IDENTIFICATION OF WISCONSIN TUBIFICIDAE AND NAIDIDAE

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INTRODUCTION

Oligochaete worms of the families Tubificidae and Naididae are common and frequently abundant in freshwater habitats, but there exists very little information concerning the life histories and ecology of even the commonest species. In fact, we do not have even an adequate inventory of the aquatic oligochaete fauna for most regions of North America. This unfortunate situation is apparently the result of a widely held notion that aquatic oligochaetes are difficult to identify to the species level. This *was* true, for older keys often required dissection of specimens or examination of serial sections, and failed to include many species which we now know to be common. However, taxonomic studies by Brinkhurst during the 1960s resulted in the production of keys (Brinkhurst 1964, 1965, Brinkhurst and Jamieson 1971) which make possible the identification of specimens mounted whole on microscope slides. Thus, while most older publications dealing with aquatic oligochaetes were primarily systematic, there has been a recent emphasis on natural history, ecology and pollution tolerance of various species. Keys for the identification of common aquatic worms are presented here with the hope that they will stimulate and facilitate more studies of this sort on the lakes and streams of Wisconsin.

While several keys to North American Tubificidae and Naididae have been published in the past decade, we feel that it is valuable to present these keys for regional use because those currently available consider many species unlikely to occur in the inland waters of the upper midwest (Brinkhurst 1965, 1967; Brinkhurst and Jamieson 1971); fail to include a few species now known to occur in the waters of Wisconsin; are unnecessarily unwieldy for a restricted area, since they do not proceed directly to the species level (Brinkhurst and Jamieson 1971); have had only a very limited distribution (Brinkhurst 1967, Hiltunen 1970, 1973); or use terminology or nomenclature inconsistent with that in the recent

world monograph of Brinkhurst and Jamieson (1971). The keys presented here proceed directly to the species level and include only species known from the inland waters of Wisconsin (Howmiller, 1974, and unpublished records of Loden). Records of Wisconsin aquatic oligochaetes have come from collections in lakes representing a considerable range of environmental conditions (cf. Howmiller 1974) but rather few collections from running water habitats have been studied. It is thus likely, particularly for the naidids, that investigations in streams will turn up species not included in our keys. When such specimens are encountered, it will be necessary to consult Brinkhurst and Jamieson (1971) or other taxonomic references cited in the bibliography of this paper.

The keys are meant for identification of worms mounted whole on microscope slides. Magnification of up to 440X is required and higher magnification is occasionally convenient. Amman's lactophenol[1], Turtox CMC, or a mixture of the two are suitable mountants. Amman's lactophenol seems to clear specimens more quickly, but CMC allows more freedom in handling of slides, since it hardens. A mixture allows one to exploit the best features of the two. For more detailed taxonomic studies, or when specimens will be made part of permanent collections, a resinous mounting medium is recommended.

Characteristics Used in Identification of Tubificidae

Tubificid oligochaetes typically bear setae arranged in four bundles, two dorso-lateral and two ventro-lateral, on each segment except the first (Fig. 1a, 1b). The form of the setae provides the most valuable features for identification of most species. Most tubificids have setae which are bifid (two-toothed) distally, though the sizes and arrangement of the teeth vary greatly between species (Fig. 2a-h). Many species have pectinate setae (Fig. 2i-p), hair setae (e.g. Fig. 2t), or both, in dorsal bundles. Other unusual shapes occur and are often highly characteristic of the species which bear them (e.g. Fig. 2q-s, u).

Unfortunately, many tubificid species cannot be identified by characteristics of the somatic setae alone. This category includes 10 of the 17 species in this key and some of the most commonly occurring species. Identification of these species requires sexually mature specimens for the examination of genital structures.

[1]20 g phenol crystals, 16 ml lactic acid, 20 ml distilled water, and 31 ml glycerol. A small amount of aniline blue may be added.

Some species have setae on the ventral side of one or two segments (X-XI) reduced in number and specially modified for reproductive purposes. Where somatic setae are not sufficiently distinctive these penial (e.g. Fig. 2v) or spermathecal (e.g. Fig. 2x, y) setae provide valuable characteristics for identification.

Variously shaped penis sheathes (Fig. 3a-l), generally borne on segment X or XI, are used in the identification of mature specimens of some species.

Collections often include large numbers of unidentifiable immature worms. Most workers separate these into two groups based on the presence or absence of hair setae. When sufficient numbers of mature individuals have been identified from a given habitat, it is often possible to come to a reasonable conclusion concerning the specific identity of the immatures with hairs, those without hairs, or both.

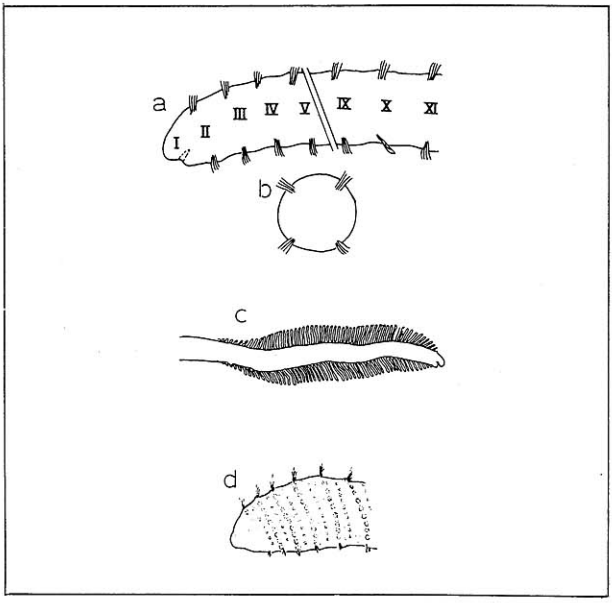

FIGURE 1. Portions of the body of tubificids; a) longitudinal side view of a generalized tubificid showing the method of numbering segments. Setae are borne on all segments except the first (I). b) cross-sectional view of generalized tubificid showing dorso-lateral and ventro-lateral bundles of setae. c) posterior end of *Branchiura sowerbyi* showing dorsal and ventral gills. d) anterior end of *Peloscolex multisetosus* showing characteristic papillation of body wall. DRAWINGS ARE NOT ALL TO SAME SCALE.

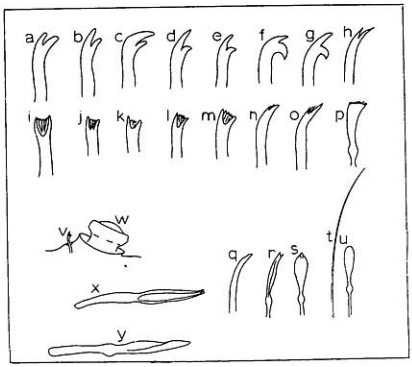

FIGURE 2. Setae of Tubificidae: a-h) various bifid setae; a,b) as of many *Limnodrilus* species, c) anterior of *L. udekemianus*, d) anterior ventral of *Ilyodrilus templetoni*, e) anterior ventral of *Tubifex tubifex*, f) posterior ventral of *Peloscolex multisetosus multisetosus*, g) posterior ventral of *P. m. longidentus*, h) ventral of *Aulodrilus limnobius*, i-p) various pectinate setae; i) *Peloscolex multisetosus*, j,k) *Tubifex tubifex*, 1) *Ilyodrilus templetoni*, m) *Potamothrix hammoniensis*, n,o) *Aulodrilus pluriseta*, p) *A. americanus*. q) simple anterior seta of *Aulodrilus americanus*, r,s) lateral and facial view of flattened dorsal seta of *A. limnobius*, t,u) hair and dorsal "oar shaped" setae of *A. pigueti*, v,w) penial seta and penis of *Potamothrix moldaviensis*, x) spermathecal seta of *P. moldaviensis*, y) spermathecal seta of *P. hammoniensis*. DRAWINGS NOT ALL TO SAME SCALE.

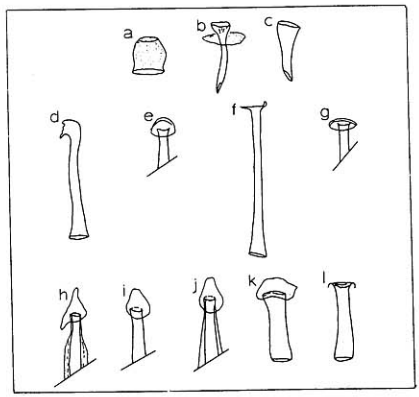

FIGURE 3. Penis sheathes of some tubificid species; a) *Tubifex tubifex*, b) *Tubifex kessleri americanus*, c) *Ilyodrilus templetoni*, d,e) *Limnodrilus hoffmeisteri*, f, g) *L. spiralis*, h) *L. cervix*, i) *L. claparedeianus*, j) a form intermediate between h and i, k) *L. udekemianus*, l) *L. profundicola*. DRAWINGS NOT ALL TO SAME SCALE.

KEY TO TUBIFICIDAE

Known from the Inland Waters of Wisconsin

1 Posterior segments of worm bearing prominent gill filaments (Fig. 1c) ..... *Branchiura sowerbyi*

1' No gill filaments on posterior segments 2

2(1') Hair setae present in anterior dorsal bundles 3

2' Hair setae absent 10

3(2) Body wall bearing papillae in two rows on each segment; row of large papillae in line with the setae, row of smaller papillae in between (Fig. 1d) . .*Peloscolex multisetosus* 4

3' No papillae, body wall naked 5

4(3) Posterior ventral setae with distal tooth as short or shorter than the proximal tooth (Fig. 2f)..... *Peloscolex multisetosus multisetosus*

4' Posterior ventral setae with distal tooth longer than the proximal tooth (Fig. 2g)..... *Peloscolex multisetosus longidentus*

5(3') Dorsal bundles behind segment VII with hair setae and oar-shaped setae (Fig. 2t, u), no pectinate setae ..... *Aulodrilus pigueti*

5' No oar-shaped setae, anterior dorsal bundles containing pectinate setae..... 6

6(5') Pectinate setae with reduced distal tooth and only one or two intermediate teeth which are about the same size as the distal tooth (Fig. 2n, o)..... *Aulodrilus pluriseta*

6' Pectinate setae having both lateral teeth considerably larger than the intermediate teeth (Fig. 2j-m)..... 7

7(6') Mature specimens bearing modified genital setae...*Potamothrix* ..... *hammoniensis*[1]

7' No specialized genital setae; mature specimens with cuticular penis sheathes (Fig. 3a-1)..... 8

8(7') Penis sheathes short, tub shaped (Fig. 3a) ..... *Tubifex tubifex*

8' Penis sheathes elongate, tapering distally 9

9(8') Penis sheathes narrowly conical but with a broad base, distal end pointed, opening lateral (Fig. 3b) ... *Tubifex kessleri americanus*

9' Penis sheathes conical (often wrinkled in whole mounts); opening lateral, oblique or terminal (Fig. 3c) ..... *Ilyodrilus templetoni*

10(2') Anterior setae simple or with distal tooth much reduced (Fig. 2q), posterior dorsal setae broadly palmate (Fig. 2p) ..... *Aulodrilus americanus*

10' Anterior setae distinctly bifid, no palmate setae 11

11(10') Anterior ventral setae with distal tooth much thicker and longer than the proximal and set at nearly a right angle to the shaft (Fig. 2c), mature specimens with penis sheathes as in Fig. 3k ..... *Limnodrilus udekemianus*

11' Anterior ventral setae with distal tooth as thin or thinner than the proximal and shorter, equal, or only slightly longer than the proximal tooth 12

12(11') Dorsal setae of median and posterior segments broadly flattened just below teeth (Fig. 2r, s), anterior dorsal and ventral setae with distal tooth much thinner and shorter than the proximal (Fig. 2h) ..... *Aulodrilus limnobius*

12' No broadly flattened setae in dorsal bundles, anterior dorsal and ventral setae with the distal tooth at the least only slightly thinner and shorter than the proximal 13

13(12') Mature specimens bearing modified genital setae in the region of segment X; these spermathecal setae relatively large and broad (Fig. 2x); may also have fleshy penes with accessory penial setae (Fig. 2v, w) on segment XI ..... *Potamothrix moldaviensis*

13' No specialized genital setae; mature specimens with cuticular penis sheathes in the region of segment XI 14

14(13') Fully mature specimens with penis sheathes at least thirty times as long as width at base 15

14' Fully mature specimens with penis sheathes no longer than fifteen times width at base 16

15(14) Penis sheathes with thick two-layered walls, narrowing and the walls becoming thinner abruptly just below the head, head of penis sheath triangular, not bilaterally symmetrical (Fig. 3h). ..... *Limnodrilus cervix*[2]

15' Penis sheathes with thin walls, the sheath not narrowing abruptly near the head, head of sheath pear shaped and bilaterally symmetrical (Fig. 3i) ..... *Limnodrilus claparedeianus*[2]

16(14') Penis sheathes relatively long, 300-900 μ when fully developed.17

16' Penis sheathes short, 200-300 μ when fully developed 18

17(16) Head of penis sheath a hood turned at a sharp angle to the shaft (Fig. 3d, e).....*Limnodrilus hoffmeisteri*

17' Head of penis sheath a broad plate which is slightly upturned at one point (Fig. 3f, g) .....*Limnodrilus spiralis*[3]

18(16') Anterior ventral setae with distal tooth much longer and thicker than the proximal and set at nearly a right angle to the shaft (Fig. 2c), penis sheathes as in Fig. 3k..... *Limnodrilus udekemianus*

18 Anterior ventral setae with distal tooth at most slightly longer and typically somewhat thinner than the proximal (Fig. 2a, b), penis sheathes as in Fig. 31 .....*Limnodrilus profundicola*

NOTATIONS CONCERNING TAXONOMIC PROBLEMS

[1]*Potamothrix hammoniensis, P. bavaricus* and *P. bedoti* would all key out to this point. These are morphologically very similar and one or more of them occur in Wisconsin. Howmiller (1974) reported *P. hammoniensis* from Lake Geneva but the report was based upon few specimens and some judgment was involved in the identification. As mentioned by Brinkhurst and Jamieson (1971) there is considerable variation in form of spermathecal setae within this species. *Potamothrix hammoniensis* has been reported only twice before from North American (Brinkhurst 1967, Howmiller and Beeton 1970). *Potamothrix bavaricus* has been more frequently found but Timm (1972) feels that all records should be referred to *P.* (as *Euilyodrilus*) *bedoti.* Timm (1970, 1972) and Hrabe (1967) distinguish between *P. bavaricus* and *P. bedoti* on the basis of differences in placement and form of the spermathecal setae. Brinkhurst (1965) believes that *bedoti* was established on the basis of unusual specimens of *bavaricus* and thus considers *bedoti* a synonym of the latter (Brinkhurst and Jamieson 1971).

[2]In many North American collections, it is difficult to distinguish between *Limnodrilus cervix* and *L. claparedeianus* on the basis of penis sheath morphology (Figs. 3h, i). Specimens with sheaths intermediate in form (Fig. 3i) are often more common than those considered characteristic of either of the two species. It would seem that, in these cases, they do not form separate populations and recognition of this should be made by reporting the presence of specimens appearing to be *cervix - claparedeianus* intermediates.

[3]Brinkhurst (1965, Brinkhurst and Jamieson 1971) considers this form to be a variant of *L. hoffmeisteri* and treats the name *spiralis* as a synonym. Cook and Johnson (1974) have suggested that *spiralis* may be a hydrid between *L. hoffmeisteri* and *L. claparedeianus* but some authors (cf. Kinney

1972) treat it as a distinct taxon. We recognize *L. spiralis* because, in addition to being morphologically distinct, some evidence indicates that it may be ecologically different from typical *L. hoffmeisteri* and that it may occur with *L. hoffmeisteri* where *L. claparedeianus* is apparently not present (Howmiller 1974, and unpublished observations of Loden).

Characteristics Used in Identification of Naididae

The morphology of the setae of naidids is similar to that of tubificids. One difference in the terminology is that the setae associated with the hairs in the dorsal bundles are referred to as "needle setae". These are not necessarily needle-shaped, but, depending on the species, may vary in appearance from hair-like to sigmoid bifid structures resembling the ventral setae.

Features present in many naidids which do not occur in tubificids include eyespots (normally found in *Nais, Arcteonais* and *Stylaria*; Fig. 4d,e) elongation of the prostomium to form a proboscis *(Stylaria, Arcteonais,* some *Pristina;* Fig. 4b, d, e), and rather elaborate posterior gills (*Dero,* Fig. 4c).

All the species of Naididae may be identified from immature specimens. As these worms typically reproduce asexually, mature specimens are found only infrequently. These may be recognized by swelling of the body in the clitellar region (V-VIII) and, in some species, by the presence of genital setae.

Specimens frequently consist of chains of zooids which develop and separate from the parent worm to become new individuals. When worms are preserved, the zooids often separate, creating difficulty in determining the number of worms in the original sample. Useful indicators to determine if a particular specimen is a fragment of a worm include the shape of the prostomium, the segment on which the dorsal setae begin, and the shape of the anterior ventral setae. In the genus *Dero* the posterior zooid will have a complete set of gills, while an anterior fragment will usually have the gills missing or incomplete.

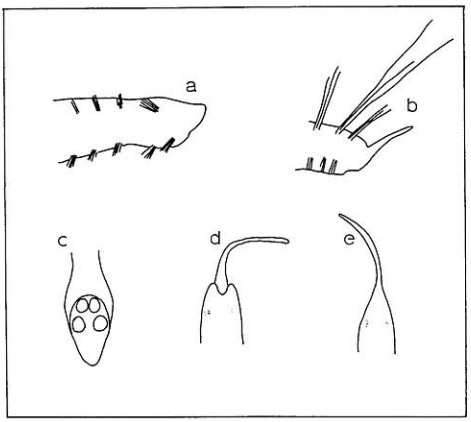

FIGURE 4. Portions of the body of some Naididae; a) anterior end of *Amphichaeta leydigii*, b) anterior end of *Pristina longiseta leidyi*, c) posterior end of *Dero (Dero) nivea*, d) anterior end of *Stylaria lacustris*, e) anterior end of *S. fossularis*. DRAWINGS NOT ALL TO SAME SCALE.

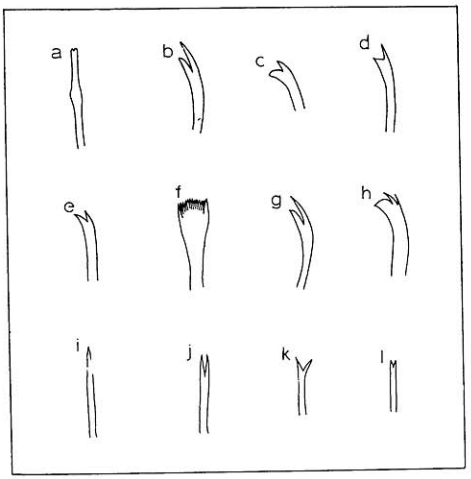

FIGURE 5. Setae of some Naididae; a) needle seta of *Ophidonais serpentina*, b) anterior seta of *Paranais frici*, c) *Piguetiella michiganensis*, d) needle of *Dero (Dero) digitata*, e) needle of *Dero (Aulophorus) furcatus*, f) palmate needle of *Dero (Aulophorus) vagus*, g) needle of *Haemonais waldvogeli*, h) seta of ventral side of VI, *Vejdovskyella intermedia*, i)needle of *Nais simplex*, j) needle of *N. elinguis*, k) needle of *N. communis*, l) needle of *N. variabilis*. DRAWINGS NOT ALL TO SAME SCALE.

KEY TO NAIDIDAE

Known from the Inland Waters of Wisconsin

1 Dorsal setae present 3
1' Dorsal setae absent 2

2(1') Setae of II 130 μ or greater in length ... *Chaetogaster diaphanus*
2' Setae of II less than 130 μ in length ... *Chaetogaster diastrophus*

3(1') Hair setae present in dorsal bundles 7
3' Hair setae absent 4

4(3') Dorsal bundles consist of one broad, simple-pointed or slightly cleft seta (may be absent in many segments) (Fig. 5a) ..... *Ophidonais serpentina*
4' Dorsal setae distinctly bifid 5

5(4') Dorsal setae start in segment III (Fig. 4a). (These are very small worms, frequently found in plankton samples.) ..... *Amphichaeta leydigii*[1]
5' Dorsal setae start behind segment III 6

6(5') Dorsal setae start in segment V (Fig. 5b) ..... *Paranais frici*
6' Dorsal setae start in segment VI (Fig. 5c). ..... *Piguetiella michiganensis*

7(3) Dorsal setae start in segment II (Fig. 4b) ..... *Pristina longiseta leidyi*[2]
7' Dorsal setae start behind segment II 8

8(7') Posterior end modified to form caudal gills[3] 9
8' Gills absent 12

9(8) A pair of non-retractile palps associated with gills 11
9' Palps absent 10

10(9') Branchial fossa extended behind gills (Fig. 4c) ..... *Dero (Dero) nivea*
10' Branchial fossa not extended; distal tooth of needle seta longer than proximal (Fig. 5d) ..... *Dero (Dero) digitata*

11(9) Needles palmate (Fig. 5f) ..... *Dero (Aulophorus) vagus*
11' Needles bifid; distal tooth shorter than proximal (Fig. 5c) ..... *Dero (Aulophorus) furcatus*

12(8') Dorsal setae start from approximately XVI (Fig. 5g) ..... *Haemonais waldvogeli*
12' Dorsal setae start from V or VI 13

13(12') Prostomium formed into a proboscis 14
13' Proboscis absent 16

14(13) Dorsal bundles with 1-3 hair setae 15
14' More than 5 hair setae per dorsal bundle, arranged in a fanshape ..... *Arcteonais lomondi*

15(14) Proboscis arises from an invagination of the prostomium (Fig. 4d) ..... *Stylaria lacustris*
15' Proboscis arises from the tip of the prostomium (Fig. 4e)..... ..... *Stylaria fossularis*

16(13') Hair setae strongly serrated, more than three per bundle 17
16' Hair setae usually smooth, less than three per bundle 18

17(16) Posteriorly from VI ventral setae one per bundle; a thickened seta normally present in VI (Fig. 5h) ..... *Vejdovskyella intermedia*[4]
17' Posteriorly from VI ventral setae more than one per bundle, no thickened setae present..... *Vejdovskyella comata*

18(16') Needle setae simple-pointed (Fig. 5i) ..... *Nais simplex*
18' Needle setae bifid 19

19(18') Teeth of needle setae elongate, parallel (Fig. 5j) ...*Nais elinguis*
19' Teeth of needle setae shorter..... 20

20(19') Teeth of needle setae divergent (Fig. 5k); ventral setae of II-V resemble those of posterior segments ..... *Nais communis*
20' Teeth of needle setae more closely applied (Fig. 51) .... *Nais variabilis*[5]

NOTATIONS CONCERNING TAXONOMIC PROBLEMS

[1]The genus *Amphichaeta* has been inadequately studied. Jarl Hiltunen (pers. comm.) believes that more than one species of worm resembling *A. leydigii* may be present in collections from Wisconsin. The differences among the specimens are ignored in this key pending future studies of this group.

[2]Harman and McMahan (1975) have recently completed a study of this species, which may now be more correctly referred to as *Pristina leidyi.*

[3]Incomplete specimens of *Dero* will not key out.

[4]Brinkhurst (Brinkhurst and Jamieson 1971) considers *Vejdovskyella intermedia* to be a junior synonym of *V. comata* because of the merging of characters. Populations have been found in Wisconsin which show the distinctive characters which Sperber (1948) described and these two species have thus been separated in the present key.

[5]*Nais variabilis* is an extremely variable species and may be virtually indistinguishable from *N. communis* (Brinkhurst 1966, Brinkhurst and

Jamieson 1971) or *N. elinguis* (Loden, unpublished data).

The taxonomic problems to which we have referred in our notes reflect, to some extent, the limited number of characters which these soft-bodied animals offer the taxonomist who bases his analyses on morphological grounds. Some of these problems may be solved by biochemical approaches (cf. Milbrink and Nyman 1973a and b) but ecologists will also be able to make important contributions, "For where is the species that has no ecological reality?" (Brinkhurst and Jamieson 1971). We hope that the field biologist or ecologist contemplating work with the aquatic oligochaetes will not be dismayed by minor taxonomic problems such as those we have alluded to. Without ecological knowledge the taxonomists' judgments will not be put to the final test.

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†ADDENDUM

On 18 June, 1976 Dr. Richard P. Howmiller died from injuries sustained in a vehicle accident. His untimely death is a tragic loss to the scientific community, and his outstanding achievements will be remembered for years to come. This paper is published posthumously.