

## APPENDIX B: IDENTIFICATION GUIDE TO COMMON STREAM BENTHIC MACROINVERTEBRATES OF VIRGINIA



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## INTRODUCTION

### *Scope of Key*

Stream benthic macroinvertebrates are small stream-dwelling animals that do not have vertebrae and are visible with the naked eye. Because different types of benthic macroinvertebrates differ in their sensitivity to stream impacts, the composition of the benthic macroinvertebrate community in a stream can provide information about the relative health of the given watershed.

Stream benthic macroinvertebrates are complex in form and function. This guide was developed to help simplify benthic macroinvertebrate identification, introduce stream benthic macroinvertebrates to the regulated public and regulators, and facilitate the use of the benthic condition assessment parameter in the future for assessing stream impacts in Virginia.

This guide only covers the most common benthic macroinvertebrates found in Virginia. Most groups, or taxa, in this guide are keyed to the order level, with emphasis on those that are commonly collected in Virginia streams. Others are keyed to the phylum, class or family level. The taxonomic hierarchy used to classify animals is as follows:

Kingdom → Phylum → Class → **Order** → Family →  
Genus → Species

### *Using the Key*

This key is made up of sections called couplets or triplets. A couplet consists of two character choices, each of which leads you to a result. The result can either be an endpoint, or lead the user to another couplet or triplet. A triplet is similar to a couplet, but has three character choices, all of which can lead to an endpoint or another couplet or triplet. Endpoints are in bold and are the lowest taxonomic level in the key. Couplets and triplets are in paired and tripled numbers. The first character choice in a couplet or triplet is a number (e.g. 1). The second choice in a couplet or triplet is a number with a "prime" symbol attached (e.g. 1'). In a triplet, the third character choice is a number with a double-prime symbol attached (e.g. 1"). Following the number for each choice in a couplet is the location where the present couplet or triplet originated. This number is in parentheses. Additionally, a glossary of terms is provided on page 188.

## HOW TO READ A COUPLET


*Previous couplet* →

*Current couplet* →

*If the organism is identified by this half [6 (3'')] of couplet 6, then the organism is an adult beetle, order Coleoptera*

6 (3''). Body hard, beetle-like; hardened wingpads meet along centerline of back (Fig. 14) .....adult beetles, order **Coleoptera** (in part)

*Endpoint (in bold)*



*Character description on figure.*

*Figure heading or first half of couplet 6.*


Figure 14. Examples of different types of adult beetles (order Coleoptera).

*Figure for first half of couplet 6.*

*Description of taxa described by endpoint*

*Adult beetles vary considerably in shape; however, the body of all adult beetles is very hard. Beetles are facultative to most forms of environmental stress. Some species have very narrow environmental requirements and are found only in undisturbed areas.*

6' (3''). Body mostly soft, not beetle-like; wingpads, if present, are more soft (Fig. 15).....7



*Figure for second half of couplet 6.*

Figure 15. Examples of stream macroinvertebrates with non-beetle-like bodies.

*Figure heading for second half of couplet 6.*

*If the organism is identified by this half [6' (3'')], then proceed to couplet 7.*

## ACKNOWLEDGEMENTS

Matthew Rowe and Chris Lockett of the Maryland Department of the Environment (MDE), Dave Penrose of North Carolina State University, and Larry Butler and Diana Saccone of the Reston Association provided invaluable technical advice and editorial support for the Benthic Condition section of this Manual.

## PHOTOGRAPH AND ILLUSTRATION CREDITS

The following websites were used to obtain photographs for this guide:

[www.usa.ca](http://www.usa.ca), [www.naturdetektive.de](http://www.naturdetektive.de), [www2.nrm.se](http://www2.nrm.se),  
<http://members.aol.com/Mkohl2/NAPleuroceridae.html>,  
[www.microscopy-uk.org.uk](http://www.microscopy-uk.org.uk), [www.benthos.org](http://www.benthos.org), [www.inhs.uiuc.edu](http://www.inhs.uiuc.edu),  
[www.bioweb.lu](http://www.bioweb.lu), [www.dec.state.ny.us](http://www.dec.state.ny.us), [www.bayern.de](http://www.bayern.de),  
[www.cals.ncsu.edu](http://www.cals.ncsu.edu),  
[www.delawarenaturesociety.org](http://www.delawarenaturesociety.org), [www.utexas.edu](http://www.utexas.edu),  
[www.insects.tamu.edu](http://www.insects.tamu.edu), [www.kulak.ac.be](http://www.kulak.ac.be),  
[www.cedarcreek.umn.edu](http://www.cedarcreek.umn.edu), [www.canadianbiodiversity.org](http://www.canadianbiodiversity.org),  
[www.riverwatershed.org](http://www.riverwatershed.org), [www.zooex.baikal.ru](http://www.zooex.baikal.ru), [www.nps.gov](http://www.nps.gov),  
[www.bugpeople.org](http://www.bugpeople.org),  
[www.reflex.at/.../Tiere\\_im\\_Wasserzygoptera.htm](http://www.reflex.at/.../Tiere_im_Wasserzygoptera.htm),  
[www.uci.net](http://www.uci.net), [www.dfg.ca.gov](http://www.dfg.ca.gov), [www.info.wlu.ca](http://www.info.wlu.ca), [www.usask.ca](http://www.usask.ca),  
[www.julia-nki.hu](http://www.julia-nki.hu), [www.shore.co.monmouth.nj.us](http://www.shore.co.monmouth.nj.us),  
[www.ittiofauna.org](http://www.ittiofauna.org), [www.umd.umich.edu](http://www.umd.umich.edu), [www.zooex.baikal.ru/  
beetles/hydrophilidae.htm](http://www.zooex.baikal.ru/beetles/hydrophilidae.htm), [www.ausrivas.canberra.edu.au](http://www.ausrivas.canberra.edu.au),  
[www.epa.gov](http://www.epa.gov)

The following books were used to obtain illustrations for this guide:

Cummins, K.W. and R.W. Merritt. 1996. *An Introduction to the Aquatic Insects of North America, Third Edition*. Kendall/Hunt Publishing Company.

Voshell, Jr., Reese. 2002. *A Guide to Common Freshwater Invertebrates of North America*. The McDonald and Woodward Publishing Company.

## KEY TO COMMON STREAM BENTHIC MACROINVERTEBRATES OF VIRGINIA (WITHOUT FIGURES)

1. With shell (Fig. 1)..... 2  
1'. Without shell (Fig. 2)..... 3
- 2 (1). Body enclosed by single shell (Fig. 3)  
.....snails and limpets, class **Gastropoda**  
2' (1). Body enclosed by two hinged shells (Fig. 4)  
.....clams and mussels, class **Bivalvia**
- 3 (1'). Body contains fewer than six legs (or leg-like appendages), or no legs; worm-like (Fig. 5)..... 4  
3' (1'). Body contains more than six legs (Fig. 6)..... 5  
3" (1'). Body contains six legs (Fig. 7).....class **Insecta** (in part) ..... 6
- 4 (3). Body unsegmented, flattened; eyespots usually present. (Fig. 8)  
.....flatworms, class **Turbellaria**  
4' (3). Body segmented; no distinct head or appendages  
(Fig. 9).....aquatic worms, phylum **Annelida**  
4" (3). Body segmented, with a head (may be retracted  
in body); most have leg-like appendages (pro-legs) (Fig. 10)  
.....true flies (larvae), class **Insecta**, order **Diptera**
- 5 (3'). Body with large carapace and pair of pincer-like  
appendages (Fig. 11).....crayfish, family **Cambaridae**  
5' (3'). Body without large carapace and pair of pincer-like appendages;  
flattened from top to bottom (Fig. 12)  
.....aquatic sowbugs, order **Isopoda**  
5" (3'). Body without large carapace and pair of pincer-like appendages;  
flattened from side to side (Fig.13).....scuds, order **Amphipoda**
- 6 (3"). Body hard, beetle-like; hardened wingpads meet along centerline  
of back (Fig. 14).....adult beetles, order **Coleoptera** (in part)  
6' (3"). Body mostly soft, not beetle-like; wingpads, if present, are more  
soft (Fig. 15)..... 7
- 7 (6'). Head with rostrum ; first pair of legs may be larger than the rest  
(Fig. 16).....true bugs, order **Hemiptera**  
7' (6'). Head without rostrum; lower jaw of head with grasping append-  
age (Fig. 17).....dragonflies and damselflies, order **Odonata**  
7" (6'). Head not as above (Fig. 18)..... 8

*Continue on next page* →

- 8 (7"). End of body with two long tails (cerci) and no hooks; no gills on abdomen (Fig. 19).....stoneflies, order **Plecoptera**
- 8' (7"). End of body with three (sometimes two) long tails (cerci) and no hooks; gills present on sides of abdomen  
(Fig. 20).....mayflies, order **Ephemeroptera**
- 8" (7"). End of body with hooks; if without hooks, then body ends in one slender filament **or** several short appendages **or** body flat and plate-like; larvae may make constructed case or net (Fig.20).....9
- 9 (8"). End of body with pair of hooks; most construct a case of various material including silk, sand, pebbles, or plant material, few are free living  
(Fig. 21).....caddisflies, order **Trichoptera**
- 9' (8"). End of body with 2 pairs of hooks, each on a pro-leg, or end of body with a single slender filament; conspicuous filaments on sides of abdomen  
(Fig. 22); large opposing jaws  
.....fishflies, dobsonflies, and alderflies, order **Megaloptera**
- 9" (8"). End of body without pair of hooks, slender filament, or conspicuous filaments on sides of abdomen (except in whirligig beetle larvae, which have a pair of hooks on end of abdomen on a single pro-leg and filaments on sides of abdomen); body may be flat and plate-like  
(Fig. 23) .....larval beetles, order **Coleoptera**

## KEY TO COMMON STREAM BENTHIC MACROINVERTEBRATES OF VIRGINIA (WITH FIGURES)

1. With shell (Fig. 1)..... 2

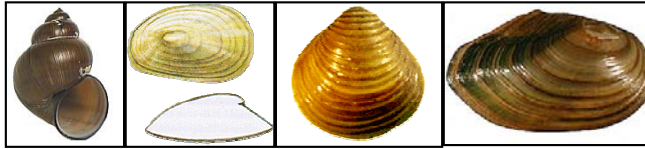


FIGURE 1: Examples of stream benthic macroinvertebrates with shells.

1'. Without shell (Fig. 2)..... 3



FIGURE 2: Examples of stream benthic macroinvertebrates without shells.

2 (1). Body enclosed by single shell (Fig. 3)  
 .....snails and limpets, class **Gastropoda**



FIGURE 3: Examples of different types of snails (class Gastropoda).

*Gastropods are freshwater macroinvertebrates consisting of a single shell, with a soft body inside. In most types, the shell is coiled, with the exception of the limpets, which have a flat cone-shaped shell with no coiling. Gastropods range from environmental stress tolerant to stress sensitive, depending on type.*

2' (1). Body enclosed by two hinged shells (Fig. 4)  
 .....clams and mussels, class **Bivalvia**



FIGURE 4: Examples of different types of bivalve (class Bivalvia).

*Bivalves are freshwater macroinvertebrates consisting of two shells, with a soft body inside. Clams have somewhat rounded shells. Mussels have more oval-shaped shells. Clams are generally tolerant to environmental stress, whereas mussels are generally sensitive to environmental stress.*



3 (1'). Body contains fewer than six legs (or leg-like appendages),  
or no legs; worm-like (Fig. 5) ..... 4



FIGURE 5: Examples of worm-like stream macroinvertebrates with fewer than six legs, or no legs.

3' (1'). Body contains more than six legs (Fig. 6)..... 5



FIGURE 6: Examples of stream macroinvertebrates with more than six legs.

3" (1'). Body contains six legs (Fig. 7)  
.....class Insecta (in part), ..... 6

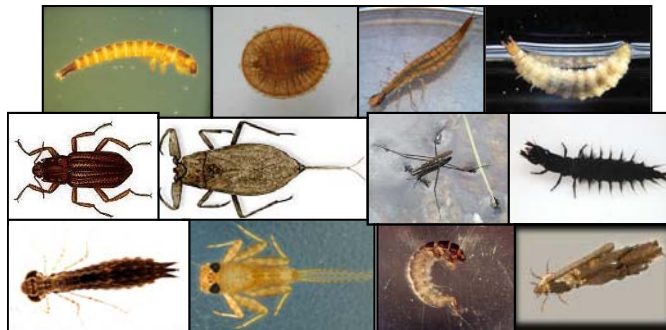


FIGURE 7: Examples of stream macroinvertebrates with six legs.

- 4 (3). Body unsegmented, flattened; eyespots usually present.  
(Fig. 8).....flatworms, class **Turbellaria**



FIGURE 8: Example of a flatworm (class Turbellaria)

*Flatworms are freshwater benthic macroinvertebrate worms that are unsegmented and flattened from top to bottom. Most are dark shades of gray, brown, or black. Most common kinds of flatworms are somewhat tolerant to environmental stress.*

- 4' (3). Body segmented; no distinct head or appendages  
(Fig. 9).....aquatic worms, phylum **Annelida**

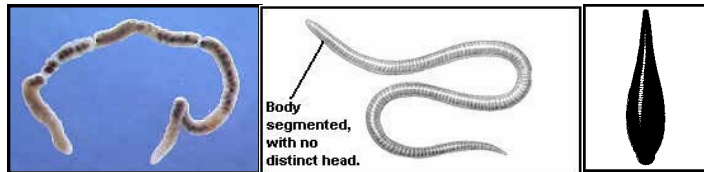


FIGURE 9: Examples of annelids (phylum Annelida).

*Annelids are freshwater benthic macroinvertebrate worms that are segmented, cylindrical or flattened, and elongate. Leeches (subclass Hirudinea) have a sucker on the front and the rear. Oligochaetes (subclass Oligochaeta) lack any suckers. Oligochaetes*

- 4'' (3). Body segmented, with a head (may be retracted in body); most have leg-like appendages (pro-legs) (Fig. 10)  
.....true flies (larvae), class Insecta, order **Diptera**



FIGURE 10: Example of dipteran larvae (class Diptera)

*Dipteran larvae are worm-like freshwater benthic macroinvertebrate insects that are segmented, have a distinct head, and most have several fleshy appendages. A few types are very tolerant to environmental stress.*

5 (3'). Body with large carapace and pair of pincer-like appendages (Fig. 11).....crayfish, family **Cambaridae**



FIGURE 11: Example of a crayfish (family Cambaridae)

*Crayfish are crustaceans with a large carapace and a pair of large pincer-like appendages. They are facultative to most forms of environmental stress.*

5" (3'). Body without large carapace and pair of pincer-like appendages; flattened from top to bottom (Fig. 12)  
.....aquatic sowbugs, order **Isopoda**



FIGURE 12: Example of an isopod (family Asellidae)

*Isopods are crustaceans that are flattened from top to bottom. They are common in leaf-packs and in small-order streams. Asellidae is the only family of isopods in Virginia streams. Most types of aquatic isopods are tolerant to environmental stress.*

5" (3'). Body without large carapace and pair of pincer-like appendages; flattened from side to side (Fig.13)  
.....scuds, order **Amphipoda**

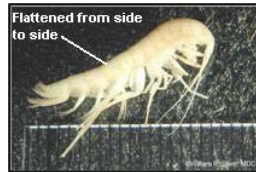


FIGURE 13: Example of scud (order Amphipoda)

*Scuds are crustaceans that are flattened from side to side and shrimp-like in appearance. They are common in leaf-packs and in small-order streams. Scuds are facultative to most forms of environmental stress.*

6 (3"). Body hard, beetle-like; hardened wingpads meet along centerline of back (Fig. 14)  
 .....adult beetles, order **Coleoptera** (in part)



FIGURE 14: Examples of different types of adult beetles (order Coleoptera).

*Adult beetles vary considerably in shape; however, the body of all adult beetles is very hard. Beetles are facultative to most forms of environmental stress. Some species have very narrow environmental requirements and are found only in undisturbed areas.*

6' (3"). Body mostly soft, not beetle-like; wingpads, if present, are more soft (Fig. 15).....7



FIGURE 15: Examples of stream macroinvertebrates with non-beetle-like bodies.

7 (6'). Head with rostrum ; first pair of legs may be larger than the rest (Fig. 16).....true bugs, order **Hemiptera**

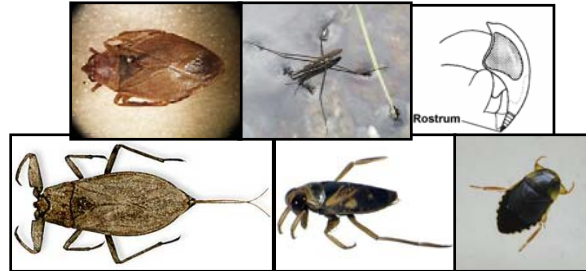


FIGURE 16: Examples of different types of hemipterans (order Hemiptera).

*Hemipterans are considered true bugs, with piercing-sucking mouthparts. Several types have an enlarged first pair of legs. Since hemipterans do not depend on dissolved oxygen for respiration, some types can be found in very polluted environments.*

7' (6'). Head without rostrum; lower jaw of head with retractable grasping appendage (Fig. 17)  
.....dragonflies and damselflies, order **Odonata**



FIGURE 17: Examples of dragonflies and damselflies (order Odonata), and grasping appendage.

*Odonates are distinguished by the grasping appendage on the underside of their head. Dragonflies are generally larger and more stout than damselflies. Additionally, damselflies have three flat, elongate paddle-like gills on the end of their body.*

7" (6'). Head not as above (Fig. 18).....8



FIGURE 18: Stream macroinvertebrates without a grasping appendage and with non-piercing-sucking mouthparts.



8 (7"). End of body with two long tails (cerci) and no hooks; no gills on abdomen (Fig. 19).....stoneflies, order **Plecoptera**



FIGURE 19: Examples of different types of stoneflies (order Plecoptera).

*Stoneflies can be distinguished from other aquatic insects by their long thin antennae, which project in front of the head. They have two (never three) long filament-like tails on the end of their body. Additionally, many have gills on the underside of the thorax. Gills are never present on the abdomen. Stoneflies are the most pollution sensitive order in all of the aquatic insects.*

8' (7"). End of body with three (sometimes two) long tails (cerci) and no hooks; gills present on sides of abdomen (Fig. 20).....mayflies, order **Ephemeroptera**



FIGURE 20: Examples of different types of mayflies (order Ephemeroptera).

*Most mayflies are distinguished by having three filament-like tails on the end of their body. Gills are located laterally on the abdomen. Most species of mayflies are very sensitive to environmental stress.*

8" (7"). End of body with hooks; if without hooks, then body ends in one slender filament **or** several short appendages **or** body flat and plate-like; larvae may make constructed case or net (Fig. 20)..... 9



FIGURE 21: Stream macroinvertebrates with bodies that end in hooks, a single filament, or several short appendages; some make constructed case or net.

9 (8"). End of body with pair of hooks; most construct a case of various material including silk, sand, pebbles, or plant material, few are free living (Fig. 21)

.....caddisflies, order **Trichoptera**



FIGURE 22: Examples of different types of caddisflies (order Trichoptera).

*Caddisflies are distinguished by having a pair of pro-legs at the end of their body, each with a single hook. Most have filament or branched gills on their abdomen. Many caddisflies construct a case or net out of various materials including silk, sand, pebbles, or plant material. Most species of caddisflies are very sensitive to environmental stress.*

9' (8"). End of body with 2 pairs of hooks, each on a pro-leg, or end of body with a single slender filament; conspicuous filaments on sides of abdomen (Fig. 22); large opposing jaws ..... fishflies, dobsonflies, and alderflies, order **Megaloptera**



FIGURE 23: Examples of different types of megalopterans (order Megaloptera).

*Most megalopterans are very large relative to other aquatic insect larvae. They have large opposing jaws and filament-like appendages on the sides of their abdomen. Most have a pair of hooks on the end of their body, with the exception to the alderflies, which have a single slender filament. Megalopterans are considered facultative to most environmental stress.*

9" (8"). End of body without pair of hooks, slender filament, or conspicuous filaments on sides of abdomen (except in whirligig beetle larvae, which have a pair of hooks on end of abdomen on a single pro-leg and filaments on sides of abdomen); body may be flat and plate-like (Fig. 23)

.....larval beetles, order **Coleoptera**



FIGURE 24: Examples of different types of beetle larvae (order Coleoptera).

*Beetle larvae can be very difficult to distinguish from other aquatic insect larvae. Bodies of water beetle larvae are variable. Some have large sickle-like opposing jaws. Most do not have conspicuous filaments on the sides of their abdomen or a pair of hooks on the end of their body. Beetles are facultative to most forms of environmental stress. Some species have very narrow environmental requirements and are found only in undisturbed areas.*





## GLOSSARY OF TERMS

1. **Abdomen:** The third main division of the body in insects; behind the head and the thorax.
2. **Carapace:** Large, shield-like structure covering the front end of crayfish.
3. **Cerci:** Long, filament-like appendages extending from the abdomen of mayflies and stoneflies.
4. **Crustaceans:** The subphylum of arthropods that includes the isopods, scuds, crayfish, and shrimp in streams.
5. **Facultative:** Referring to stream benthic macroinvertebrates that occur in environments with conditions ranging from low to moderate levels of environmental stress.
6. **Lateral:** A feature located on the side of the body or other structure.
7. **Pro-legs:** A non-jointed appendage that serves for locomotion or attachment.
8. **Rostrum:** Structure on the head of hemipterans for piercing prey.
9. **Segmented:** Referring to distinct body regions or sections in annelid worms.
10. **Sensitive:** Usually found in nearly pristine environments; quickly eliminated with disturbance.
11. **Tolerant:** Referring to stream benthic macroinvertebrates that occur in disturbed environments.

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Cummins, K.W. and R.W. Merritt. 1996. *An Introduction to the Aquatic Insects of North America, Third Edition*. Kendall/Hunt Publishing Company.

Maryland Department of Natural Resources Chesapeake Bay and Watershed Programs Monitoring and Non-Tidal Assessment Division. 2002. *Family-level Key to the Stream Invertebrates of Maryland and Surrounding Areas, Third Edition*. CBWP-MANTA-EA-99-2

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**NOTES:**