

## Two new species of *Potamothenix* (Oligochaeta: Tubificinae) from plateau lakes of Yunnan Province, southwest China

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**Abstract.**—Two new species of *Potamothenix* (Oligochaeta: Tubificinae), *P. rhytipeniatus*, new species and *P. aductus*, new species, are described from Fuxian Lake and Xingyun Lake of Yunnan Province, southwest China. *Potamothenix rhytipeniatus* differs from congeners by its wrinkled penis surface and vasa deferentia entering the atrium subapically. *Potamothenix aductus* is distinguishable from all congeners by lacking a spermathecal duct. Hitherto, 31 species of freshwater oligochaetes have been recorded from Yunnan Province, including seven endemic species from plateau lakes.

**Keywords:** endemic species, oligochaete morphology, plateau lakes, Tubificinae

The existence of unique fauna in ancient lakes of Yunnan Province, southwest China has been recognized through several studies (Wang 1988, Yang & Chen 1995, Sket 2000). However, our knowledge of freshwater oligochaetes in these lakes is poor; only an aberrant branchiobdellidan species was reported from Erhai Lake (Liang 1963). During the limnological investigation of lakes in this province in 2002–2003, a number of oligochaete samples were collected. In four previous accounts (Cui & Wang 2005, 2008, 2009, Cui et al. 2008), 29 species, belonging to 2 families and 14 genera, were reported on the basis of the collected material. As a serial study, the present paper gives the description of two new species of *Potamothenix* (Oligochaeta: Tubificinae) from two plateau lakes.

### Materials and Methods

Located in the Yunnan-Guizhou Plateau in southwest China, Fuxian Lake and Xingyun Lake originated from a

common palaeolake in the early Holocene. They were isolated in the middle Holocene Epoch, but a water course, Gehe River, remains, through which Fuxian Lake receives water from Xingyun Lake (Nanjing Institute of Geography & Limnology 1990). For the main physico-chemical parameters of the two lakes, refer to our three previous accounts (Cui et al. 2008, Cui & Wang 2008, 2009).

Lake sediment samples were collected with a weighted Petersen grab (16 cm<sup>2</sup>) and processed through a 250 μm sieve. Large worms were sorted manually in a white porcelain dish, and small ones were sorted under a dissecting microscope. Specimens were preserved in 10% formalin.

Preserved specimens were examined first in temporary glycerine mounts, then stained with borax carmine, dehydrated in an alcohol series, cleared in xylene, and mounted in Canada balsam. Measurements of body and chaetae were made from glycerine mounts. Other observations were made on the permanent mounts. Drawings were made using a camera lucida. Types and other specimens are deposited in the Institute of Hydrobiology

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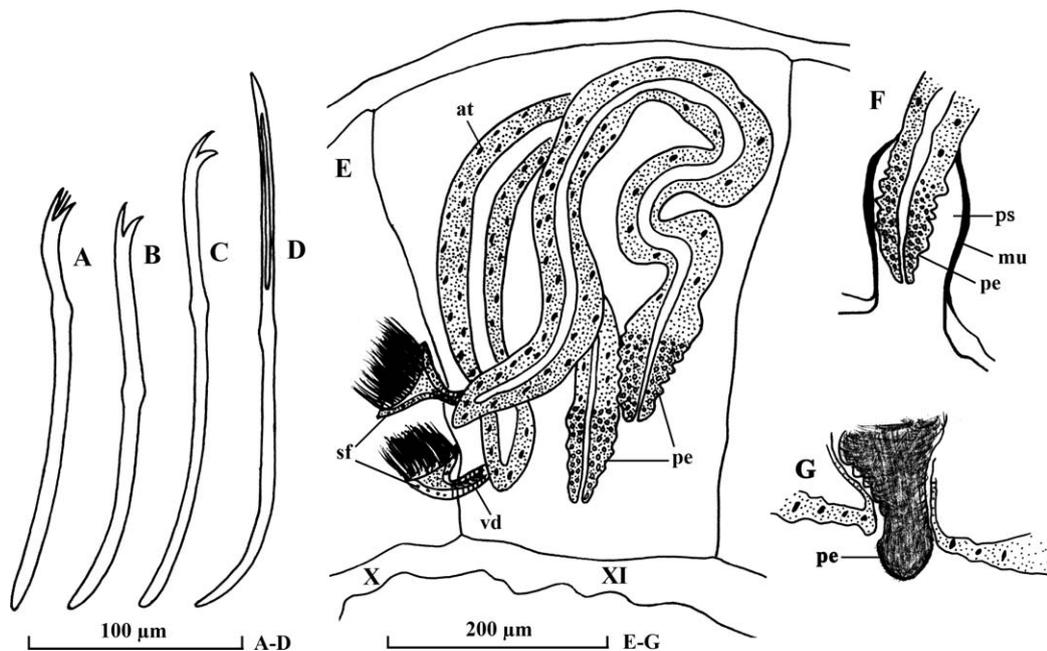


Fig. 1. *Potamothrix rhytipeniatus*. A, dorsal pectinated chaeta from VIII; B, dorsal bifid from VI; C, ventral chaeta from IV; D, spermathecal chaeta; E, lateral view of male ducts in segments X–XI; F, G, penes of two paratypes.

(IHB), Chinese Academy of Sciences (CAS), Wuhan, China. Abbreviations used in the figures are: Roman numerals = segment number; at = atrium; mu = muscle; pe = penis; pr = prostate gland; ps = penial sac; sa = spermathecal ampulla; sc = spermathecal chaeta; scs = spermathecal chaeta sac; sf = sperm funnel; sz = spermatozeugmata; vd = vas deferens.

#### Systematics

Class Clitellata

Family Naididae

Subfamily Tubificinae

Genus *Potamothrix* Vejdovský & Mrázek (1902)

*Potamothrix rhytipeniatus*, new species

Fig. 1

*Holotype*.—IHB YAN 200304051, mature specimen mounted in Canada balsam, stained with borax carmine.

*Type locality*.—Xingyun Lake (24°18'01"N, 102°47'58"E), eastern Yunnan, China; depth

5 m, bottom temperature 16.1°C, dissolved oxygen at bottom 7.6 mg/L, total nitrogen in water 2.960 mg/L, total phosphorus in water 0.129 mg/L, fine silt; 7 Apr 2003, coll. Y. Cui.

*Paratypes*.—IHB YAN 20030405b, e, k, mature specimens mounted in Canada balsam, stained with borax carmine, three specimens from type locality.

*Other materials*.—IHB YAN 20030405a, c, d, f–j, m, o–s, mature specimens mounted in Canada balsam, stained with borax carmine, 14 specimens from type locality.

*Etymology*.—The specific name “*rhytipeniatus*” is Greek for “rhytis penis” and refers to penes with wrinkly surface.

*Description*.—Thirteen complete specimens 4.0–8.7 mm in length (Holotype: 4.2 mm), 24–46 segments (Holotype: 24). Diameter at XI 0.5–0.6 mm (Holotype: 0.5 mm). Prostomium conical. Clitellum inconspicuous.

Dorsal chaetae (0)1–4 hairs and 2–4 bifids per bundle, hairs slender, without

serration, 320–380  $\mu\text{m}$  long anteriorly, and 280–325  $\mu\text{m}$  long posteriorly; bifids (Fig. 1A, B) usually pectinated, 50–62  $\mu\text{m}$  long, 2.0–2.5  $\mu\text{m}$  thick, with 2–3 fine intermediate teeth, upper prong slightly longer and thinner than lower or equally long. Ventral chaetae (Fig. 1C) anteriorly 3–7 per bundle, 70–80  $\mu\text{m}$  long, 2.0–2.5  $\mu\text{m}$  thick, upper prongs conspicuously longer and thinner than lower, posteriorly 2–3 per bundle, 60–65  $\mu\text{m}$  long, 1.8–2.2  $\mu\text{m}$  thick. Spermathecal chaetae (Fig. 1D) one per bundle in mid-X, entally embedded in glandular sac, 70–96  $\mu\text{m}$  long, 2.5  $\mu\text{m}$  thick, ental part curved and ectal part grooved. Penial chaeta absent. Male pores paired in line with ventral chaetae, posterior to middle of XI. Spermathecal pores paired in line with ventral chaetae in mid-X, immediately anterior to spermathecal chaetae.

Pharyngeal glands in II–III. Chloragogen cells from VI onwards. No coelomocytes. Male genitalia (Fig. 1E) paired. Vasa deferentia (Fig. 1E, vd) very short, 25–40  $\mu\text{m}$  long and 12–24  $\mu\text{m}$  wide, entering atrium subapically. Atrium (Fig. 1E, at) 580–730  $\mu\text{m}$  long, 40–80  $\mu\text{m}$  wide, tubular and bipartite, proximal part (two-fifths of total atria) with densely granular inner layer, distal part sparsely granulated. Prostate gland absent. Penis (Fig. 1E–G, pe) cylindrical and tapering ectally, surface folded, pliciformed, 76–150  $\mu\text{m}$  long, 56–100  $\mu\text{m}$  wide basally and 26–58  $\mu\text{m}$  wide ectally. Penial sac (Fig. 1F, G, ps) 100–150  $\mu\text{m}$  long, 58–86  $\mu\text{m}$  wide, with outer muscular layer 7–17  $\mu\text{m}$  thick.

Spermathecae ampullae broken (all collected specimens), with numerous spermatozeugmata in coelom.

*Distribution and habitat.*—Known only from type locality, Yunnan Province, China. Freshwater lake, 5 m deep, water temperature about 16°C, fine silt.

*Remarks.*—This species has two distinguishing characters. First, the penial surface of the new species is wrinkly,

whereas that in most penes-possessing congeners is smooth. Secondly, its vasa deferentia enter the atria subapically, whereas those of other species join the atria apically. *Potamothenix rhytipeniatus* appears closely related to *P. cekanovskajae* Finogenova 1972 and *P. manus* Finogenova 1976 from the Caspian Sea (Finogenova & Poddubnaja 1990) in the respect that all of them have bipartite atria without prostate glands. However, the atria of the new species is conspicuously short, only one-fifth to one-quarter the length of atria of the other two species. In addition, the new species has hairs and pectinate chaetae, whereas its two allies have dorsal bifids only. With regard to the relatively short atria, the new species shows some affinity to *P. bavaricus* (Öschmann 1913) and *P. scleropenis* Cui & Wang 2005. However, the ratio of vasa deferentia to atria and the shapes of the atria are different among them. Specifically, the ratio of measurements of the vasa deferentia to atrium are 1:18 to 1:23 and bipartite for *P. rhytipeniatus*; 1:8 to 1:9 and tripartite for *P. bavaricus* (Timm 1970, Finogenova & Poddubnaja 1990), and 1:3 and homogenous for *P. scleropenis* (Cui & Wang 2005).

*Potamothenix aductus*, new species

Fig. 2

*Holotype.*—IHB YAN 20020812a, whole-mounted specimen.

*Type locality.*—East of Gushan Island (24°24'05"N, 102°52'45"E) in Fuxian Lake, eastern Yunnan Province, China; depth 78 m, bottom temperature 15.9°C, dissolved oxygen at bottom 9.6 mg/L, total nitrogen in water 0.155 mg/L, total phosphorus in water 0.023 mg/L, fine clay; 8 Aug 2002, coll. Y. Cui and X. Liu.

*Paratypes.*—IHB YAN 20020812n; one specimen from type locality, IHB YAN 20020808b, one specimen from southeast of Niumo (24°28'40"N, 102°52'31"E) in Fuxian Lake, eastern Yunnan, China;

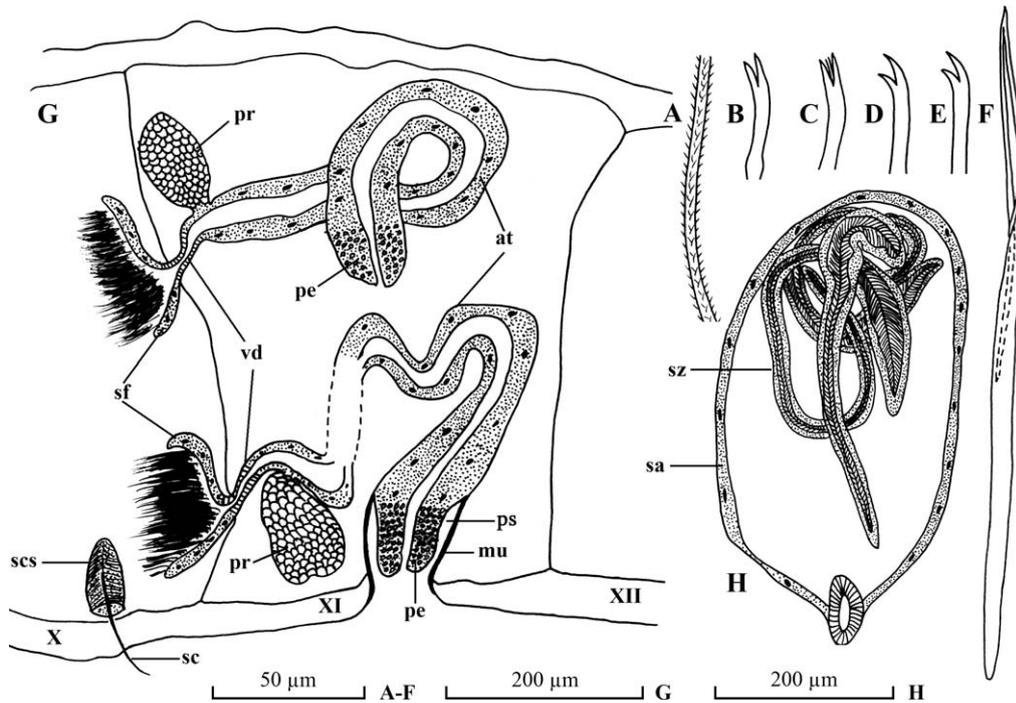


Fig. 2. *Potamothenx aductus*. A, hair; B, distal end of dorsal bifid from VI; C, distal end of dorsal pectinate chaeta from VIII; D, distal end of dorsal bifid from III; E, distal end of ventral chaeta from V; F, spermathecal chaeta; G, lateral view of male ducts in segments X–XII; H, spermatheca.

depth 108 m, bottom temperature 14.0°C, dissolved oxygen at bottom 6.6 mg/L, total nitrogen in water 0.184 mg/L, total phosphorus in water 0.023 mg/L, fine clay; 8 Aug 2002, coll. Y. Cui and X. Liu.

*Other materials.*—IHB YAN 20020812c, one specimen from the same locality with paratypes, IHB YAN 20030209b, one specimen from northeast of Dashazui (24°22′58″N, 102°49′49″E) in Fuxian Lake, eastern Yunnan, China; depth 87 m, bottom temperature 13.7°C, dissolved oxygen at bottom 5.8 mg/L, total nitrogen in water 0.229 mg/L, total phosphorus in water 0.022 mg/L, fine clay; 14 Feb 2003, coll. Y. Cui.

*Etymology.*—The specific name “*aductus*” is Latin for “no ducts” and refers to the absence of a spermathecal duct.

*Description.*—Two complete specimens 9.2–11.8 mm long (Holotype: 9.2 mm), diameter at XI 0.80–0.96 mm (Holotype: 0.96 mm), 49–68 segments (Holotype: 49

segments). Prostomium conical. Clitellum inconspicuous.

Dorsal chaetae (Fig. 2C, D) of II–VI bifid only, 7–8 per bundle, 100–144 µm long, 3.0–4.0 µm thick, upper prong longer and thicker than lower. From VII onwards, dorsals 1–6 hairs and 3–6 bifids per bundle; hairs (Fig. 2A) feathered, 340–420 µm long, 2.8–3.2 µm thick basally; bifids (Fig. 2B, C) pectinate, 108–140 µm long, 3.0–4.0 µm thick, with 0–2 intermediate teeth, upper prong slightly longer or as long as, and thinner than lower. Ventral chaetae (Fig. 2E) bifid, 6–8 per bundle anteriorly, 140–150 µm long, 3.0–3.5 µm thick; 2–4 (5) per bundle in postclitellar segments, 80–110 µm long, 2.4–3.2 µm thick, with prongs similar to those of dorsals in II–VI. Spermathecal chaetae (Fig. 2F, G, sc) one per bundle in middle to posterior part of X, entally embedded in glandular sacs, about 180–220 µm long, 4.0 µm thick,

with ectal parts grooved and contorted. Penial chaetae absent. Male pores paired in line with ventral chaetae of mid-XI. Spermathecal pores paired in line with ventral chaetae, posterior to middle of X, immediately anterior to spermathecal chaetae.

Pharyngeal glands in II–III. Chloragogen cells from VI onwards. No coelomocytes. Male genitalia (Fig. 2G) paired. Vasa deferentia (Fig. 2G, vd) short, 40–50  $\mu\text{m}$  long, 13–22  $\mu\text{m}$  wide, entering atrium apically. Atrium (Fig. 2G, at) 580–640  $\mu\text{m}$  long, 30–75  $\mu\text{m}$  wide, tubular and rather homogenous, with thin outer muscular layer and thick inner epithelium. Prostate glands (Fig. 2G, pr) small, 90–110  $\mu\text{m}$  long, maximum 62–75  $\mu\text{m}$  wide, attaching to ental atrium. Soft parts of penis (Fig. 2G, pe) small, 62–80  $\mu\text{m}$  long, 66–75  $\mu\text{m}$  wide basally and 26–44  $\mu\text{m}$  wide ectally, cylindrical and tapering ectally, enclosed in penial sacs. Penial sac (Fig. 2G, ps) 90–110  $\mu\text{m}$  long, 54–84  $\mu\text{m}$  wide, with muscular layer 4–6  $\mu\text{m}$  thick.

Spermathecae (Fig. 2H) without duct, oval ampullae (Fig. 2H, sa) 440–490  $\mu\text{m}$  long, maximally 250–280  $\mu\text{m}$  wide. Spermatozeugmata (Fig. 2H, sz) 2–4 in each ampulla, about 460–710  $\mu\text{m}$  long.

*Distribution and habitat.*—Known only from Fuxian Lake, Yunnan Province, China. Freshwater lake, 70–110 m depth, water temperature less than 16°C, fine clay.

*Remarks.*—This species is easily distinguishable from all congeners by lacking a spermathecal duct and the contorted ectal parts of the spermathecal chaetae.

With regard to the homogenous atria with prostate glands, the new species is similar to *Potamothenix scleropenis* Cui & Wang 2005 from Yunnan Province, China. However, *P. scleropenis* differs from this new species by having a penial sheath and penial chaetae.

### Conclusions

The genus *Potamothenix*, established by (Vejdovský & Mrázek 1902) for *P.*

*moldaviensis* Vejdovský & Mrázek 1902, was revised by Holmquist (1985) and Finogenova & Poddubnaja (1990). Altogether, 18 species were previously known and mainly distributed in the Holarctic region (Brinkhurst & Jamieson 1971, Hrabec 1981, Brinkhurst & Wetzel 1984, Finogenova & Poddubnaja 1990, Šporka 1994, Milbrink 1999, Milbrink & Timm 2001). Through recent investigation of plateau lakes, four species of *Potamothenix* (Oligochaeta: Tubificinae), *P. rhytipeniatus*, *P. aductus*, *P. scleropenis* Cui & Wang 2005 and *P. bedoti* (Piguet 1913), are known from Fuxian Lake and Xingyun Lake of Yunnan Province, southwest China. They are the lowest-latitude members of the genus hitherto known. Moreover, studies show that *Potamothenix* is unexpectedly species-rich in plateau lakes of Yunnan Province, especially in Fuxian Lake where three species were recorded, and the specific identities of another two species of *Potamothenix* are still in doubt and need further confirmation from more specimens. With regard to the total findings of oligochaetes from Yunnan, we have reported 31 species, including seven endemic forms. To increase our faunistic knowledge about Chinese oligochaetes, more studies in plateau waters should be carried out.

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## Literature Cited

- Brinkhurst, R. O., & B. G. M. Jamieson. 1971. Aquatic Oligochaeta of the world. Oliver and Boyd, Edinburgh.
- , & M. J. Wetzel. 1984. Aquatic Oligochaeta of the world: supplement. A catalogue of new freshwater species, descriptions, and revisions.—Canadian Technical Report of Hydrography and Ocean Sciences 44:1–101.
- Cui, Y. D., & H. Z. Wang. 2005. *Potamothenis scleropenis* sp. nov. (Oligochaeta: Tubificidae) from Fuxian Lake, the deepest lake in southwest China.—Zoological Science 22(12): 1353–1357.
- , & ———. 2008. Ecology of macrozoobenthic communities in two plateau lakes of Southwest China.—Chinese Journal of Oceanology and Limnology 26(4):345–352.
- , & ———. 2009. Three new species of Tubificinae, Oligochaeta, from two plateau lakes in Southwest China.—Zootaxa 2143: 45–54.
- , X. Q. Liu, & H. Z. Wang. 2008. Macrozoobenthic community of Fuxian Lake, the deepest lake of southwest China.—Limnologia 38:116–125.
- Finogenova, N. P. 1972. New species of Oligochaeta from the Dnieper and Bug Firth and the Black Sea and a revision of some species.—Trudy Zoologicheskogo Instituta Akademii Nauk SSSR 52:94–116 (in Russian).
- . 1976. New species of oligochaete worms of the family Tubificidae from the Caspian Sea.—Zoologicheskii Zhurnal 55:1563–1566 (in Russian).
- , & T. L. Poddubnaja. 1990. One more revision of the genus *Potamothenis* Vejdovský et Mrázek, 1902 (Oligochaeta, Tubificidae).—Zoologische Jahrbücher Abteilung für Systematik, Geographie und Biologie der Tiere 117:55–83.
- Holmquist, C. 1985. A revision of the genera *Tubifex* Lamarck, *Ilyodrilus* Eisen, and *Potamothenis* Vejdovský et Mrázek (Oligochaeta, Tubificidae), with extensions to some connected genera.—Zoologische Jahrbücher Abteilung für Systematik, Geographie und Biologie der Tiere 112:311–366.
- Hrabe, S. 1981. The freshwater Oligochaeta (Annelida) of Czechoslovakia.—Acta Universitatis Carolinae Biologica 1979:1–167.
- Liang, Y. L. 1963. Studies on the aquatic Oligochaeta of China. I. Descriptions of new naids and branchiobdellids.—Acta Zoologica Sinica 15(4):560–570.
- Milbrink, G. 1999. Distribution and dispersal capacity of the Ponto-Caspian tubificid oligochaete *Potamothenis heuscheri* (Bretscher, 1900) in Scandinavia.—Hydrobiologia 406:133–142.
- , & T. Timm. 2001. Distribution and dispersal capacity of the Ponto-Caspian tubificid oligochaete *Potamothenis moldaviensis* Vejdovský et Mrázek, 1903 in the Baltic Sea Region.—Hydrobiologia 463:93–102.
- Nanjing Institute of Geography and Limnology (CAS), The Fuxian Lake. China Ocean Press, Beijing.
- Öschmann, A. 1913. Über eine neue Tubificiden-Art.—Zoologischer Anzeiger 42:559–565.
- Piguet, E. 1913. Notes sur les Oligochètes.—Revue Suisse de Zoologie 21:111–146.
- Sket, B. 2000. *Fuxiana yangi* g. n., sp. n. (Crustacea: Amphipoda), a “baikaloid” amphipod from the depths of Fuxian Hu, an ancient lake in the karst of Yunnan, China.—Archiv für Hydrobiologie 147(2):241–255.
- Šporka, F. 1994. *Potamothenis tudoranceai* sp. n., a new species of Tubificidae (Oligochaeta) from the Ethiopian Rift Valley Lake Zwai (Africa).—Biologia, Bratislava 49(2):161–165.
- Timm, T. 1970. On the fauna of the Estonian Oligochaeta.—Pedobiologia 10:52–78.
- Vejdovský, F., & A. Mrázek. 1902. Ueber *Potamothenis* (*Clitellio*?) *moldaviensis* n. g., n. sp.—Sitzungsberichte der königlichen böhmischen Gesellschaft der Wissenschaften in Prag 24: 1–7.
- Wang, L. Z. 1988. An ecological study on Mollusca population in plateau lakes of Yunnan. Journal of Yunnan University 10 (Supplement), 37–43.
- Yang, J. X., & Y. R. Chen. 1995. The biology and resource utilization of the fishes of Fuxian Lake, Yunnan. Yunnan Science and Technology Press, Kunming, China, (in Chinese with English summary)

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