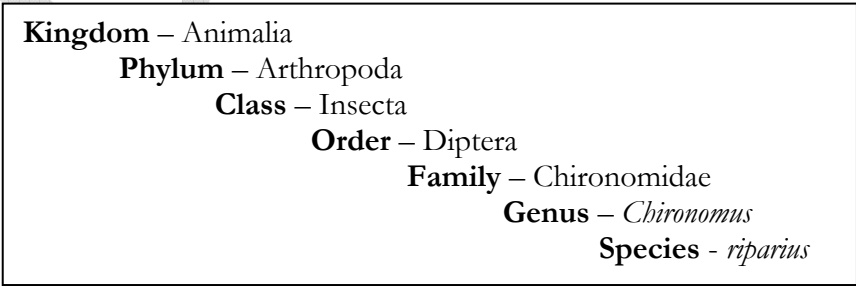
Notes: Some additional information about the biology of the group is included. This can include information on feeding, economic importance, or any interesting facts about these organisms.

Nomenclature: Common and Scientific Names

In this key organisms are often referred to by both their common and scientific names. A single organism can have several common names depending on who is referring to the organism and in what region it is found. Scientific names are more specific because international rules dictate that an organism can have only one scientific name.

The use of scientific names permits the classification of organisms into nested categories based on the evolutionary history of the organisms. For example, the species *Chironomus riparius* belongs to the family Chironomidae which in turn belongs to the order Diptera within the class Insecta (Figure 1.2). This tells you that all of the species within the family Chironomidae are more closely related to each other than they are to any other species outside of the family.

As you move up the classification, all of the families in the order Diptera are more closely related to each other than they are to other families. As you move through the keys you will be working your way down this classification. For example, the first key deals with organisms belonging to the kingdom Animalia. The next key is for Insecta, a class nested within Animalia, followed by keys for several orders within Insecta. However, the individual keys are not necessarily based on the evolutionary relationships of these organisms. The characters used to identify organisms are not always the same characters used to determine how closely they are related. This is because many of the characters used to determine evolutionary relationships are very difficult to see (*e.g.*, internal morphology, genetics) or require live specimens (*e.g.*, behavior). Therefore, you must be careful about the evolutionary conclusions you make using this guide. The only way to be sure if organisms are closely related is if they belong to the same group (*e.g.*, family, order, class) and not how closely they key out in this guide.

> **Kingdom** – Animalia
>   **Phylum** – Arthropoda
>   **Class** – Insecta
>   **Order** – Diptera
>   **Family** – Chironomidae
>   **Genus** – *Chironomus*
>   **Species** - *riparius*

Figure 1.2: Taxonomic hierarchy using the midge *Chironomus riparius* as an example.

Groups of Aquatic Invertebrates Covered in this Guide
* Not known from Mongolia

Phylum Platyhelminthes
      Class Turbellaria

Phylum Nematoda (Nemata)

Phylum Nematomorpha

Phylum Annelida
      Class Oligochaeta
      Class Hirudinea

Phylum Mollusca
      Class Gastropoda
      Class Bivalvia

Phylum Arthropoda
      Class Arachnida
          Order Araneae
        Subclass Acari
    Subphylum Crustacea
        Subclass Branchiopoda
          Order Cladocera
        Subclass Copepoda
        Subclass Ostracoda
        Subclass Malacostraca
          Order Isopoda
          Order Amphipoda
      Class Insecta
        Subclass Apterygota
          Order Collembola
        Subclass Pterygota
          Order Ephemeroptera
              Family Acanthametropodidae*
              Family Ameletidae
              Family Ametropodidae
              Family Baetidae
              Family Caenidae
              Family Ephemerellidae
              Family Ephemeridae
              Family Heptageniidae
              Family Isonychiidae
              Family Leptophlebiidae
              Family Metretopodidae
              Family Oligoneuriidae
              Family Polymitarcyidae
              Family Potamanthidae
              Family Siphlonuridae

Order Odonata
    Suborder Zygoptera
        Family Calopterygidae
        Family Lestidae
        Family Coenagrionidae
    Suborder Anisoptera
        Family Aeshnidae
        Family Cordulegaster*
        Family Corduliidae
        Family Gomphidae
        Family Libellulidae
Order Plecoptera
        Family Pteronarcyidae
        Family Taeniopterygidae
        Family Nemouridae
        Family Leuctridae
        Family Capniidae
        Family Chloroperlidae
        Family Perlidae
        Family Perlodidae
Order Hemiptera
        Family Belostomatidae
        Family Corixidae
        Family Gelastocoridae*
        Family Gerridae
        Family Hebridae*
        Family Hydrometridae*
        Family Mesoveliidae*
        Family Naucoridae*
        Family Nepidae*
        Family Notonectidae*
        Family Pleidae
        Family Saldidae
        Family Veliidae*
Order Megaloptera
        Family Corydalidae
        Family Saldidae
Order Neuroptera
        Family Sisyridae
Order Trichoptera
        Family Apataniidae
        Family Brachycentridae
        Family Glossosomatidae
        Family Goeridae
        Family Helicopsychidae *
        Family Hydroptilidae
        Family Hydropsychidae
        Family Leptoceridae
        Family Lepidostomatidae
        Family Limnephilidae

Family Molannidae
Family Phryganeidae
Family Polycentropodidae
Family Psychomyiidae
Family Rhyacophilidae
Family Stenopsychidae
Order Lepidoptera
Family Pyralidae or Crambidae
Order Coleoptera
Family Chrysomelidae
Family Curculionidae
Family Dryopidae**
Family Dytiscidae
Family Elmidae
Family Gyrinidae
Family Haliplidae
Family Heteroceridae**
Family Hydraenidae**
Family Hydrophilidae
Family Psephenidae**
Family Scirtidae**
Family Staphylinidae
Order Diptera
Family Blephariceridae
Family Ceratopogonidae
Family Chaoboridae
Family Chironomidae
Family Cylindrotomidae
Family Culicidae
Family Deuterophlebiidae
Family Dolichopodidae
Family Empididae
Family Ephydridae
Family Hybotidae
Family Limoniidae
Family Muscidae
Family Pediciidae
Family Sciomyzidae
Family Simuliidae
Family Stratiomyidae
Family Syrphidae
Family Tabanidae
Family Tipulidae