

APPENDIX B:

Minimum Standard Taxonomic Identification for Aquatic Invertebrates

Taxonomic Identification guidance adapted from (*“Water Quality Monitoring Protocols for Streams and Rivers, 2020; Pennsylvania Department of Environmental Protection”*).

Note: The Taxonomy Reference List does not list recent revised editions for many of the references. For most taxa, Merritt, Cummins & Berg (5th edition) level of taxonomic ID is acceptable, as stated below. However, if newer editions of other references (i.e., Single Order texts) are used, the resulting identifications will be accepted.

Taxonomic Level: The level of identification for most aquatic macroinvertebrates¹ will be to genus based on the recommended references listed in the Taxonomic Reference List below. Some individuals collected will be immature, and not exhibit the characteristics necessary for confident identification. Therefore, the lowest level of taxonomy attainable will be sufficient. Certain groups, however, may be identified to a higher taxonomic level, as follows:

- Snails (Gastropoda) – Family
- Clams, mussels (Bivalvia) – Family
- Flatworms (Platyhelminthes)
- Segmented worms (Annelida)
 - Aquatic earthworms & tubificids – Class Clitellata
 - leaches – Class Lumbriculata
 - Moss animalcules – Phylum
- Bryozoa Proboscis worms – Phylum
- Nemertea Roundworms – Phylum Nematoda
- Water mites – Acariformes

¹Presently, the identification of Chironomidae, or midges, is to the Family level. Record macroinvertebrate identifications on forms similar to those in Appendix C.

Taxonomy Reference List: This invertebrate taxonomic reference list is arranged in prioritized format to reflect current applicability in Pennsylvania.

Primary: The “primary” listings within any taxonomic group, printed in bold-face type below, are the best or most applicable to our needs. With respect to Insecta, Merritt, Cummins & Berg – 5th edition, is the most comprehensive listing for common Pennsylvania taxa. Pecharsky, et al. is the regional fauna key that is most applicable to Pennsylvania, but still may not include all Pennsylvania taxa. However, since both texts are both up-to-date, they can be used in conjunction with each other to provide the primary authority for insects as a group, unless otherwise indicated. The Single Order texts (i.e. Edmunds et al. Wiggins, Steward and Stark) are subject to recent revisions and, therefore. Would also still be relevant for their respective orders.

Secondary: The “secondary” listings are not as up-to-date or as applicable to Pennsylvania as the primary listing, but can be very important in supplying additional detailed figures, taxonomic identifications.

Others: The “others” listings are less important for taxonomic identifications but are provided as additional sources of valuable or interesting information. The reasons for listing them are because they: a) are very out-of-date, b) are regional keys, c) are not exclusively aquatic, or d) offer no more genus information than other references but may provide information for anyone interested in keys to species identifications.

INSECTA

Merritt, RW, KW Cummins & ML Berg, Eds. 2019. An Introduction to the Aquatic Insects of North America, 5th Edition. Kendall/Hunt Publishing Company, Dubuque, Iowa. 1480 pp.

Pecharsky, BL, PR Fraissinet, MA Penton, DJ Conklin Jr. 1990. Freshwater Macroinvertebrates of Northeastern North America. Cornell University Press. 456 pp.

Torre-Bueno, JR. 1937. A Glossary of Entomology. 336 pp. (reprinted 1973, New York Entomological Society).

Secondary:

Brigham, AR, Brigham, WU, A Gnilka. 1982. Aquatic Insects and Oligochaetes of North and South Carolina. Midwest Aquatic Enterprises. Mahomet, IL.

Hilsenhoff, WL. 1981. Aquatic Insects of Wisconsin. Geological and Natural History Survey. Madison, WI. 60 pp. (revised ed. Of 1975 publication).

Others:

Usinger, RL, et al. 1956. Aquatic Insects of California with Keys to North American Genera and California Species. Univ. of California Press, Berkely and Los Angeles. 508 pp.

EPHEMEROPTERA

Merritt, Cummins & Berg and Pecharsky, et al.

Edmunds, GF, Jr., SL Jensen, L. Berner. 1976. The Mayflies of North and Central America. University of Minnesota Press. 330 pp.

Secondary:

Pfeiffer, J., E. Kosnicki, J. Bilger & BD Marshall. 2006. A Photographic Key to the Baetidae of EPA Region III.

McCafferty, WP. 1975. The Burrowing Mayflies of the United States. (Ephemeroptera: Ephemeroidea). Trans. Amer. Ent. Soc. 101:447-504.

Morihara, DK & WP McCafferty. 1979. The Baetis Larvae of North America. (Ephemeroptera: Baetidae). Trans. Amer. Eng. Soc.. 105:139-221.

Others:

Burks, BD. 1953. The Mayflies or Ephemeroptera of Illinois. Bull. Ill. Nat. Hist. Surv. 26:1-216. (Reprinted 1975, Entomological Reprint Specialists).

Hucko, S & GR Finni. 1974. A Key to the Mayfly Nymphs (Insecta Ephemeroptera) of Pennsylvania and a Checklist of Pennsylvania Mayfly Species. Allegheny College Environmental Studies Report

19. 19 pp.
Needham, JG, JR Traver, VC Hsu. 1935. The Biology of Mayflies with a Systematic Account of North American Species. Comstock, Ithaca. 759 pp.

PLECOPTERA

Stewart, KW & BP Stark. 2002. Nymphs of North American Stonefly Genera (Plecoptera) 2nd edition. Thomas Say Foundation. Entomological Society of America. 12:1-509.

Secondary:

____ & _____. 1984. Nymphs of North American Perlodinae Genera (Plecoptera: Perlodidae). Great Basin, Nat. 44:373-415.
Surdick RF. 1985. Nearctic Genera of Chloroperlinae (Plecoptera: Chloroperlidae). Illinois Biological Monographs #54. University of Illinois Press. 146 pp.

Others:

Surdick, RF & KC Kim. 1976. Stoneflies (Plecoptera of Pennsylvania): A Synopsis. Penn State Univ. Agri. Exp. St. Bull. 808 73 pp. (Caution – Some stonefly genera that have been collected in Pennsylvania are not included in this publication.)
Frison, TH. 1935. The Stoneflies or Plecoptera of Illinois. Bull. Ill. Nat. His. Surv. 20:281-471. (Reprinted 1975, Entomological Reprint Specialists.)
Hitchcock, SW. 1974. Guide to the Insects of Connecticut. Part VII. The Plecoptera or Stoneflies of Connecticut. Bull. Conn. State Geol. Nat. His. Surv. 107:1-262.
Harper, PP & HBN Hynes. 1971. The Nymphs of the Taeniopterygidae of Eastern Canada (Insecta: Plecoptera). Can. J. Zool. 49:915-920.
____ & _____. 1971. The Leuctridae of Eastern Canada (Insecta: Plecoptera). Can. J. Zool. 49:915-920.
____ & _____. 1971. The Capniidae of Eastern Canada (Insecta: Plecoptera). Can. J. Zool. 49:921-940.
____ & _____. 1971. The Nymphs of the Nemouridae of Eastern Canada (Insecta: Plecoptera). Can. J. Zool. 49:1129-1142.
Kondratieff, BC, RF Kirchner, JR Voshell, Jr. 1981. Nymphs of Diploperla. Ann. Entomol. Soc. Am. 74:428-30.

TRICOPTERA

Merritt, Cummins & Berg and Pecharsky, et al.

Wiggins, GB. 1996. Larvae of North American Caddisfly Genera (Tricoptera), 2nd edition. University of Toronto Press, Toronto. 457 pp.

Others:

Ross, HH. 1944. The Caddisflies or Tricoptera of Illinois. Bull. Ill. Nat. Hist. Surv. 23:1-326. (Reprinted 1972, Entomological Reprint Specialists.)

Hydropsychidae

Schefler, PW & GB Wiggins. 1986. A Systematic Study of the Nearctic Larvae of the Hydropsyche Morose Group (Trichoptera: Hydropsychidae). Royal Ontario Museum. 94 pp.

Others:

Schuster, GA & Etnier, DA. 1978. A Manual for the Identification of the Larvae of the Caddisfly Genera Hydropsyche Pictet and Synphitopsyche Ulmer on Eastern and Central North America (Trichoptera: Hydropsychidae). Report No. EPA-600/4-78-060. US EPA, Cincinnati. 128 pp.

Rhyacophila species

Weaver III, JS & JL Sykora. 1979. The Rhyacophila of Pennsylvania with Larval Descriptions of R. banksi and R. camenteri (Trichoptera: Rhyacophilidae). Annal. Carnegie Museum. 48:403-423. (Note: Flint (1962) must be used in conjunction with this paper since it relies on some of flint's figures for complete characteristics.)

Secondary:

Flint, OS, Jr. 1962. Larvae of the Caddisfly Genus Rhyacophila in Eastern North America (Trichoptera: Rhyagophilidae). Proc. U.S. Nat. Mus. 113:465-493.

DIPTERA

Merritt, Cummins & Berg and Pecharsky, et al.

Secondary:

Gelhaus, J.K. 2002. Manual for the Identification of Crane Fly Larvae for Southeastern U.S.

Others:

Johannsen, OA (Part V by Lillian C. Thomsen). Aquatic Diptera. (Reprinted 1969 from Memoirs Nos. 164, 167, 205, 210 of Cornell University Agric. Exp. Station Entomological Reprint Specialists.)

Chironomidae

Merritt, Cummins & Berg and Pecharsky, et al.

Although the following references are regional in nature, they provide photograph figures of key characters for almost all the common genera found in Merritt, Cummins & Berg.

Secondary:

Epler, JH. 2001. Identification Manual for the Larval Chironomidae (Diptera) of North and South Carolina. A guide to the Taxonomy of the Midges of Southeastern United States, including Florida.

Special Publication SJ2001-SP13. North Carolina Department of Environment and Natural Resources, Raleigh, NC, and St. Johns River Water Management District, Palatka, FL 526 pp.

Oliver, DR & ME Roussel. 1983. The insects and Arachnids of Canada. Part 11. The General of Larval Midges of Canada. Diptera: Chironomidae. Agric. Can. Publ. 1746:1-263.

Simpson, KW & RW Bode. 1980. Common Larvae of Chironomidae (Diptera) from New York State Streams and Rivers, with Particular Reference to the Fauna of Artificial Substrates. Bull. N.Y. State Mus. 439:1-105.

Others:

Mason, WT, Jr. 1973. An Introduction to the Identification of Chironomid Larvae. Nat. Environ. Res. Cent./EPA. Cincinnati, OH. 90 pp. Note: This key was developed from specimens found in the larger channel areas of the Ohio River system, and therefore, does not include many new genera, or genera that are more common to small stream systems.

Simuliidae

Adler, PH & KC Kim. 1986. The Blackflies of Pennsylvania (Simuliidae: Diptera) Bionomics, Taxonomy and Distribution. Agri. Exp. Sta. Bull. 856. Penn. St. Univ. 88 pp.

COLEOPTERA

Merritt, Cummins & Bert and Pecharsky, et al.

Secondary:

Arnett, RH, Jr. 1973. The Beetles of the United States. The American Entomological Institute. 1112 pp.

Dryopoid Beetles

Secondary:

Brown, HP. 1972. Aquatic Dryopoid Beetles (Coleoptera) of the United States. Biota of Freshwater Ecosystems Identification Manual No. 6. Wat. Poll. Conf. Res. Ser. EPA. Washington, DC.

ANISOPTERA

Merritt, Cummins & Berg and Pecharsky, et al.

Needham, JG, MJ Westfall, Jr., & ML May. 2000. Dragonflies of North America. Scientific Publishers, Gainesville, FL, 639 pp. (revised edition of Needham @ Westfall – 1955).

Westfall, Jr., MJ & ML May. 1996. Damselflies of North America. Scientific Publishers, Gainesville, FL 649 pp.

Others:

Needham, JG & MJ Westfall, Jr. 1955. A Manual of the Dragonflies of North America (Anisoptera). University of California Press, Berkeley. 615 pp. (Reprinted 1975, 1980) (retained because it has character; diagnostic tables not included in the 2000 edition that may still be useful.)

OTHER INTERVEBRATES

Thorp, JH & AP Covich. 1991. Ecology and Classification of North American Freshwater Invertebrates. Academic Press, Inc. 911 pp.

Pennak, RW. 1989. Freshwater Invertebrates of the United States: Protozoa to Mollusca, 3rd ed.; John Wiley & Sons, Inc. 628 pp.

Bogan, AE. 1993. Workshop of Freshwater Bivalves of Pennsylvania. Unpublished 80 pp. This document is Dr. Art Bogan's mussel key that is periodically updated and "fine-tuned" and has excellent color plates. It may be available from Dr. Bogan at the following address: North Carolina Museum of Natural History; PO Box 29555, Raleigh, NC 27626-0555.

Secondary:

Burch, JB 1972. Freshwater Sphaeriacean Clams (Mollusca; Pelecypoda) of North America. Biota of Freshwater Ecosystems Identification Manual No. 3. Wat. Poll. Conf. Res. Ser. EPA Washington, DC.

Hobbs, HH, Jr. 1972. Crayfish (Astacidae) of North and Middle America. Biota of Freshwater Ecosystems Identification Manual No. 3. Wat. Poll. Conf. Res. Ser. EPA Washington, DC.

Holsinger, Jr. 1972. The Freshwater Amphipod Crustaceans (Gammaridae) of North America, Biota of Freshwater Ecosystems Identification Manual No. 9. Wat. Poll. Conf. Res. Ser. EPA Washington, DC.

Jokinen, EH. 1992. The Freshwater Snails (Mollusca: Gastropoda) of New York State, New York State Museum Bulletin 482. 112 00.

Kenk, R. 1972. Freshwater Planarians (Turbellaria) of North America. Biota of freshwater Ecosystems Identification Manual No. 1. Wat. Poll. Cont. Res. Ser. EPA Washington, DC.

Klemm, DH. 1972. Freshwater Leeches (Annelide: Hirudinea) of North America. Biota of Freshwater Ecosystems Identification Manual No. 8. Wat. Poll. Conf. Res. Ser. EPA. Washington, DC.

Williams, WD. 1972. Freshwater Isopods (Asellidae) of North America. Biota of Freshwater Ecosystems Identification Manual No. 7. Wat. Poll. Conf. Res. Ser. EPA. Washington, DC.