Introduction

Illinois RiverWatch uses biological monitoring to estimate stream health. As indicators of the quality of a stream’s biotic community, the benthic macroinvertebrates collected during the biological survey provide useful information for estimating water quality, habitat conditions and overall stream health. Accurate identification of these organisms is essential to producing reliable information for estimating stream health.

This macroinvertebrate identification key is intended for use by RiverWatch Citizen Scientists as a tool for accurate identification of benthic macroinvertebrates. Organisms featured in the key are specific to Illinois streams. Macroinvertebrates commonly found elsewhere in the Midwest may also be identified using this key, since most organisms listed are common to the region.

Learning the Lingo

Aquatic organisms are identified based on their physical characteristics. Most aquatic organisms share common features that allow them to survive in aquatic habitats. As they evolved, each species also developed unique structures and body shapes well suited for survival in a particular microhabitat. For instance, the adult whirligig beetle is a predator that swims at the water surface. Its eyes are divided so that it has one pair of eyes that can see above the water and one that can see underwater. Some have chewing mouthparts while others have piercing or sucking mouthparts; some have gills while others have siphons or breathing tubes; some have short, flattened bodies while others are slender or curved. These distinctive features are used to separate one group of organisms from another until each can be identified based on its unique physical characteristics.

A firm grasp of the vocabulary used to distinguish these features is essential to identifying benthic macroinvertebrates. Basic terms describe orientation, body divisions, body structures and other aspects of the organism. Orientation refers to the direction or location (top, bottom, front, back, etc.) of a particular structure on the body of the organism being identified. Body divisions are the parts or sections (head, thorax, abdomen, etc.) of the organism. Common orientation and body division terms are introduced in the following section. Body structure terms describe specific parts of the organism, such as legs, claws, wings or gills. Other descriptive terms are also used to further describe particular structures of the organism. Terms used in this key are defined in the glossary.
From Top to Bottom and Head to Tail: Some Basic Terms

Several common orientation terms are used to indicate the position of a specific structure. These terms are usually variations on top, bottom, front and back. Figure 1 illustrates where some of these terms are referring to in reference to a generic aquatic insect.

Figure 1: Aquatic Insect Orientations
Most aquatic insect bodies are divided into three regions: the head, thorax and abdomen. The head usually appears as a single segment, although it actually consists of six or seven fused segments. It includes the mouthparts and sensory structures such as the eyes and antennae.

The second region, or thorax, is located immediately behind the head. It consists of three segments: the prothorax (first segment), mesothorax (second or middle segment), and metathorax (third or last segment). Legs or wings are attached to the thorax. The feet of an insect are referred to as tarsal segments or tarsi.

The third region is called the abdomen. It is located immediately behind the thorax and is often the longest region of the body. The abdomen typically consists of 8 to 11 segments, and may have various hairs, filaments or gills attached. Many insect larvae also have structures attached to the end of the abdomen, such as hooks, prolegs or respiratory structures.

The thorax and abdomen are often difficult to distinguish in some insects (members of the Diptera family, for example), and are sometimes referred to together as the trunk. The three body divisions are illustrated using a diagram of a generic aquatic insect in Figure 2.

![Figure 2: Aquatic Insect Body Divisions](image)
How to Use This Key

This key is designed for those with little or no previous experience identifying benthic macroinvertebrates. Using detailed illustrations and simple descriptions of key structures, aquatic insects can be identified through a simple process of elimination. Each pair of choices, or couplets, represents a branch in the “family tree” of Illinois RiverWatch Stream Quality Indicators.

To use the key, read each choice and select the one which best describes the organism being identified. Once a choice is selected, follow the arrow to the next pair of choices. Continue making choices and following arrows until no further choices or arrows are offered. When this “dead end” is reached, the name of the organism is listed.

All Illinois RiverWatch indicator organisms are listed in the key. Other (non-indicator) organisms commonly found in Illinois streams are also included. These non-indicator organisms are noted where they appear.

This key should be used as the primary tool for identifying benthic macroinvertebrate samples collected for RiverWatch. Once a positive identification is made, it should be cross-checked using RiverWatch field reference cards (Stream Quality Indicators of Illinois) or one of the other identification keys recommended in the Illinois RiverWatch Stream Monitoring Manual.

Text adapted in part from Aquatic Entomology: The Fishermen’s and Ecologists’ Illustrated Guide to Insects and Their Relatives (W. Patrick McCafferty, 1981)
Glossary

ORIENTATION
Anterior — forward; refers to the head end of the body or that part of a structure located nearest the head of the body
Basal — origin; refers to the origin of a structure, generally closest to the point of attachment to the body
Distal — end; refers to that part of a structure furthermost from its point of attachment to the body
Dorsal — top, upper or back; refers to the upper or top part of the body or structure
Lateral — side; refers to the site of the body or structure
Medial — middle; refers to the longitudinal midline of the body
Posterior — rear; refers to the tail end of the body or that part of a structure located nearest the tail of the body
Ventral — lower, bottom or front; refers to the lower or bottom part of the body or structure

BODY DIVISIONS
Abdomen — the third major body region of an insect, typically divided into 8 to 11 individual segments
Head — the first major body region of an insect, including mouthparts and sensory structures such as the eyes and antennae.
Mesothorax — the second or middle segment of the thorax
Metathorax — the third, most posterior segment of the thorax
Prothorax — the first, most anterior segment of the thorax
Thorax — the second (middle) major body region of an insect, often divided into three parts or segments

BODY STRUCTURES
Antennae — a variously shaped appendage of the head, occurring in pairs, commonly located between the eyes
Beak — hard, cone-shaped mouthparts
Cephalothorax — a single body region consisting of a head and thorax that are little differentiated from each other
Compound eyes — multifaceted eyes, usually situated laterally on the head of some aquatic insects (dragonflies, damselflies,
Mouthparts — any of several various structures which form the mouth of an insect; typical structures include the labrum, labium, madibles, maxilla
Exoskeleton — external, rigid body wall of arthropods
Eyespots — single eye or eye-like structure found on the head
beetles, etc.)
Filaments — slender, finger- or thread-like appendage such as antennae or gills
Gills — structures used for absorption of oxygen from the water
Labium — lower lip or most posterior whole mouthpart of the insect head
Labrum — upper lip or most anterior, unpaired mouthpart of the insect head
Lobe — a rounded projection
Operculum — a covering of a chamber (ex.: the disc-like structure covering the opening of the shell in an operculate snail)
Plate-like gills — broad, flattened gills
Prolegs — a fleshy, unsegmented, leglike or lobelike structure; usually occurring in pairs and located on the thorax of some fly larva and on the abdomen of various other insect larva
Protuberance — a projection or bulge; a rounded projection
Simple eyes — non-faceted eyes, usually smaller than compound eyes
Spiracle — an external opening along the body wall of insects used for air intake
Tubules — long, filamentous, tube-shaped structures
Wingpad — a developing wing or sheath of a developing wing

OTHER DESCRIPTIVE TERMS
Apex — tip or point of a structure
Caudal (or Anal) — a structure that is located on the very end, or near the anus of an organism
Elongated — long and thin; extended and lengthened
Membranous — consisting of or resembling a thin, pliable skin-like tissue serving to line or connect various body structures
Operculate — functioning as a covering for other structures (ex.: the triangular, rectangular or oval shaped gill coverings on the abdominal segments of various mayfly larvae)
Segmented — divided into sections, often of similar size, and joined in a linear fashion (ex.: leeches, aquatic worms and the abdominal regions of many aquatic insects)
Terminal — forming or located at the end of a structure

Definitions adapted in part from Aquatic Entomology: The Fishermen’s and Ecologists’ Illustrated Guide to Insects and Their Relatives (W. Patrick McCafferty, 1981)

Key prepared by Dr. R. Edward DeWalt and Carolyn Peet Nixon of the Illinois Natural History Survey, 607 E. Peabody Drive, Champaign, Illinois 61820.

Drawings in the key by C. Nixon or from The Mayflies of Illinois (B.D. Burks, Illinois Natural History Survey); The Caddis Flies, or Trichoptera, of Illinois (Herbert H. Ross, Illinois Natural History Survey); The Taxonomy and Bionomics of the Aquatic Hemiptera of Illinois (David Robert Lauck, unpublished Masters Thesis from the University of Illinois); or Freshwater Sphaeriacean Clams (Mollusca: Pelecypoda) of North America (J.B. Burch, US EPA)
Molluscs (mussels, clams and snails)
continued from page 1

Mussels and Clams
Shell usually oblong, but if round, then greater than 1 in. length

Asiatic Clam
Shell with contrasting black and white stripes, often tied to objects by threads, no more than 1.5 in. length

Freshwater Mussel
Shell w/out contrasting black and white stripes; no threads; up to 6 in. length

Right-Handed Snail
Shell up to 2 in. in width or length

Fingernail or Pea Clam
Shell smooth or with low, closely spaced ridges, less than 0.5 in. length

Operculate Snail
Shell generally less than 1 in. in width

Chinese Mystery Snail
Shell w/out operculum

Limpet
Shell opening to the left

Pianorbis Snail
Shell opening to the right

Snails
Snail shell consisting of a single piece; coiled or not

Snail shell consisting of two hinged parts, not coiled

Shell coiled

Shell flattened, coiled atop itself

Shell opening to the left

Shell opening to the right

Shell conical

Shell a simple cone

Left-Handed Snail
Shell without operculum

Shell with operculum

Shell generally less than 1 in. in width

Prepared for the Illinois EcoWatch Network by the Illinois Natural History Survey, Champaign, IL 61820
Aquatic Insect Orders
continued from page 1

Thorax with 3 pair jointed legs

Abdomen with forked jumping appendage; total body length up to 3mm

Thorax w/out jointed legs; prolegs or protuberances sometimes present

Thorax with hard or leathery wings or developing wingpads

Collembola (springtails, non-indicator)

Thorax w/out wings or developing wingpads

Abdomen w/out forked jumping appendage

Mouth is an elongate or cone-like beak; adults with leathery wings

Hemiptera (true bugs, non-indicators)

Mouth parts of chewing type; adults may have hard wings

Labium (lower lip) modified as diamond-shaped mask-like structure

Labium not mask-like

Thorax with hard wings covering at least part of the abdomen

Ephemeroptera (mayflies) continued on page 6

Forked or plate-like gills on abdomen; 1 claw per leg; usually three tails, occasionally two

At most one or two abdominal segments with finger-like gills; 2 claws per leg; two tails

Plecoptera (stoneflies)

Thorax with soft wingpads

Odonata (damselflies and dragonflies), continued page 5

Prepared for the Illinois EcoWatch Network by the Illinois Natural History Survey, Champaign, IL 61820
Aquatic Insect Orders, continued
continued from page 3

Abdomen with pairs of short, fleshy, prolegs with ring of tiny hooks at tip

Abdomen lacks short, fleshy, structures with ring of hooks

Abdomen ends variously but never in 1 pair of prolegs having a single hook each (if pair of prolegs are present, then 2 hooks)

Abdomen ends in 1 pair of short or long prolegs (sometimes fused together) that have a single hook each.

Lepidoptera (aquatic moths, non-indicators)

Abdomen has well-developed lateral filaments

Abdomen lacks well-developed lateral filaments

End of abdomen with single, unforked filament or 1 pair prolegs, each with 2 hooks

If filaments at end of abdomen, then paired or forked, or if proleg, then single proleg with 4 hooks

Megaloptera (hellgrammites and alderflies), continued page 5

Trichoptera (caddisflies), continued page 7

Coleoptera (beetles, in part), continued page 9

Prepared for the Illinois EcoWatch Network by the Illinois Natural History Survey, Champaign, IL 61820
Megaloptera (dobson flies and alderflies) continued from page 4

Tip of abdomen with pair of prolegs armed with 2 claws

Hellgrammite (dobsonfly larvae)

Tip of abdomen with single long filament

Alderfly

Odonata (dragonflies and damselflies) continued from page 3

Abdomen w/out external gills

Abdomen with external gills oar-like – careful, sometimes these are knocked off

Dragonflies

Damselflies

First antennal segment very long

All antennal segments same length

Broadwinged Damselflies

Narrow-winged Damselflies

Prepared for the Illinois EcoWatch Network by the Illinois Natural History Survey, Champaign, IL 61820
Ephemeroptera (mayflies)

continued from page 3

Thorax covering much of abdomen, with prominent spines

Thorax not enlarged, no prominent spines laterally

Facial plate facing forward (visible from above)

Mouthparts facing downward (not visible from above)

Gills on second abdominal segment either operculate, forked, or lacking

Gills on second abdominal segment normal platelike gills

Forelegs w/ out rows of long stiff hairs

Forelegs with double row of long, stiff hairs

Gills on segment 2 operculate (may be rectangular, triangular or oval)

Gills on segment 2 not operculate, although those on segment 3 or 4 may be operculate; otherwise gills are platelike or forked

Armored Mayflies

Clinging Mayflies

Burrowing Mayflies

Swimming Mayflies

Other Mayflies

Prepared for the Illinois EcoWatch Network by the Illinois Natural History Survey, Champaign, IL 61820
Trichoptera (caddisflies) continued from page 4

All three thoracic segments hardened

One or more thoracic segments membranous

Abdomen without filamentous gills

(Microcaddisflies, always less than 6mm, often only 2 or 3 mm long)

Other Caddisflies

Hydropsychid Caddisflies

Abdomen with conspicuous bundles of filamentous gills

Caddis either free living, or case variable (made of sand, silk, or plant material), but not domed or coiled

Caddis either free living, or case variable (made of sand, silk, or plant material), but not domed or coiled

Caddis with sand case either domed top with flattened bottom, or coiled like a snail case

Caddis with coiled case

Caddis with domed case

Snail-case Caddisflies

Other Caddisflies

Saddle-case Caddisflies

Prepared for the Illinois EcoWatch Network by the Illinois Natural History Survey, Champaign, IL 61820
Diptera (true flies) continued from page 3

**Fly Pupae, non-indicators**

- **Blackfly Pupae**
  - Pair of highly branched gills on thorax about 1/2 length of body; slipper-shaped case
- **First thoracic segment with fleshy prolegs with hooks**
- **Lower third of abdomen swollen; head usually with fans for feeding**
- **Last abdominal segments with tubules; body blood red in life**

**Body with developing wingpads**

- **Body w/out developing wingpads**
  - Head inconspicuous, sometimes with only hard mouthparts and slender rods; often retracted into body

**Body w/out developing wingpads**

- **Head fully formed and distinct from thorax**
- **Several abdominal segments with prolegs; abdominal tip with feathery pointed lobes; lateral lobes on other abdominal segments**
- **Several abdominal segments with prolegs; abdominal tip with disc containing dark spiracles surrounded by 2-8 lobes (most commonly 6)**

**Head fully formed and distinct from thorax**

- **Abdomen variable, but not with the combination of abdominal prolegs, feathery lobe at tip and lateral abdominal lobes**
- **Abdominal tip w/out disc, spiracles, and lobes**

**Snipe Fly**

- **First thoracic segment w/out fleshy prolegs**

**Crane Fly**

- **Body very slender; lacking abdominal prolegs or lateral filaments**

**Bloodworm**

- **Last abdominal segments w/out tubules; body color varies**
- **Body very slender; lacking abdominal prolegs or lateral filaments**

**Midge**

- **Body not slender, possibly thorax or abdominal segments swollen; may have abdominal prolegs; lateral filaments possible**

**Biting Midge**

- **Abdominal tip w/out disc, spiracles, and lobes**

**Other Fly**

- **Other Fly**

Prepared for the Illinois EcoWatch Network by the Illinois Natural History Survey, Champaign, IL 61820
Coleoptera (beetles)

continued from page 3

Body w/out wings: larval beetles

Body elongate, head and legs not concealed when present

Compound eyes undivided

Leg length proportional to body size, clawed segment much shorter than previous segments combined

Body completely hardened; last abdominal segment with operculum (flap) with pair of hooks, often with gills protruding

Body with membranous segments; last abdominal segment w/out operculum

Abdomen with or w/out lateral filaments; tip of abdomen w/out cone-shape projection bearing four hooks

Abdomen with lateral filaments; tip of abdomen with single cone-shape projection with four hooks

Abdomen with lateral filaments; tip of abdomen w/out cone-shape projection with four hooks

Other Beetle, a non-indicator

Other Beetle, a non-indicator

Water Penny

Body disc shaped, covering head and legs

Compound eyes split into dorsal and ventral pairs; back two pair of legs reduced

Legs long for body size, clawed segment long, about as long as previous 4 segments

Whirligig Beetle

Whirligig Beetle

Riffle Beetle

Body w/out wings: larval beetles

Body with hard wings: adult beetles

Body elongate, head and legs not concealed when present

Compound eyes undivided

Leg length proportional to body size, clawed segment much shorter than previous segments combined

Body completely hardened; last abdominal segment with operculum (flap) with pair of hooks, often with gills protruding

Body with membranous segments; last abdominal segment w/out operculum

Abdomen with or w/out lateral filaments; tip of abdomen w/out cone-shape projection bearing four hooks

Abdomen with lateral filaments; tip of abdomen with single cone-shape projection with four hooks

Other Beetle, a non-indicator

Other Beetle, a non-indicator

Water Penny

Body disc shaped, covering head and legs

Compound eyes undivided

Leg length proportional to body size, clawed segment much shorter than previous segments combined

Body completely hardened; last abdominal segment with operculum (flap) with pair of hooks, often with gills protruding

Body with membranous segments; last abdominal segment w/out operculum

Abdomen with or w/out lateral filaments; tip of abdomen w/out cone-shape projection bearing four hooks

Abdomen with lateral filaments; tip of abdomen with single cone-shape projection with four hooks

Other Beetle, a non-indicator

Other Beetle, a non-indicator

Water Penny

Body disc shaped, covering head and legs

Compound eyes undivided

Leg length proportional to body size, clawed segment much shorter than previous segments combined

Body completely hardened; last abdominal segment with operculum (flap) with pair of hooks, often with gills protruding

Body with membranous segments; last abdominal segment w/out operculum

Abdomen with or w/out lateral filaments; tip of abdomen w/out cone-shape projection bearing four hooks

Abdomen with lateral filaments; tip of abdomen with single cone-shape projection with four hooks

Other Beetle, a non-indicator

Other Beetle, a non-indicator

Water Penny

Body disc shaped, covering head and legs

Compound eyes undivided

Leg length proportional to body size, clawed segment much shorter than previous segments combined

Body completely hardened; last abdominal segment with operculum (flap) with pair of hooks, often with gills protruding

Body with membranous segments; last abdominal segment w/out operculum

Abdomen with or w/out lateral filaments; tip of abdomen w/out cone-shape projection bearing four hooks

Abdomen with lateral filaments; tip of abdomen with single cone-shape projection with four hooks

Other Beetle, a non-indicator

Other Beetle, a non-indicator

Prepared for the Illinois EcoWatch Network by the Illinois Natural History Survey, Champaign, IL 61820