REPORT NO. B2-13

A TAXONOMIC KEY TO THE *TUBIFICOIDES* (OLIGOCHAETA, TUBIFICIDAE) INHABITING TUKTOYAKTUK HARBOUR, NORTHWEST TERRITORIES

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NORTHERN OIL AND GAS ACTION PROGRAM

PROJECT B-2: CRITICAL ESTUARINE AND MARINE HABITATS OF THE CANADIAN ARCTIC COASTAL SHELF

SUBPROJECT B-2-3: NEARSHORE BENTHIC MONITORING, BEAUFORT SHELF

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A TAXONOMIC KEY TO THE TUBIFICOIDES (OLIGOCHAETA, TUBIFICIDAE) INHABITING TUKTOYAKTUK HARBOUR, NORTHWEST TERRITORIES

by

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This is a working draft report. Comments and suggestions regarding additions or deletions to this key are being solicited to ensure that the final publication is at once complete, accurate and useful. For this reason permission to cite or reproduce this manuscript in its present form must be obtained from M. Lawrence, Department of Fisheries and Oceans, 501 University Crescent, Winnipeg, Manitoba, R3T 2N6.

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ABSTRACT

The illustrated taxonomic key presented is to the Tubificoides (Oligochaeta, Tubificidae) inhabiting Tuktoyaktuk Harbour, Northwest Territories. Two species, namely, Tubificoides cuspisetosus Baker and Tubificoides pseudogaster (Dahl) are described. The ecology and distribution of the family Tubificidae are discussed.

KEY WORDS: Tubificoides, pseudogaster, cuspisetosus, Tubificidae, oligochaete, Tuktoyaktuk Harbour, key, taxonomy, systematics, ecology

INTRODUCTION

There has been a paucity of information on the taxonomy of marine oligochaetes. These animals have often been overlooked or misidentified in sample processing. In recent years, however, oligochaetes have been more comprehensively studied and descriptive accounts on the distribution and biology of several species have shown that this group of animals is an important ecological component of the benthic fauna (Baker 1980, 1983; Brinkhurst 1980, 1982, 1984; Brinkhurst and Baker 1979; Brinkhurst et al. 1972; Chapman and Brinkhurst 1984; Davis 1974a,b).

Presented herein is an illustrated taxonomic key to the oligochaete species found to inhabit Tuktoyaktuk Harbour, Northwest Territories. The intent of the key is to facilitate the ease with which species determinations can be made, thereby eliminating the use of out-of-area and obsolete keys resulting in the questionability of species identification. The key presented is not intended to include an exhaustive species list for the study area, but is a preliminary examination reflecting those specimens obtained in collections from sampling programs conducted in the harbour by the Department of Fisheries and Oceans (Winnipeg). Species lists obtained from published and unpublished literature did not provide additional oligochaete species since investigators did not key the animals lower than class. This key will be updated in future studies to include specimens from present and possibly future sampling programs being conducted in the harbour, thus eventually providing an exhaustive and thorough examination of all the oligochaete species inhabiting the harbour.

SITE DESCRIPTION: TUKTOYAKTUK HARBOUR, N.W.T.

Tuktoyaktuk Harbour (133°W, 69°N) is situated on the eastern edge of the MacKenzie River Delta. The harbour is approximately 6.5 km long and 1.8 km wide (Bond 1982). The maximum recorded depth is 26 m, but the common depth encountered in the harbour is 10 m (Barber 1968) prior to recent dredging operations; the bottom sediment is predominantly silt-clay (Thomas et al. 1981).

Two narrow channels, the eastern and western entrance, at the harbour mouth maintain a seaward connection. The surface waters of the harbour are influenced by the Mackenzie River outflow, resulting in highly variable salinity fluctuations culminating in a sharp halocline, separating upper and deeper waters. Surface waters are also influenced by runoff from the three major inlets, Freshwater Creek, Mayogiak Inlet, and Reindeer Creek. Barber (1968) suggests that introduced ground water may also influence the salinity of the harbour waters. The upper water salinity ranges from 1 $g.L^{-1}$ to 13.7 $g.L^{-1}$ in the summer months, while in deep waters it exceeds 30 $g.L^{-1}$ (Bond 1982). The surface water temperature ranges up to 15°C in summer and averages 0°C in winter while the bottom temperature ranges from 0°C in summer to -0.5°C in winter (Bond 1982). Tides in the harbour are semi-diurnal (Dohler 1964).

METHODOLOGY

COLLECTION, PRESERVATION AND PREPARATION

Oligochaetes may be collected qualitatively by hand-picking and dip-netting, and quantitatively by dredge, core, or bottom grab sampling. Dahl (1960) recommends a bottom grab sampler and a microcorer to obtain a representative sample. Oligochaetes are then removed from the sediment by sieving and manual sorting techniques.

Great care should be taken in sieving samples. The use of a fine sieve (No. 60 mesh) is recommended (Chekanovskaya 1962). A too vigorous agitation may break specimens or damage those anatomical features required for species identification.

Oligochaetes should first be placed in a narcotizing agent to avoid muscular contraction, making anatomical work difficult if not impossible. Specimens are narcotized in 0.015% propylene phenoxetol, fixed in a 5-10% formaldehyde solution for 48 hours, and then stored in 70% ethanol (Cook and Brinkhurst 1975). Other suitable narcotizing agents include chloretone, chloroform vapors, magnesium sulphate, and 2% hydrxylamine hydrochloride (Pennak 1978). Better fixatives for valuable or rare species are mixtures of Zenker's, Bouin's, or Carnoy's fluid (Chekanovskaya 1962).

The external anatomy of tubificids is examined in a whole mount preparation of the specimen. In the preparation of temporary or permanent slide mounts, the specimen is placed on its side, revealing both the ventral and dorsal fascicles. Temporary mounts are made in Amman's lactophenol (one part carbolic acid, one part lactic acid, one part water, two parts glycerol) (Brinkhurst 1978). Permanent mounts are prepared using Turtox CMCP-9AF or

CMC-10 mounting medium and the cover slips are ringed with Glyceel (Gurr product) to prevent evaporation of the medium (Brinkhurst 1978). Specimens can also be permanently mounted in Canada balsam (Baker 1983).

The genera of the family Tubificidae are identified by the structure of the male genital system which is not visible in whole mounts. The genitalia are mounted whole or prepared for histological sectioning using conventional histological methods.

TAXONOMIC CRITERIA

In the family Tubificidae, taxonomic characters of importance are the number, form, and detailed structure of the setae, and the morphology and arrangement of the male genitalia and spermatheca (Cook and Brinkhurst 1975).

SETAE: Plate I, Fig. 1 a, b, c

The chitinoid setae are located symmetrically in two dorsolateral and two ventrolateral fascicles in each segment, except segment I. Simple-pointed, bidentate, and pectinate setae are sigmoid bearing a nodulus. The bidentate seta diverges distally to a distal and proximal denticle which may or may not be of equal length. The pectinate seta has a number of slender, secondary denticles between the distal and proximal denticle. The hair seta has an elongated, slender, simple-pointed shaft without a nodulus. The number of seta and the decrease in number per fascicle posteriorly are taxonomically important.

MALE GENITALIA: Plate I, Fig. 2

The male genitalia (paired structure) consists of testis located on the posterior interface of septum 10/11, on the anterior face of which are located the ciliated sperm funnel which collect and conduct the sperm to the vas deferens and then to the atrium. The atrium terminates in a true penis or pseudopenis. A glandular prostate gland is attached to the atrium by a short stalk. The true penis may or may not have a cuticular sheath, the shape and size being taxonomically important. The spermatheca located in segment X receives and stores the sperm.

SYSTEMATIC RESUME

PHYLUM ANNELIDA

Distinguishing characteristics are: metamerism; coelomic fluid functioning as a hydraulic skeleton; straight digestive tract; digestion is extracellular; excretion by means of nephridia; closed blood vascular system; nervous system consists of a brain, pair of anterior connectives surrounding the gut, and a long double or single ventral nerve cord with ganglionic swellings and lateral nerves in each segment.

CLASS CLITELLATA

Hermaphroditic reproductive system; clitellum present; cocoon development; parapodia absent; setae occurring in fascicles; with or without hair seta; with or without eyes and/or oral suckers.

SUBCLASS OLIGOCHAETA

Oral suckers absent; maximum of two pairs of testis anterior to the paired ovary; protandrous; coelom spacious.

ORDER HAPLOTAXIDA

Male sperm funnel at least one segment in front of its gonopore.

SUBORDER TUBIFICINA

One pair of testis and ovary; clitellum one cell thick, fascicles containing many setae.

FAMILY TUBIFICIDAE

Asexual reproduction uncommon; spermathecae in segment X; male gonopore on segment XI; eyes lacking; body length greater than 2 cm; inhabiting freshwater, estuarine, and saltwater.

GENUS TUBIFICOIDES

Cuticular penis sheath; sperm as spermatozeugma in the spermatheca; inhabiting brackish or marine waters.

SPECIES

Tubificoides cuspisetosus Baker 1983

Tubificoides pseudogaster (Dahl 1960)

KEY TO THE TUBIFICOIDES INHABITING TUKTOYAKTUK HARBOUR, N.W.T.

Tubificoides

Anterior fascicles with bifid, 3-4 simple-pointed, and hair setae; penis sheath elongate, slender with distal tip slightly flared ..... T. cuspisetosus Baker (Plate II)

Anterior fascicles with bifid seta only; penis sheath thimble shaped or cylindrical ..... T. pseudogaster (Dahl) (Plates III, IV)

Tubificoides cuspisetosus Baker 1983 Plate II,

Holotype USNM 079839 Figs. 3, 4, 5

L. 10-14 mm, 39-67 segments. Prostomium bluntly conical, small papilla may be present at apex, slightly shorter than broad at peristomium. Clitellum width 500-560 μm (fixed whole mounts). Anterior dorsal fascicle contains 2-4 short hair setae and 2-4 bifid setae (to segments VI or VII). Bifid setae have both the dorsal and proximal denticle of equal length. Posterior dorsal fascicle contains 3-4 short hair setae and 3-4 sharply, simple-pointed setae (from segments VI (VII)). The hair setae are smooth. Anterior ventral fascicle contains 4-5 (6-7) bifid setae (to segments VI (VII)). Posterior ventral fascicle contains 3-4 (5) simple-pointed setae (from segments VI (VII)). Ventral setae absent in segment XI. Genital setae are lacking.

Male genitalia (structures paired) consists of a sperm funnel with lips of equal length; vas deferens 18-22 μm wide with ciliated lumen and thin walls, approximately 1500 μm long; vas deferens joins atrium subapically below

the swollen head opposite to entrance of stalked prostate gland. Atrium is cylindrical, 275-320 μm long to base of penis sheath, and is tripartite; a swollen head, 54-62 μm wide, a mid tubular section, 47-63 μm wide, and a distal terminus. The atrium terminates in a true penis. The cuticular penis sheath is elongate and slender with the distal tip slightly flared; sheath is 75-100 μm long, 27-54 μm wide at base, and 17-27 μm wide apically. The penis is enclosed in a short, muscular penial sac. Spermatheca (paired structure) has a slightly bulbous base, 37-50 μm wide, and a narrow duct, 20-25 μm wide, leading to the ampulla which extends anteriorly to segment IX or posteriorly to segment XI. Spermathecal apertures are located in segment X. Spermatozeugmata are long and vermiform.

Reference: Baker 1983

Distribution: T. cuspisetosus inhabits marine subtidal waters, 3-125 m deep. Distributional records include the Beaufort Sea, Alaskan and Norwegian waters.

Tubificoides (= Limnodrilus) pseudogaster (Dahl 1960) Plates III, IV
Figs. 6, 7, 8, 9

Lectotype ZMC

L. 7.8 mm, 51 segments. Prostomium bluntly conical, slightly shorter than broad at peristomium. Clitellum not observed (Baker 1980), however, Dahl (1960) found that it was poorly developed in segments X-XI. Anterior fascicle contains 3-5 bifid setae, posterior fascicle only two. Two setae per fascicle, from segment XI, are found both dorsally and ventrally. Distal denticle of bifid setae may be slightly longer than proximal denticle. Setal

length up to 60 μm at segment VI and up to 70 μm at segment IX. Setal length decreases posteriorly to 50 μm. Ventral setae absent in segment XI. Hair, simple-pointed, and genital setae are lacking.

An enlarged intestinal section is found in segment IX. The intestinal walls are thickened dorsally and laterally and a glandular structure is present, hence the name pseudogaster, pseudo = false, gaster = stomach.

Male genitalia (structures paired) consists of large flattened sperm funnel protruding into segment X; vas deferens, long and narrow, ranging from 16.7-17.2 μm wide, enters the atrium opposite to the prostate gland. The atrium is tripartite; a glandular swollen head, a mid-tubular section, and a distal terminus. The atrium terminates in a true penis with a cuticular sheath slightly cone-shaped enclosed in a deep penial sac. Spermatheca (paired structure) has a small distal ampullae and a long duct, 300 μm long with ducts accounting for 225 μm. Spermathecal apertures are lateral in position in segment X.

Specimens of T. pseudogaster show variations in the structure of the cuticular penis sheath, suggesting that this species exists as a series of morphotypes (Baker 1983). The cuticular penis sheath varies from a cylindrical or slightly cone shaped sheath from specimens collected at site Victoria A, British Columbia, to an elongate, thimble shape at site Victoria B (Fig. 10) (Brinkhurst and Baker 1979). Penis sheath lengths range from 67-127 μm (Victoria A) to 107-147 μm (Victoria B) (Brinkhurst and Baker 1979).

References: Dahl 1960; Brinkhurst and Baker 1979; Baker 1980, 1983.

Distribution: T. pseudogaster inhabits mud, sand, and clay substrata. Distri-

butional records include the western coast of North America, Canadian arctic, and northern European waters.

Cocoon Formation

Cocoon formation commences in the clitellum where the clitellar glands secrete the wall of the cocoon and albumin in which the eggs are deposited (Brinkhurst and Jamieson 1971). Cocoons obtained for Tubificoides sp. from Tuktoyaktuk Harbour are ovoid with a posterior tubular outgrowth and a more pronounced anterior one (Plate IV, Fig. 10). The cocoon contains from 2-3 eggs and averages 0.87 mm long.

ECOLOGY: TUBIFICIDAE

Tubificids inhabit freshwater, estuarine, and saltwater colonizing a wide variety of substrata (Brinkhurst 1963a). They can burrow into the bottom sediments up to 35 cm, although 95% are found in the upper 16 cm and 74% in the upper 8 cm (Davis 1974a,b). Core samples analyzed have indicated that tubificids coexist vertically and horizontally in the substratum (Brinkhurst and Chua 1969). Tubificids may be food specialists through selective ingestion and/or digestion, thus raising their assimilation efficiency by feeding on preferred foods (Brinkhurst et al. 1972).

The dense populations of tubificids in lake bottoms, virtually due to the exclusion of polychaetes, are believed to influence the stratigraphy and bioturbation mainly by subsurface ingestion of sediment and surface egestion (Diaz 1980). Studies undertaken in the Toronto Harbour have shown that the top 4-6 cm of sediment was overturned by tubificids up to 12 times per year, resulting in the regeneration of nutrients (Appleby and Brinkhurst 1970).

Tubificids inhabiting stagnant mud lake bottoms, in particular those in organically polluted environments, appear able to tolerate relatively low oxygen levels and for short periods of time anoxic conditions (Barnes 1974). However, Chapman and Brinkhurst (1984) have indicated that tubificids show an enhanced survival to toxicants but not to anoxia.

Giere (1975) concluded that contrary to freshwater oligochaetes marine species, although utilized by primary carnivores, are only of minor trophic importance. In areas where marine oligochaetes dominate in number over polychaetes, they may be of importance in the trophic dynamics.

PLATES

ABBREVIATIONS USED IN PLATES

AT	atrium
CL	clitellum
CS	cuticular penis sheath
DD	distal denticle
DS	dorsolateral setae
FG	female gonopore
MG	male gonopore
N	nodulus
O	ovary
OS	ovisac
P	penis
PD	proximal denticle
PR	prostate gland
PRO	prostomium
PS	penial sac
SD	secondary denticle
SF	sperm funnel
SP	spermatheca
SPA	spermathecal aperture
SV_1	anterior seminal vesicle
SV_2	posterior seminal vesicle
T	testis
VA	Victoria Site A
VB	Victoria Site B
VD	vas deferens
VS	ventrolateral setae

Plate I

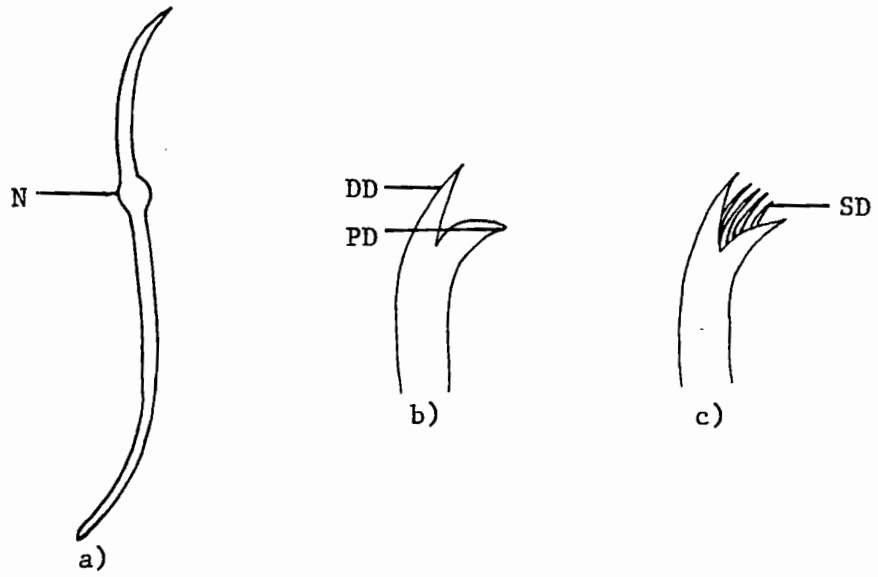


Fig. 1. Comparison of setal shapes. (a) seta, sigmoid; (b) seta, bifid; (c) seta, pectinate.

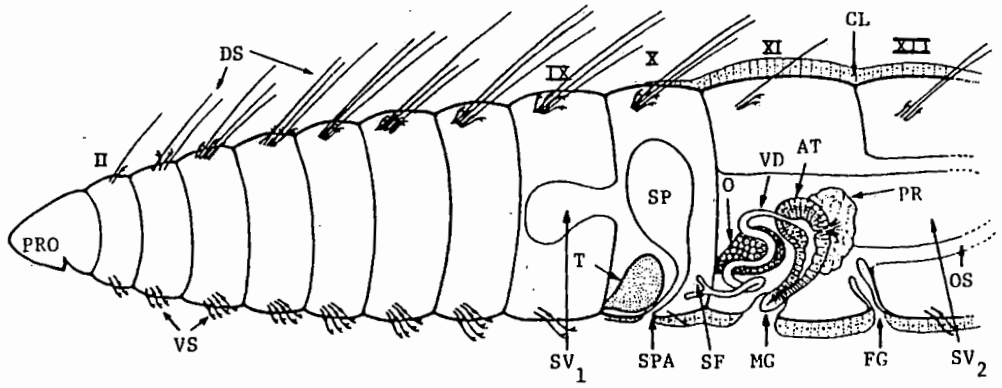


Fig. 2. Taxonomic characteristics of the family Tubificidae. (modified from Brinkhurst 1982).

Plate II

10 µm

Fig. 3. Tubificoides cuspisetosus Baker, dorsal bifid seta (after Baker 1983).

50 µm

Fig. 4. Tubificoides cuspisetosus Baker, cuticular penis sheath (after Baker 1983).

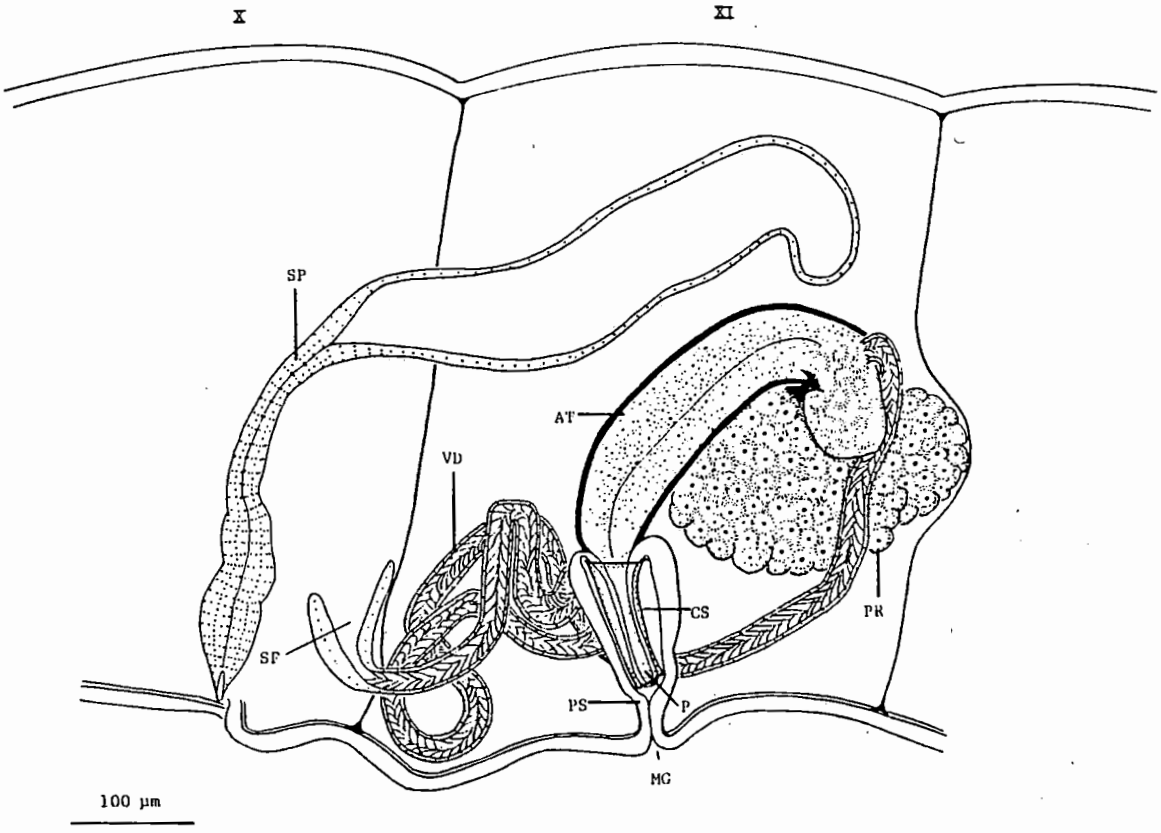


Fig. 5. Tubificoides cuspisetosus Baker, lateral view of the male genitalia in segments X and XI (modified from Baker 1983).

Plate III

Fig. 6. Tubificoides pseudogaster (Dahl), (a) dorsal bifid seta of segment III, (b) ventral bifid seta of segment VII (after Baker 1980).

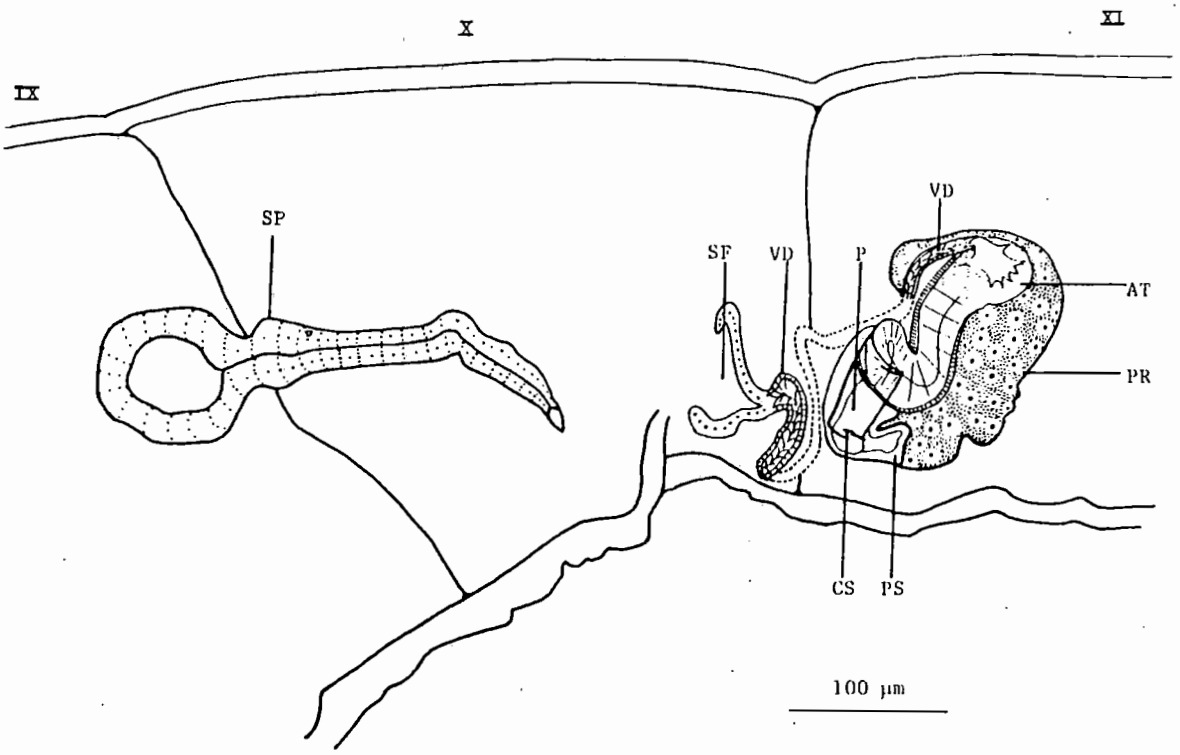


Fig. 7. Tubificoides pseudogaster (Dahl), lateral view of the male genitalia in segments X and XI. Note: atrium has folded over itself, detail is reduced (modified from Baker 1980).

Plate IV

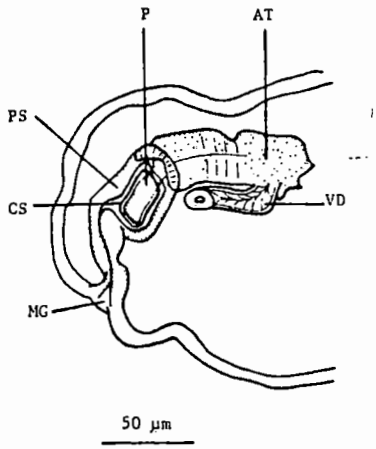
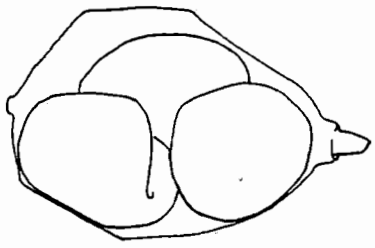


Fig. 8. Tubificoides pseudogaster (Dahl), lateral view of the male genitalia in segment XI (modified from Baker 1980).

Fig. 9. Tubificoides pseudogaster (Dahl), cuticular penis sheaths (redrawn from Brinkhurst and Baker 1979).



0.87 mm

Fig. 10. Cocoon of Tubificoides sp.

GLOSSARY

BIFID. Forked, divided into two denticles.

CLITELLUM. A swollen glandular region in the anterior region, segments X to XII or XIII.

FASCICLE. A group, cluster, or compact bundle.

HOLOTYPE. The single specimen taken as "the type" by the original author of a species.

LECTOTYPE. A specimen, selected from a syntypic series, subsequent to the original description, to serve as holotype.

NODULUS. A swelling in the midsection of a seta, to which the muscles are attached.

PECTINATE. Bearing fine comblike setae or denticles.

PERISTOMIUM. The segment or segments behind the head and surrounding the mouth.

PROSTOMIUM. The portion of the head which projects forward and overhangs the mouth.

PSEUDOPENIS. A temporary structure produced by the evagination of the distal terminus of the atrium.

SPERMATHECA. An evagination of the body wall consisting of a narrow tubular duct and storage ampulla. The spermatheca receives and stores the sperm.

SPERMATOZEUGMA pl. spermatozeugmata. Organized bundles of sperm found in the atrium prior to copulation and in the spermatheca following copulation. Generally consists of an inner lumen surrounded with sperm heads oriented inward and sperm tails radiating outward.

TRUE PENIS. A permanent structure. A tubular or conical projection of the atrium terminus into the penial sac.

USNM. United States National Museum.

VERMIFORM. Shaped like a worm.

ZMC. Zoological Museum, University of Copenhagen.

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BIBLIOGRAPHY

Additional references (*) have been included that were used in the preparation of the basic text of the report.

APPLEBY, A.G., and R.O. BRINKHURST. 1970. Defecation rate of three tubificid oligochaetes found in the sediment of Toronto Harbour, Ontario. J. Fish. Res. Board Can. 27: 1971-1982.

BAKER, H.R. 1980. A redescription of Tubificoides pseudogaster (Dahl) (Oligochaeta: Tubificidae). Trans. Amer. Micros. Soc. 99(3): 337-342.

BAKER, H.R. 1983. New species of Tubificoides Lastockin (Oligochaeta; Tubificidae) from the Pacific northeast and the Arctic. Can. J. Zool. 61(6): 1270-1283.

BARBER, F.G. 1968. On the water of Tuktoyaktuk Harbour. Can. Dep. Energy Mines Res. Mar. Sci. Branch Manuscr. Rep. Ser. 9: 32 p.

BARNES, R.D. 1974. Invertebrate Zoology. W.B. Saunders Co., Toronto, 870 p.

BOND, W.A. 1982. A study of the fishery resources of Tuktoyaktuk Harbour, southern Beaufort Sea coast, with special reference to life histories of anadromous coregonids. Can. Fish. Mar. Serv. Tech. Rep. 1119: 90 p.

BRINKHURST, R.O. 1963a. The biology of the Tubificidae with special reference to pollution. Proc. 3rd Seminar on Problems in Water Pollution, Cincinnati, 1962.

*BRINKHURST, R.O. 1963b. Taxonomic studies on the Tubificidae (Annelida, Oligochaeta). Int. Revue ges. Hydrobiol. Hydrogr. Syst. Beih. 2: 1-89.

BRINKHURST, R.O. 1971. A guide for the identification of the British aquatic oligochaete. Freshwater Biological Association Scientific Publication No. 22, 55 p.

BRINKHURST, R.O. 1973. Marine and brackish water oligochaeta. Fish. Res. Board Can. Tech. Rep. 420: 1-9.

BRINKHURST, R.O. 1974. Factors mediating interspecific aggregation of tubificid oligochaetes. J. Fish. Res. Board Can. 31: 460-462.

BRINKHURST, R.O. 1978. Freshwater Oligochaeta in Canada. Can. J. Zool. 56: 2166-2175.

BRINKHURST, R.O. 1980. Taxonomy, pollution and the sludge worm. Mar. Pollut. Bull. 11(9): 248-251.

BRINKHURST, R.O. 1982. Evolution in the Annelida. Can. J. Zool. 60(5): 1043-1059.

BRINKHURST, R.O. 1984. Comments on the evolution of the Annelida. Hydrobiologia 109: 189-191.

BRINKHURST, R.O., and H.R. BAKER. 1979. A review of the marine Tubificidae (Oligochaeta) of North America. Can. J. Zool. 57(8): 1553-1569.

*BRINKHURST, R.O., P.M. CHAPMAN, and M.A. FARRELL. 1983. A comparative study of respiration rates of some aquatic oligochaetes in relation to sublethal stress. Int. Revue ges. Hydrobiol. 68(5): 683-699.

*BRINKHURST, R.O., and K.E. CHUA. 1969. Preliminary investigation of the exploitation of some potential nutritional resources by three sympatric tubificid oligochaetes. J. Fish. Res. Board Can. 26: 2659-2668.

BRINKHURST, R.O., K.E. CHUA, and N.K. KAUSHIK. 1972. Interspecific interactions and selective feeding of tubificid oligochaetes. Limnol. Oceanogr. 17: 122-123.

BRINKHURST, R.O., and B.G.M. JAMIESON. 1971. Aquatic Oligochaeta of the World. Univ. Toronto Press, Toronto. 860 p.

*BRKOVIC-POPOVIC, I., and M. POPOVIC. 1977. Effects of heavy metals on survival and respiration rate of Tubificid worms: Part I - Effects on survival. Environ. Pollut. 131: 65-72.

*CHAPMAN, P.M., and R.O. BRINKHURST. 1980. Salinity tolerance in some selected aquatic oligochaetes. Int. Revue ges. Hydrobiol. 65(4): 499-505.

CHAPMAN, P.M., and R.O. BRINKHURST. 1984. Lethal and sublethal tolerances of aquatic oligochaetes with reference to their use as a biotic index of pollution. Hydrobiologia 115: 139-144.

*CHAPMAN, P.M., M.A. FARRELL, and R.O. BRINKHURST. 1982. Effects of species interactions on the survival and respiration of Limnodrilus hoffmeisteri and Tubifex tubifex (Oligochaeta, Tubificidae) exposed to various pollutants and environmental factors. Water Res. 16: 1405-1408.

*CHAPMAN, P.M., M.A. FARRELL, and R.O. BRINKHURST. 1982. Relative tolerances of selected aquatic oligochaetes to individual pollutants and environmental factors. Aquatic Toxicology 2: 47-67.

CHEKANOVSKAYA, O.V. 1962. Vodnye Maloshehetinkovye Chervy Fauny SSSR [Aquatic Oligochaeta of the USSR]. In Keys to the fauna of the USSR. Akademiya Nauk SSSR, Moscow. 513 p. (Trans. from Russian, Amerind Publishing Co. Pvt. Ltd., New Delhi).

*CHUA, K.E., and R.O. BRINKHURST. 1973. Evidence of interspecific interactions in the respiration of tubificid oligochaetes. J. Fish. Res. Board Can. 30: 617-622.

COOK, D.G., and R.O. BRINKHURST. 1975. Oligochaeta, p. 136-146. In Light's Manual. 3rd ed. University of California Press, Berkeley and Los Angeles. 716 p.

DAVIS, R.B. 1974a. Tubificids alter profiles of redox potential and pH in profundal lake sediments. Limnol. Oceanogr. 19: 342-346.

DAVIS, R.B. 1974b. Stratigraphic effects of tubificids in profundal lake sediments. Limnol. Oceanogr. 19: 466-488.

DAHL, I.O. 1960. The oligochaeta fauna of three Danish brackish water areas. Medd. Dan. Fisk. Havunders 2: 1-20.

DIAZ, R.J. 1980. Ecology of freshwater and estuarine Tubificidae (Oligachaeta), p. 319-330. In R.O. Brinkhurst and D.G. Cook (ed.) Aquatic Oligochaete Biology. Plenum Press, New York and London.

DOHLER, G. 1964. Tides in Canadian waters. Can. Dep. Mines Tech. Surveys (Unpublished).

GIERE, D. 1975. Population structure, food relations and ecological role of marine oligochaetes, with special reference to meiobenthic species. Marine Biology. 31: 139-156.

*GIESE, A.C., and J.S. PEARSE. 1975. Reproduction of marine invertebrates. Vol. III. Annelids and Echiurans. Academic Press, New York. 343 p.

*GOODNIGHT, C.J. 1959. Oligochaeta, p. 522-537. In W.T. Edmondson (ed.) Freshwater Biology. John Wiley & Sons Inc., New York, 1248 p.

*KAESTNER, A. 1964. Lehrbuch der Speziellen Zoologie, Band I [Invertebrate Zoology]. VEB Gustav Fischer Verlag, Jena 597 p. (Trans. from German, John Wiley & Sons, Inc. 1967).

PENNAK, R.W. 1978. Freshwater Invertebrates of the United States. 2nd ed. John Wiley & Sons Ltd., New York, 803 p.

*STEPHENSON, J. 1930. The Oligochaeta. Clarendon Press, Oxford. 978 p.

*STIMPSON, K.S., D.J. KLEMM, and J.K. HILTUNEN. 1982. A guide to the freshwater Tubificidae (Annelida: Clitellata; Oligochaeta) of North America. Environmental Protection Agency, Ohio, 61 p.

THOMAS, D.J., W.A. HEATH, K.A. THOMPSON, and J.M. KOLEBA. 1981. An oceanographic study of Tuktoyaktuk Harbour, Northwest Territories, 1980. Rep. Prep. Dome Petrol. Ltd. (Unpublished), 244 p.

*WAVRE, M., and R.O. BRINKHURST. 1971. Interactions between some tubificid oligochaetes found in sediments of Toronto Harbour, Ontario. J. Fish. Res. Board Can. 28: 335-341.

ADDENDUM: A Taxonomic Key to the Tubificoides (Oligochaeta, Tubificidae) Inhabiting Tuktoyaktuk Harbour, Northwest Territories.

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Since the completion of this key, two additional oligochaete species have been found to occur in the benthos of Tuktoyaktuk Harbour, these being Tubificoides crenacoleus and some belonging to the Tubificoides diazi/Tubificoides maureri complex. These species will be encorporated in a future updated version of this key to be produced in the near future.