TAXONOMICAL STUDIES ON *FRIDERICIA* (ENCHYTRAEIDAE, Oligochaeta) ALONG THE CHANGJIANG (YANGTZE) BASIN

XIE Zhicai, LIANG Yanling, WANG Hongzhu
(State Key Laboratory of Freshwater Ecology and Biotechnology, Institute of Hydrobiology, The Chinese Academy of Sciences, Wuhan 430072)

**Abstract** Four terrestrial species of *Fridericia* along the Changjiang Basin are described. Among them, *Fridericia chongqingensis* sp. nov. is diagnosed by the much branched (13—19 twigs) peptonephridia, the midventral nephridial efferent ducts, the longer sperm funnel, the well-developed seminal vesicle, the presence of 2 (sometimes 3) sessile globular spermathecal diverticula, and one small accessory gland cell (known in vivo) at each ectal orifice. While *Fridericia parsoniana* Issel, 1904 and *F. maculata* Issel, 1904 are recorded from China for the first time.

**Key words** Enchytraeidae, Oligochaeta, *Fridericia*, new species, new record.

1 Introduction

Since Michaelsen (1889) erected the genus *Fridericia*, about 130 species in the genus have been described throughout the world (Nielsen & Christensen, 1959, 1961, 1963; Dózsa-Farkas et al., 1985, 1992; Römcke & Dózsa-Farkas, 1996; Schmelz & Römcke, 1998). In China, only 8 species of the genus were known, among which, *F. bulbosa* (Rosa, 1887), *F. bulboides* Nielsen & Christensen, 1959, *F. carmichaeli* Stephensen, 1915, *F. callosa* (Eisen, 1878), *F. alba* Moor, 1895, were reported (Chen, 1959; Liang & Xie, 1992; Wang et al., in press; Xie et al., in press).

Recently, a faunal survey of enchytraeids was carried out along the Changjiang Basin. Among the collected specimens, 4 terrestrial species of *Fridericia*, including one new species and 2 new records in China, were observed and the descriptions are presented herein.

2 Material and methods

Worms were extracted by using the wet-funnel method (O’Connor, 1962) and fixed in 10% formalin. Observations were made on specimens both in vivo and after fixation. For preserved materials, whole worms or dissected specimens were stained in borax carmine or paracarmine and mounted in Canada balsam. Measurements in the descriptions are based on fixed specimens. Types of the new species are deposited in Specimen Room of Invertebrates, Institute of Hydrobiology, the Chinese Academy of Sciences.

3 Results

*Fridericia chongqingensis* sp. nov. (Fig.1 A—E)
**Description**  Body length 8—11.5 mm. Segments 44—73. Paleepidermal glands well-developed, arranged transversely, 3—4 rows per segment. Head pore in 0/1, large, longitudinally elongate. Dorsal pores from VII onwards. Chaetae straight, with distinct ental hooks, 100—104 μm in maximal length and ca. 7 μm in maximal width. Chaetae distribution: (1), 2, 3, 4, (5)—3, 4, 5; 2, 3, 4, 5, (6)—(1), 2, 3, 4. Clitellum in XII—1/2XIII, clitellar glands oblong, irregularly distributed, not interrupted dorsally and ventrally. Copulatory glands absent. Spermathecal pores midlateral of 4/5. Male pores midventral of XII. Both lateral and ventral chaetae of XII absent.

Brain oblong in dorsal view, convex anteriord, truncate or round posteriorly, 130—136 μm long and 90—92 μm wide. Septal glands 3 pairs, all with ventral lobes. No secondary septal glands. Peptonephridia much branched (Fig. 1A), extending backwards to V, with 5—8 middle twigs (some divided into subtwigs) and 8—11 terminal twigs (type c, sensu, Nielsen & Christensen, 1959). Chloragogen cells well-developed, from VI onwards, cylindrical, filled with golden-brown granules, 14 μm high and 8 μm wide. Chylus cells in XIV—XVII. Blood colorless. Dorsal vessel originating in XX—XXIII. Coelomic fluid containing many detached chaetae. Nucleated coelomocytes discoid, up to 20—40 μm in diameter, with regular outline, evenly granulated (type c, sensu Møller, 1970); anucleated corpuscles oval, up to 6—8 μm in diameter (Fig. 1C). 5 pairs preclitellar nephridia at 6/7—10/11, with efferent ducts arising from midventral of postseptate (Fig. 1B). Seminal vesicle large, occupying the whole of segments X—XII. Sperm funnel cylindrical, soft-bodied, 610—620 μm long, 150—158 μm wide, covered by pale, large, granular cells; collar narrower than funnel (97—100 μm) (Fig. 1E). Vasa deferentia confined to XII, much coiled irregularly. Penial bulbs semi-spherical in lateral view, 230—236 μm long, 110—115 μm wide and 93—95 μm high. No egg sacs. 1—2 mature egg at a time. Spermathecae in V, with a narrow ental duct (long ca. 15 μm). Two ental duct connecting with oesophagus respectively. Ampulla conical, 105—110 μm long and 128—132 μm wide; with 2 (sometimes 3 in some specimens from Nanning) sessile globular diverticula (58—60 μm in size) at the base of ampulla. Spermatozoa scattered in the lumen of ampulla and diverticula. Ectal duct 468—472 μm long and 23—25 μm wide. One small ectal gland cell (brown in vivo) attached at each ectal pore.

**Type material**  Holotype, Whole mounted specimen, Mt. Baoding, Chongqing City, China, bam-

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**Fig.1**  *Fridericia chongqingensis* sp. nov.
A. Peptonephridium;  B. Nephridium in 15/16;  
C. Coelomocytes;  D. Spermathecae;  E. Sperm funnel.

**Other material examined**  20 specimens also from type locality; 5 specimens from soil of pine forests, Chongqing City, China (November, 1997); 6 from soil of Nanhu Park, Nanning City, Guangxi Zhuang Autonomous Region (September, 1995).

**Etymology**  Named "chongqingensis" from the type locality.

**Remarks**  Regarding the general morphological characters, the new species is closely related to *F. multisegmentata* Wang et al., *F. perrieri* (Vejdovsky, 1877) and *F. agricola* Moore, 1895. However, besides in addition to the much branched peptonephridia and the presence of ectal gland cell at spermathecal pore, the new species also differs from *F. multisegmentata* by the less body length, the midventral nephridial efferent ducts, the more anterior origin of dorsal vessel and the longer sperm funnel; from *F. perrieri* by the fewer chaetae per bundle, the more posterior origin of dorsal vessel, the longer sperm funnel, the well-developed seminal vesicle and the morphology of spermatheca; from *F. agricola* by the more chaetae per bundle, the truncated brain and the midventral nephridial efferent ducts. The details of difference among them are given in Tab. 1.

**Tab. 1**  **Comparison of Fridericia chongqingensis** sp. nov. with allied species

<table>
<thead>
<tr>
<th></th>
<th><em>F. chongqingensis</em></th>
<th><em>F. multisegmentata</em></th>
<th><em>F. perrieri</em></th>
<th><em>F. agricola</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>sp. nov.</td>
<td>Wang et al., 1999</td>
<td>(Vejdovsky, 1877)</td>
<td>Moore, 1895</td>
</tr>
<tr>
<td>Length (mm)</td>
<td>8 – 11.5</td>
<td>20 – 28</td>
<td>10 – 25</td>
<td>20 – 25</td>
</tr>
<tr>
<td>Segments</td>
<td>44 – 73</td>
<td>73 – 80</td>
<td>33 – 64</td>
<td>65 – 72</td>
</tr>
<tr>
<td>Chaetae/bundle</td>
<td>2 – 5(6)</td>
<td>2 – 4</td>
<td>4 – 8</td>
<td>2 – 4(5)</td>
</tr>
<tr>
<td>Citellum</td>
<td>XII – 1/2XIII</td>
<td>XII – XIII</td>
<td>XI – 1/2XIII</td>
<td>XII – 1/2XIII</td>
</tr>
<tr>
<td>Posterior of brain</td>
<td>truncated</td>
<td>truncated</td>
<td>round</td>
<td>round</td>
</tr>
<tr>
<td>Peptonephridia</td>
<td>13 – 19 branches</td>
<td>ca. 11 branched</td>
<td>branched</td>
<td>5 – 7 branches</td>
</tr>
<tr>
<td>Origin of dorsal vessel</td>
<td>XX – XXIII</td>
<td>XXV – XXVI</td>
<td>XVI – XXI</td>
<td>?</td>
</tr>
<tr>
<td>Efferent duct of nephridia</td>
<td>midventral</td>
<td>terminal</td>
<td>ventral</td>
<td>ventral</td>
</tr>
<tr>
<td>Sperm funnel (length:width)</td>
<td>4 – 4.5:1</td>
<td>2.2:1</td>
<td>2.5 – 3:1</td>
<td>4.5 – 1</td>
</tr>
<tr>
<td>Seminal vesicle</td>
<td>well developed</td>
<td>well developed</td>
<td>poorly developed or absent</td>
<td>well developed</td>
</tr>
<tr>
<td>Spermathecae</td>
<td>lumen of ampulla and 2 diverticula inseparable; with one ectal glands (brown in vivo)</td>
<td>lumen of ampulla and 2 diverticula inseparable; no ectal glands</td>
<td>lumen of ampulla and 2 diverticula separable; canal of ectal duct coiled before reaching ampulla; no ectal glands</td>
<td>lumen of ampulla and 2 diverticula separable; no ectal glands</td>
</tr>
</tbody>
</table>

**Fridericia bulbosa** (Rosa, 1887)  (Fig. 2A, B)

*Neoenchytraeus bulbosus* Rosa, 1887: 2.

*Fridericia bulbosa* Nielsen & Christensen, 1959: 72, Fig. 71; Chen, 1959: 18, Fig. 27; Healy, 1979: 55; Möller, 1971: 147, Fig. 7; Rota, 1994a: 250 – 251; Rota, 1995: 204.

**Description**  Body length 9 – 10 mm. Segments 49 – 54. Epidermal glands 1 – 3 rows in one seg-
ment. Chaetae 2 per bundle throughout. Clitellum in XII–1/2 XIII, the gland cells scattered. Peptonephridia commencing as wide tube and gradually tapering in IV–V, with 2–3 terminal or subterminal branches. Chylus cells in XIV–XVI. Dorsal vessel originating in XVI–XVII. Coelomocytes: nucleated type a, up to 25–30 μm long; anucleate 4–8 μm. Seminal vesicles absent. Sperm funnel 1.5–2 times longer than wide, with collar narrower than the funnel (Fig. 2B). No egg sacs. Only one mature egg. Spermethcae confined to V, through an ental duct communicating with the dorso-lateral part of oesophagus. Ampulla onion-shaped, without diverticula. Ectal duct stout, with one medium-sized ectal gland at the ectal orifice (Fig. 2A).

**Locality** Bamboo forest in Chongqing City (November, 1997).

**Remarks** The characters of our specimens conform to the descriptions given by Rosa (1887) and Nielsen & Christensen (1959). Critical characters for identification are: small body size, chaetae usually 2 per bundle, peptonephridia short, unbranched or with 2–3 terminal or subterminal branches, nucleated coelomocytes without granulation, long spermethcal ectal ducts, ectal gland medium-sized. In morphological characters, *Fridericia bulbosa* is most close to *Fridericia bulboides* Nielsen & Christensen 1959, but, it is easily distinguished from *bulboides* by the presence of only 2 chaetae in the precitellar region (4 in *bulboides*), short and with 2–3 terminal or subterminal branches of peptonephridia (slender and unbranched in *bulboides*) and one medium-sized ectal gland at ectal orifice.

**Geographic distribution** Denmark, Armenia, America, Ireland, Germany, Italy, Tunisia, Algeria, China.

*Fridericia paroniana* Issel, 1904 (Fig. 2C, D)

*Fridericia paroniana* Issel, 1904: 31–39; Nielsen & Christensen, 1959: 76, Fig. 74; Rota, 1995: 214.

**Description** Body length 5–8 mm. Segments 35–46. Epidermal glands arranged in 3–5 transverse rows per segment. Chaetae with distinct ental hook, 2 (rarely 4) per bundle, 40–60 μm long. Clitellum in XII–1/2 XIII, gland cells scattered. Brain much convex anteriorly, truncate posteriorly. Peptonephridia with 1–2 terminal or subterminal branches. Chylus cells in XIV–XVI. Nephridia from 6/7 onwards, with 5 pairs in front of clitellum, with efferent duct originating midventrally. Blood colorless. Dorsal vessel originating in XXII–XXIV. Coelomocytes: nucleated type a, ca. 30 μm; anucleate large, ca. 11 μm. Seminal vesicle poorly developed. Sperm funnel 2–3 times longer than wide, with narrower collar (Fig. 2D). Spermethcae one pair, small, each with conical or cylindrical ampulla and two global, almost sessile diverticula. Two ental duct communicating separately with oesophagus in V. With one small, sessile gland at the orifice (Fig. 2C).

**Locality** Bamboo forest of Chongqing City (November, 1997).

**Remarks** The morphological characters of our specimens agree closely with the description of *Fridericia paroniana* Issel, 1904 from Europe, except some differences which are considered to be infraspecific variations. *Fridericia paroniana* much resembles *Fridericia maculata* Issel, 1904 in the number of chaetae, the few branched peptonephridia, the poor developed seminal vesicle and the spermethcae. However, it is distinguishable from *maculata* by the absence of brown epidermal glands, the well-developed accessory glands at spermethcal pore, the indistinct connection between seminal chambers of two diverticula.
and the shorter diverticula.

**Geographical distribution** Denmark, Ireland, Austria, Italy, Morocco, Algeria, new for China.

*Fridericia maculata* Issel, 1904 (Fig. 2E)

*Fridericia maculata* Issel, 1904: 31—39; Nielsen & Christensen, 1959: 79, Fig. 76; Rota, 1995: 210.

**Description** Body length 7.8—9.0 mm. Segments 37—38. Epidermal gland cells brown and 2—3 rows per segment. Chaetae with distinct ental hook, 2 (rarely 4) per bundle and 50—60 μm in maximal length. Clitellum in XII—1/2XIII, gland cells scattered. Peptonephridia without or with 2—4 short terminal or subterminal branches, often bent at mid-length at a right angle. Chylus cells in XIV—XVI. Nephridia from 6/7 onwards, 5 pairs in front of clitellum, with efferent duct originating midventrally. Dorsal vessel originating in XXII—XXIV. Coelomocytes: nucleated somewhat granular, with small nucleus; anucleate very small. Seminal vesicle poorly developed. Sperm funnel ca. 2 times as long as wide. Spermapheca small, with conical or cylindrical ampulla and two almost cylindrical diverticula, diverticula often bent towards ectal duct. Ectal duct short, with one small sessile gland at orifice (Fig. 2E).

**Locality** Bamboo forest of Chongqing City (November, 1997).

**Geographic distribution** Denmark, Italy, western Anatolia, new for China.

**Acknowledgements** The authors are indebted to Mr. Wang J. and Ms Liu R.Q. for collecting part of the samples. The studies were supported by a grant for systematic and evolutionary biology, CAS; the National Natural Science Fundation of China (NNSF) (No. 39670148); Director Fund of Institute of Hydrobiology, CAS (No. 980402); and Key Projects of CAS (No. KZ951—A1—102—01; KZ951—B1—104).

**References**


