



## Records of Enchytraeidae (Clitellata) from the People's Republic of China

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### Abstract

Eleven species of terrestrial and aquatic Enchytraeidae are reported from southeastern China. *Fridericia multisegmentata* and *Enchytraeus athecatus* are new to science, while most of the others are recorded from the country for the first time.

### Introduction

Owing to taxonomical difficulties and the influence of the opinion that enchytraeids are rare in the Oriental realm (Stephenson, 1923), taxonomists of microdrile oligochaetes in China paid more attention to Naididae and Tubificidae than to Enchytraeidae before the 1980s. The first recorded species, *Henlea ventriculosa* (d'Udekem), was reported from Tibet by Stephenson (cited in Cernosvitov, 1941). Until 1990, only three further species, *Fridericia bulbosa* (Rosa) (Chen, 1959), *Sinenchytraeus glacialis* Liang & Hsü (Liang et al., 1979), and *Isosetosa minxianensis* Xu, Zhang & Jiang, 1989 were recorded from the country. In 1992, Liang & Xie reported eight species belonging to four genera from Mt. Tianmushan in Zhejiang Province, viz. *Achaeta parva* Nielsen & Christensen, *A. indica* Prabhoo, *Hemienchytraeus bifurcatus* Nielsen & Christensen, *H. theae* Prabhoo, *Enchytraeus* sp., *Fridericia carmichaeli* Stephenson, *F. bulboides* Nielsen & Christensen and *F. callosa* (Eisen). Regarding marine enchytraeids, 11 species of five genera were recorded (Erséus, 1990, 1992a,b; Erséus et al., 1990).

In recent years, a preliminary investigation of Enchytraeidae in China was carried out. More than 20 species belonging to eight genera were found. Among them, four species of *Hemienchytraeus*, viz. *H. planisetosus* Xie, Wang & Liang sp.nov., *H. brachythecus* Xie, Wang & Liang sp.nov., *H. loksai* Dózsa-Farkas and *H. stephensoni* (Cognetti), will be published in

another paper (Xie et al., 1999). This paper reports 11 species including *Fridericia multisegmentata* sp. nov. and *Enchytraeus athecatus* sp. nov.

### Methods

Worms were extracted from samples by the wet-funnel method (O'Connor, 1962). Observations were based on living material and whole-mounted specimens, preserved in 10% formalin, stained by alum cochineal or borax carmine and mounted in Canada balsam. Measurements of internal organs refer to whole-mounted specimens and drawings were made from the mounts using a camera lucida, except Figure 2F and Figure 4B. The types and other specimens are deposited in the Specimen Room of Invertebrates, Institute of Hydrobiology, Chinese Academy of Sciences (CAS).

### Sampling sites

Sampling sites are located in the following regions (Figure 1): Fengqiu (35.1° N, 114.4° E), Henan Province; Xi'an (34.3° N, 108.9° E), Shaanxi Province; Wuhan (30.5° N, 114.3° E), Hubei Province; Changsha (24.2° N, 116.1° E), Mt. Hengshan (27° 10'–20' N, 112° 34'–114° 44' E) and Hengyang (26.9° N, 112.6° E), Hunan Province; Lingchuan (25.4° N, 110.3° E), Yangshuo (24.8° N, 110.5° E), Zhongshan (24.5° N, 111.3° E) and Tengxian (23.4°

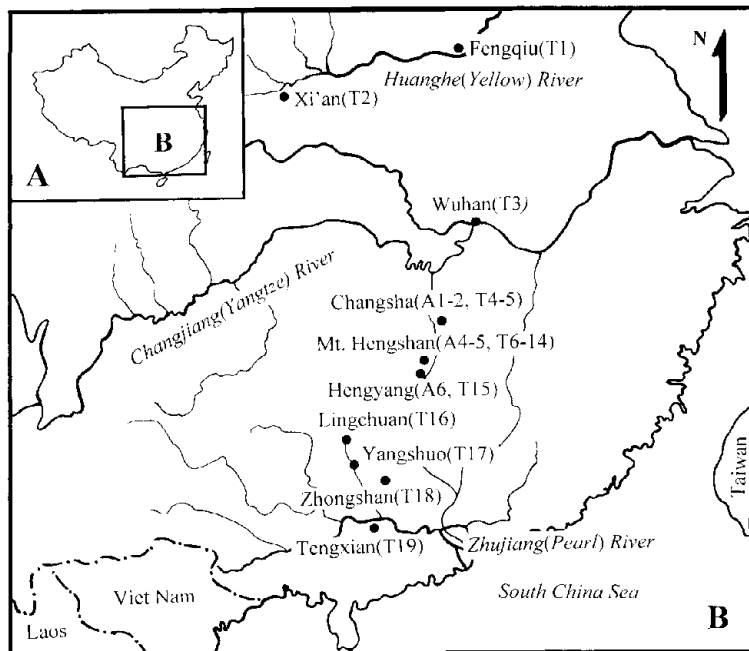


Figure 1. Distribution of sampling sites. A, China. B, sampling area.

N, 110.9° E), Guangxi Autonomous Region. These sites are as follows:

#### Aquatic sites

- A1: Ditches around Taozihu pond, Changsha, April 12, 1991.  
 A2: Xiangjiang River, Changsha, April 12, 1991.  
 A3: Brooks on Mt. Hengshan, May 9, 1991.  
 A4: Rice fields on Mt. Hengshan, May 9, 1991.  
 A5: Nanyue Reservoir at the foot of Mt. Hengshan, May 9, 1991.  
 A6: Leishui River, Hengyang, May 21, 1991.

#### Terrestrial sites

- T1: Fengqiu, villages and their vicinities, September 13–23, 1991.  
 T2: Xi'an, parks, September 5, 1991.  
 T3: Luojiashan, Wuhan, forest soil, July, 1994.  
 T4: Juzizhoutou in the middle of Xiangjiang River in Changsha, mossy soil, April 13, 1991.  
 T5: Yuelushan, Changsha, with the highest peak 296 m above sea level, forest soil, April 17, 1991 and November 13, 1994.  
 T6: Zhurongfeng, Mt. Hengshan, 1290 m above sea level, forest soil, April 24, 1991.  
 T7: Tianzhufeng, Mt. Hengshan, 1061 m, grass soil, April 25, 1991.

- T8: Cangjingdian, Mt. Hengshan, 1050 m, forest soil, April 25, 1991.  
 T9: Huangdiyan, Mt. Hengshan, ca. 950 m, mossy soil, April 24, 1991.  
 T10: Tiefusi, Mt. Hengshan, 840 m, forest soil, April 29, 1991.  
 T11: Ychoushuyuan, Mt. Hengshan, 750 m, forest soil, April 28, 1991.  
 T12: Banshanting, Mt. Hengshan, 620 m, forest soil, April 26, 1991.  
 T13: Yubanqiao, Mt. Hengshan, 290 m, forest soil, April 27, 1991.  
 T14: Forest soil near Nanyue Reservoir at the foot of Mt. Hengshan, April 9, 1991.  
 T15: Xiangshancun, Hengyang, forest soil, May 21, 1991.  
 T16: Lingchuan, vegetable patch, September 7, 1992.  
 T17: Yangshuo, on the bank of Lijiang River, September 10, 1992.  
 T18: Zhongshan, various habitats, July 21–25, 1993.  
 T19: Tengxian, various habitats, July 10–13, 1993.

#### List of species

(#: new genus record for China, \*: new species record for China.)

*Mesenchytraeus* sp. #  
*Achaeta brevivasa* Graefe, 1980\*  
*Achaeta* cf. *indica* Prabho, 1960  
*Hemifridericia parva* Nielsen & Christensen, 1959 #\*  
*Henlea perpusilla* Friend, 1911\*  
*Fridericia* cf. *alba* Moore, 1894\*  
*Fridericia bulboides* Nielsen & Christensen, 1959  
*Fridericia multisegmentata* sp. nov.  
*Enchytraeus athecatus* sp. nov.  
*Enchytraeus* cf. *christenseni* Dózsa-Farkas, 1992\*  
*Marionina riparia* Bretscher, 1899\*

## Systematic descriptions

### *Mesenchytraeus* sp. (immature)

Localities: A3, T5 (13.XI.94), T6, T7, T8, T9, T10, T11, T12.

### *Achaeta brevivasa* Graefe, 1980 (Figure 2 C, D, E, F)

Length 1.4–2 mm (fixed), 2 mm (living); segments 17–25. Head pore small. No chaetal follicles. Clitellum over XII–1/2XIII, with gland cells in transverse rows. Brain about twice as long as width, anterior concave, posterior rounded. Septal glands all united dorsally; one pair of secondary glands behind septum 5/6. Gut dilatation gradual in VII. Oesophageal appendages one pair, confined to V and without internal canal (Figure 2C). Dorsal vessel originating in VII. Nephridia from 6/7 onwards with anteseptal parts ca. 1/2 as long as postseptal; efferent ducts terminal (Figure 2E). Coelomocytes abundant and round, with attached filaments (Figure 2F); cytoplasm transparent, nuclei 1/4–1/2 of the cell, round or irregular, sometimes absent. Sperm funnels about twice as long as width, with collar slightly narrower than funnel (Figure 2D). Vasa deferentia short, confined to XII. Penial bulbs crescent-shaped. No seminal vesicles. Spermathecae dumb-bell-shaped, opening laterally and confined to V, length shorter than body width. Ampullae irregularly oval, with globules on surface and small lumen.

*Material examined:* ten whole mounts and three live specimens from T3, T5 (17.IV.91), T8.

*Remarks:* The morphological characters of our specimens conform quite well to the original description. *A. camerani* is similar to *A. brevivasa* but is larger (length=6–10mm, segments=32–35), possesses two pairs of secondary septal glands in V–VI, a dorsal

vessel was originating in VIII, and coelomocytes had larger nuclei (Graefe, 1980).

*Distribution:* Europe; Hubei Province and Hunan Province, China

### *Achaeta* cf. *indica* Prabho, 1961 (Figure 2A, B)

*Achaeta indica* Prabho. Liang & Xie, 1992.

Fixed length 2–3 mm; segments 20–30. No chaetal follicles. Clitellum over XII–XIII; gland cells scarce and small, arranged in transverse rows. Brain 1.5 times as long as wide, anterior end concave, posterior rounded. Septal glands all united dorsally. Oesophageal appendages one pair, confined to V. Gut dilatation sudden in VII (Figure 2A). Dorsal vessel originating in VII. Coelomocytes round with numerous granules. Efferent ducts of all nephridia terminal. Sperm funnels 2–4 times as long as wide, with collar slightly narrower than funnel (Figure 2B). Seminal vesicle present. Spermathecae opening ventro-laterally and extending to VII (Figure 2A); ampullae oval, ca. 60  $\mu\text{m}$  in length, 26  $\mu\text{m}$  in maximum width; ectal ducts ca. 160  $\mu\text{m}$  long and 8  $\mu\text{m}$  wide, dilated near ectal pore and forming a small spindle-shape lumen.

*Material examined:* four whole mounts and two live specimens from T14.

*Remarks:* Although individuals from the type position (India) were longer (length 7 mm, segments 31–36), and possessed oesophageal appendages extending into VI, the present material agrees with the original description (Prabho, 1961) in many characters, especially spermathecal morphology. The authors are of the opinion that it should be identified as *A. indica* for the time being.

*Distribution:* India; Zhejiang Province and Hunan Province, China.

### *Hemifridericia parva* Nielsen & Christensen, 1959 (Figure 3 A)

Length=1.6 mm (fixed), 2 mm (living); segments=21–22. Dorsal chaetae 2 per bundle; ventral chaetae 3 per bundle (2 in II) in the anteclitellar, 2 per bundle post-clitellar. Clitellum over XII–1/2XIII; gland cells oval and transversely arranged; chaetae present in XII. Posterior of brain deeply incised. No septal glands unite dorsally; secondary glands one pair in IV (Figure 3A). Dorsal vessel originating in XII–XIII. Nephridia from 6/7 onwards with efferent duct terminal. Coelomocytes of two types. Sperm funnels pear-shaped, 1.5 times as long as width, with inconspicuous collar. No seminal vesicles. Spermathecae small, connecting jointly with oesophagus (Figure 3A).

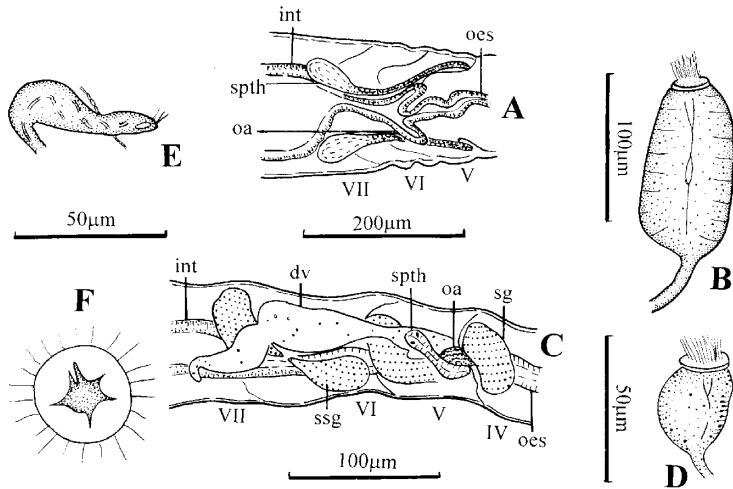


Figure 2. (A–B) *Achaeta cf. indica*. (C–F) *Achaeta brevivasa*: (A) dorsal view of IV–VII, (B, D) sperm funnel, (E) nephridium, (F) coelomocyte (freehand drawing). Abbreviations: dv, dorsal vessel; int, intestine; oa, oesophageal appendage; oes, oesophagus; sg, septal gland; ssg, secondary septal gland; spth, spermatheca.

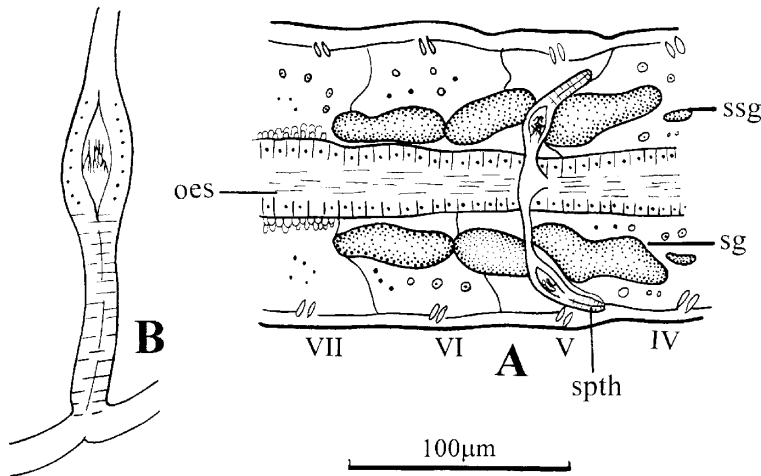


Figure 3. (A) *Hemifridericia parva*. (B) *Henlea perpusilla*. (A) dorsal view of IV–VII, (B) sperm funnels. Abbreviations: oes, oesophagus; sg, septal gland; spth, spermatheca; ssg, secondary septal gland.

**Material examined:** three specimens from T6.

**Remarks:** The specimens from the type locality (Denmark) were described as possessing 2 chaetae per bundle ventrally in XI (Nielsen & Christensen, 1959), whereas our specimens have 3 in the same position. The presence of secondary septal glands in IV was not mentioned in the original description.

**Distribution:** Europe; Hunan Province, China.

***Henlea perpusilla* Friend, 1911 (Figure 3 B)**

*Henlea perpusilla* Friend. Nielsen & Christensen, 1959.

Length 7.4 mm (fixed), 8.5 mm (living); segments 36. Chaetae 2–7 per bundle. Clitellum over XII–1/2XIII, with gland cells irregularly arranged. Posterior of brain slightly incised. Three oesophageal appendages, dorsal pair short and unbranched, ventral piece branching into two long twigs. No intestinal diverticula. Dorsal vessel originating in posterior of VIII. Sperm funnels cylindrical, 2–3 times as long as width. Spermathecal ampullae spindle-shaped, without glands at ectal pore (Figure 3B).

**Material examined:** one whole mount and two live specimens from T7.

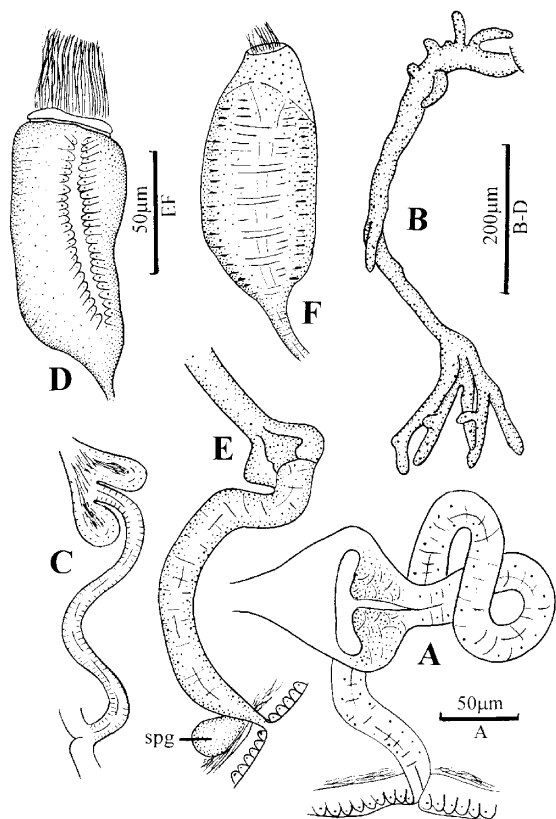


Figure 4. (A) *Fridericia cf. alba*. (B–D) *Fridericia multisegmentata* sp. nov.. (E, F) *Fridericia bulboides*; (A, C, E) spermatheca, (B) peptonephridium on one side. (D, F) sperm funnel. Abbreviation: spg. gland at spermathecal pore.

**Distribution:** Europe, Asia (Russia; Hunan Province, China), N. America, Antarctica (South Georgia Island).

***Fridericia cf. alba* Moore, 1895 (Figure 4 A)**

Length 11–12 mm (fixed), 16 mm (living); width 0.3–0.5 mm; segments 52–59. Head pore at 0/I, dorsal pores from VII onwards. Chaetae from II onwards, 2–4 in dorsal and ventral bundle, mostly 4 anteriorly (from II to ca. XXI) and 2 posteriorly; chaetae absent in XII; outer chaetae ca. 62  $\mu$ m in length, 6  $\mu$ m in maximum width. Epidermal gland cells transversely arranged, ca. 14 rows per segment (when whole-mounted), more conspicuous in the antecitellar region. Clitellum over XII–2/3XIII, with gland cells irregularly arranged; medioventral gland cells absent or scant anteriorly and in a small posterior patch.

Brain 140  $\mu$ m long, 50–60  $\mu$ m wide anteriorly and 90  $\mu$ m wide posteriorly, anterior end triangularly con-

vex, and posterior rounded or truncated. Peptonephridia one pair, straight and short, extending to IV or anterior of V, unbranched or with 1–2 twigs. Septal glands with dorsal connection in first and second pairs. Gut dilatation gradual. Dorsal vessel originating in XIX. Chylus cells present in 3 postclitellar segments, e.g. from XIV to XVI, or from XVII to XIX. Chloragogen cells from ca. VII onwards. Nephridia from 6/7 onwards with 4 pairs in front of clitellum, anteseptal parts ca. 1/2 as long as postseptal; efferent ducts originating from anterior of postseptal parts. No copulatory glands enveloping ventral nerve cord. Nucleate coelomocytes numerous, oval to round, with regular outline, with granules evenly distributed and without refractile globules, ca. 20  $\mu$ m long and 10–20  $\mu$ m wide; small anucleate corpuscles scarce, 5–7  $\mu$ m long and ca. 4  $\mu$ m wide (when whole-mounted). Detached chaetae present in coelome.

Sperm funnels cylindrical, ca. 220  $\mu$ m long and ca. 90  $\mu$ m wide, with distinct collar as wide as funnel, mostly distorted when preserved. Vasa deferentia irregularly coiled. Penial bulbs one pair, hemispherical, 60  $\mu$ m long, 36  $\mu$ m wide, 30  $\mu$ m in height, opening ventrolaterally at mid XII. One large seminal vesicle in X–XI. No egg sacs, 1–2 eggs present.

Spermathecae in V, communicating with dorsolateral region of oesophagus separately. Ampullae onion-shaped, with transversely scattered spermatozoa, 120  $\mu$ m long, 96–100  $\mu$ m in maximum width. Ectal ducts ca. 360  $\mu$ m long and 26  $\mu$ m wide, without glands at ectal pore. Ental ducts ca. 100  $\mu$ m long and 40  $\mu$ m wide (Figure 4A).

**Material examined:** five whole mounts and two live specimens from T7, T12, T16.

**Remarks:** The distinctive characters of *F. alba* are large size, short peptonephridia and simple spermathecae. In these respects, our specimens are similar to those from the type locality (Philadelphia, USA). However, the original material had chaetae were 2–7 per bundle, mostly 4, the brain slightly emarginate posteriorly, and the dorsal vessel originating in XXII. Male genital organs and nephridia were not described by Moore (1895).

**Distribution:** N. America; Hunan Province and Guangxi Autonomous Region, China.

***Fridericia bulboides* Nielsen & Christensen, 1959 (Figure 4 E, F)**

*Fridericia bulboides* Nielsen & Christensen. Liang & Xie, 1992.

Length 6 mm (fixed), 9 mm (living); segments 28–

42. Chaetae 2–4 in dorsal and ventral bundle, mostly 4 in the anteclytellar and 2 in postclytellar regions. Epidermal gland cells 5–6 rows per segment. Clitellum over XII–2/3XIII, with gland cells irregularly arranged and well developed everywhere. Peptonephridia unbranched and very long, much coiled in IV–V, extending to VI–VII. Dorsal vessel originating in XVII. Chylus cells present in region XIII–XIV. Sperm funnels cylindrical, with tall collar (Figure 4F). No seminal vesicles. Spermathecal ampullae onion-shaped, with a large gland at ectal pore (Figure 4E).

*Material examined:* seven whole mounts and two live specimens from T6, T7, T11, T14.

*Remarks:* The characteristics of our specimens coincide with the original description, except that our specimens have larger glands at spermathecal pore and a more posterior origin of dorsal vessel (XIV–XVI).

*Distribution:* Europe, Turkey, N. America, Greenland, Canada, Australia, Siberia; Zhejiang Province and Hunan Province, China.

***Fridericia multisegmentata* sp. nov. Wang, Xie & Liang (Figure 4 BCD)**

*Holotype:* Mature, whole mount, collected from Cangjingdian, Mt. Hengshan, 1050 m, broad-leaf forest dominated by beech (Fagaceae), yellow-brown soil, April 25, 1991 (T8). T8.

*Paratypes:* eight whole mounts (2 dissected), eight in 10% formalin all from T8.

*Etymology:* Named *multisegmentata* for the large number of segments.

*Description:* Fixed length 20–28 mm (holotype: 27 mm); width 0.7–0.8 mm; segments 73–80 (holotype: 80). Body whitish. Head pore at 0/1, dorsal pores from VII. Chaetae 2–4 in dorsal and ventral bundle, mostly 4 anteriorly (from II to ca. XX) and 2 posteriorly, disposed in pairs; straight, simple-pointed, with ental hook; outer chaetae ca. 101  $\mu\text{m}$  in length, 10  $\mu\text{m}$  in maximum width; chaetae absent in XII. Epidermal gland cells numerous, irregularly arranged. Clitellum over XII–XIII, gland cells irregularly arranged; medioventral gland cells absent in the anterior region (in front of the posterior border of male pores) between male pores.

Brain 126  $\mu\text{m}$  long, 100  $\mu\text{m}$  wide anteriorly and 132  $\mu\text{m}$  wide posteriorly, anterior slightly concave and posterior truncated. Peptonephridia arising ventrolaterally, branching into 6 and 7 twigs respectively in the anterior and posterior parts, one twig present in the middle part (Figure 4B). Septal glands with dorsal connection in first and second pairs; no sec-

ondary glands. Gut dilatation gradual. Dorsal vessel originating in XXV–XXVI (holotype: XXVI). Chylus cells from XI to ca. XVII. Chloragogen cells from VII. Nephridia from 6/7 with 5 pairs in front of clitellum, anteseptal parts ca. 1/3 as long as postseptal; efferent ducts originating from terminal regions of postseptal parts. No copulatory glands enveloping ventral nerve cord. Coelomocytes of two types, both oval to round, with regular outline. Nucleate coelomocytes numerous, with granules evenly distributed and with several refractile nucleoli, 30–40  $\mu\text{m}$  long and 22–26  $\mu\text{m}$  wide; small anucleate corpuscles scarce, 7–8  $\mu\text{m}$  long and 6–7  $\mu\text{m}$  wide (when whole-mounted).

Sperm funnels cylindrical, 338  $\mu\text{m}$  long and 152  $\mu\text{m}$  wide, with raised collar narrower than funnel (Figure 4D). Vasa deferentia confined to XII, irregularly coiled. Penial bulbs one pair, hemispherical, 116–132  $\mu\text{m}$  long, 97–101  $\mu\text{m}$  wide, 77–97  $\mu\text{m}$  in height, opening ventrolaterally at mid XII. One large seminal vesicle in the anterior of XI. No egg sacs. 1–2 eggs present.

Spermathecae in V, having conical ampulla and 2 diverticula with almost cylindrical outline and lumen (Figure 4C). Spermatozoa scattered throughout the common lumen of ampulla and diverticula. Ampullae ca. 70  $\mu\text{m}$  in length (from connection with ectal duct to beginning of ental duct); paired diverticula 39–43  $\mu\text{m}$  in length (from distal end to connection with ectal duct) and ca. 40  $\mu\text{m}$  in width. Each ampulla communicating with dorsolateral region of oesophagus separately by a short ental duct. Ectal ducts 480–500  $\mu\text{m}$  long and 27  $\mu\text{m}$  wide, without glands at ectal pore.

*Remarks:* The new species differs from all known *Fridericia* species by the following combination of characters:

1. the large number of segments,
2. a maximum of 4 chaetae in a bundle,
3. spermathecae with 2 diverticula and without glands at ectal pore (Table 1).

Nevertheless, there is some resemblance to *Fridericia perrieri* (Vejdovský), *Fridericia agricola* Moore and *Fridericia jordanensis* Bell concerning spermathecae and peptonephridia. Besides the different chaetae, segments and sperm funnel, the present species differs from the first two by the morphology of spermathecal lumina and nephridia, and differs from the last by the more posterior origin of the dorsal vessel.

*Distribution:* Hunan Province, China.

***Enchytraeus athecatus* sp. nov. Wang, Xie & Liang (Figure 5)**

Table 1. Comparison of *Fridericia multisegmentata* sp. nov. with allied species

	<i>F. multisegmentata</i> sp. nov.	<i>F. perrieri</i> (Vejdovsky, 1878) <sup>1)</sup>	<i>F. agricola</i> Moore, 1895 <sup>2)</sup>	<i>F. jordanensis</i> Bell, 1962
Length (mm)	20–28	10–25	20–25	10
Segments	73–80	33–64	65–72	48–58
Chaetae/bundle	2–4	4–8	2–4 (5)	4–6
Clitellum	XII–XIII	XII–1/2XIII	XII–1/2XIII	absent
Posterior of brain	truncated	round	round	round
Peptonephridia	much branched	branched	much branched	with several terminal twigs
Origin of dorsal vessel	XXV–XXVI	XVI–XXI	?	XV XVIII
Efferent duct of nephridia	terminal	ventral	ventral	terminal or ventral
Sperm funnel (length:width)	2.2:1	2.5–3:1	4.5:1	1:1
Seminal vesicle	well developed	poorly developed or absent	well developed	well developed
Spermathecae	lumen of ampulla and 2 diverticula inseparable; no ectal glands	lumen of ampulla and 2 diverticula separable; canal of ectal duct coiled before reaching ampulla; no ectal glands	lumen of ampulla and 2 diverticula separable; no ectal glands	lumen of ampulla and 2 diverticula inseparable; no ectal glands
Distribution	China	Europe. E. Africa	USA, Brazil,	Jordan

<sup>1)</sup> data from Nielsen & Christensen, 1959; Möller, 1971. <sup>2)</sup> from Moore, 1895; Bittencourt, 1974.

**Holotype:** Whole mount, collected from Juzizhoutou in the middle of Xiangjiang River in Changsha, red, mossy soil attached to the bank, April 13, 1991 (T4).

**Paratype:** one whole mount, also from T4.

**Other localities:** A4, T1, T2, T15, T16, T17, T18, T19.

**Etymology:** Named *athecaus* for the absence of spermathecae.

**Description:** Fixed length 4.7–4.8 mm (holotype: 4.7 mm); width 0.2–0.3 mm; segments 30. Head pore present in dorsal center of prostomium. Chaetae from II, mostly 2 per bundle; 1 additional chaeta (smaller or not) occasionally present ventrally from II to XIII (present in both holotype and paratype); straight, simple-pointed, without nodulus and with ental hook; 48–52  $\mu\text{m}$  in length, 2–4  $\mu\text{m}$  in width (Figure 5A); chaetae absent in XII. Clitellum over XII–1/2XIII, with gland cells irregularly arranged; medioventral gland cells absent between male pores.

Brain trapezoidal, posterior round, 96  $\mu\text{m}$  in length, 36–48  $\mu\text{m}$  in width (Figure 5B). Pharyngeal plate in II–III well developed. Peptonephridia unbranched, extending to IV (Figure 5C). A pair of small postpharyngeal bulbs attached to pharynx and situated dorsal to peptonephridia, with numerous nuclei. Septal glands without dorsal connection, or with thin connection in first pair (holotype); no secondary glands. Gut dilatation gradual. No oesophageal or intestinal appendages. Dorsal vessel originating in clitellar region. Chloragogen cells from VI. Nephridia from 6/7, with 5 pairs in front of clitellum; anteseptal parts small and postseptal elongated; efferent ducts originating from terminal of postseptal parts (Figure 5D). Coelomocytes oval and nucleate, 12–20  $\mu\text{m}$  long and 9–16  $\mu\text{m}$  wide (when whole-mounted). Detached chaetae few in coelom.

Sperm funnels sub-spherical, length 72  $\mu\text{m}$ , maximum width 62  $\mu\text{m}$ ; collars narrower than funnels, 10  $\mu\text{m}$  in length, 34  $\mu\text{m}$  in width (Figure 5E). Vasa defer-

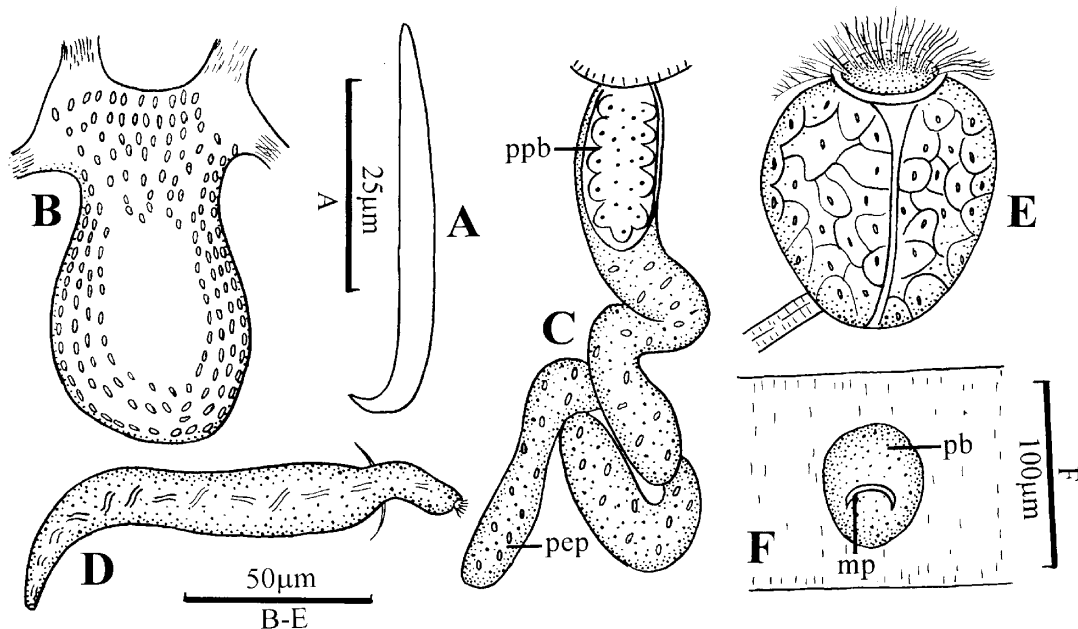


Figure 5. *Enchytraeus atheatus* sp. nov. (A) chaeta (VIII), (B) brain, (C) peptonephridium and post-pharyngeal bulb on one side, (D) nephridium (21/22), (E) sperm funnel, (F) penial bulb. Abbreviations: mp, male pore; pep, peptonephridium; pb, penial bulb; ppb, post-pharyngeal bulb.

entia confined to XII, irregularly coiled. Penial bulbs, large and spherical, 56–64  $\mu\text{m}$  in maximum length, 64–80  $\mu\text{m}$  in width, opening ventrolaterally at mid XII (Figure 5F). Seminal vesicles oval to round, one pair from posterior of X to anterior of XI (holotype) or in anterior of XI (paratype), 80–140  $\mu\text{m}$  in length and 44–80  $\mu\text{m}$  in maximum width. No egg sacs; 1–2 eggs present. Spermathecae absent.

**Remarks:** The new species resembles *Enchytraeus florentinus* Bell and *Enchytraeus varitheatus* Bouguenec & Gianni in the absence of spermathecae. However, the chaetae of *E. florentinus* are curved, the degree of curvature varying considerably in the same worm and its penial bulb is reduced to a small cluster of gland cells. The present species also differs from *E. varitheatus* by having one more pair of anteclitellar nephridia, regularly oval coelomocytes, larger penial bulb and a small number of mature eggs at a time (Table 2).

**Distribution:** Henan Province, Shaanxi Province, Hunan Province and Guangxi Autonomous Region, China.

#### *Enchytraeus* cf. *christenseni* Dózsa-Farkas, 1992

*Enchytraeus minutus* (nec Tauber) Nielsen & Christensen, 1961

*Enchytraeus christenseni* Dózsa-Farkas, 1992  
Length 2–3 mm (fixed), 5 mm (living); segments 27–29. Chaetae 2–4 per bundle. Epidermal gland cells scarce. Clitellum over XII–1/2XIII, with gland cells in transverse rows; medioventral gland cells absent in area between male pores. Brain slightly incised posteriorly. Peptonephridia unbranched, with irregular outline. No septal glands united dorsally. Dorsal vessel originating in XIII. Efferent ducts of nephridia originating from posterior of postseptal part. Coelomocytes abundant and oval. Sperm funnels cylindrical or pear-shaped, 2–3 times as long as wide, with conspicuous collar as wide as funnel. Penial bulbs large, 48–56  $\mu\text{m}$  in length, 40–44  $\mu\text{m}$  in width, ca. 20  $\mu\text{m}$  in height. Seminal vesicles small, one pair in XI. Spermathecal ampullae spherical, ca. 22  $\mu\text{m}$  in diameter; ectal ducts covered with glands, 1.5–2 times as long as ampullae, without glands at ectal pore.

**Material examined:** nine whole mounts and three live specimens from A2, A3, T13.

**Distribution:** Europe; Hunan Province, China.

#### *Marionina riparia* Bretscher, 1899 (Figure 6)

*Marionina riparia* Bretscher. Nielsen & Christensen, 1959.



Table 2. Comparison of *Enchytraeus athecatus* sp. nov. with allied species

	<i>E. athecatus</i> sp. nov.	<i>E. florentinus</i> Bell, 1947	<i>E. varithecatus</i> Bouguenec & Giani, 1987
Length (mm)	4.7–4.8	2–3	6–7.5
Segments	30	27–30	25–30
Chaetal shape	straight	curved	straight
Dorsal chaetae/bundle	2	2	2
Ventral chaetae/bundle	2 (3)	3	2
Coelomocytes	oval	oval	irregularly oval to spindle-shaped
Posterior of brain	round	slightly incised	truncated or slightly incised
Anteclitellar nephridia	5 pairs	?	4 pairs
Sperm funnels (length:width)	1.2:1	2:1	1.3:1
Penial bulbs	large	degenerate	small and compact
Eggs	1–2	?	1–6
Spermathecae	absent	absent	sometimes absent
Distribution	China	Italy	France

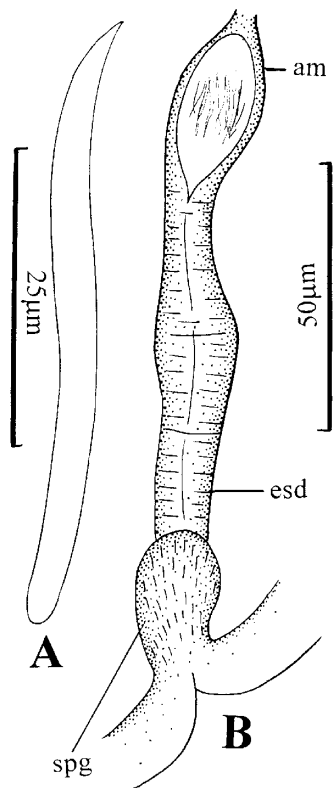


Figure 6. *Marionina riparia*, (A) chaeta (IV), (B) spermatheca. Abbreviations: am, ampulla; esd, ectal duct of spermatheca; spg, gland at spermathecal pore.

Fixed length 3 mm; segments 26. Body reddish when living. Chaetae sigmoid (Figure 6A), 2–4 per bundle, mostly 3. Epidermal gland cells 2–4 rows per segment, reddish when living. Clitellum over 1/2XI–1/2XIII, with gland cells irregularly arranged. Brain deeply incised posteriorly. Only first pair of septal glands united dorsally. Dorsal vessel originating in XIII, with reddish blood when living. Efferent ducts of nephridia originating from posterior of postseptal parts. Coelomocytes spindle-shaped and abundant. Sperm funnels cylindrical, twice as long as width, with collar narrower than funnel. Vasa deferentia confined to XII. Penial bulbs large. No seminal vesicles. The connection between spermatheca and oesophagus rather thin. Spermathecal ampullae oval, ca. 26  $\mu\text{m}$  in length, ca. 18  $\mu\text{m}$  in maximum width. Ectal ducts ca. 90  $\mu\text{m}$  long and 10  $\mu\text{m}$  wide, with a gland at ectal pore (Figure 6B).

*Material examined*: five whole mounts and two live specimens from A1, A3, A4, A5, A6.

*Remarks*: In specimens described by Nielsen & Christensen (1959), the spermathecal ampullae are larger than those of our specimens and the clitellar gland cells are arranged in transverse rows.

*Distribution*: Europe, N. Africa, Turkey; Hunan Province, China.

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