中国小蚓类研究

——附中国南极长城站附近地区两新种

Studies on Taxonomy, Distribution and Ecology of Microdrile Oligochaetes of China, with Descriptions of Two New Species from the Vicinity of the Great Wall Station of China, Antarctica

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内 容 提 要

本文介绍了中国小蚓类(环节动物门,寡毛纲)分类学、生物地理学和生态学的研究结果。记述淡水、海洋和陆地小蚓类5科38属82种,包括新种6种,新记录13种。线蚓科8属21种的记录填补了我国该类动物研究空白;巨毛盘丝蚓新种为稀罕的陆栖颤蚓类;南极淡水新种缺刻丝线蚓是乔治王岛内陆寡毛类的首次记载,海洋新种球茎似水丝蚓为该属分布地球最南端的种。聚类分析表明,中国淡水小蚓类区系有全北区特性。中国线蚓类的密度为18 200 $ind \cdot m^{-2}$,生物量为1.14 $g \cdot m^{-2}$。数学分析显示,线蚓现存量的周年变动与土壤湿度和温度有关;线蚓的密度与海拔高度呈抛物线关系,与森林凋落物、土壤有机质含量和大蚓类生物量呈正相关,与土壤钾含量、土层深度呈负相关。读者对象为教学和科研单位的动物学工作者。

提　要

本文报道了对中国小蚓类(环节动物门,寡毛纲)进行综合研究的结果,工作以分类学为主,同时兼顾地理分布与生态学内容。采样地区主要包括湖南、湖北、广西、河南和陕西等5省区。南极中国长城站附近地区的寡毛类研究结果亦作为工作的一部分暂时附上。

文中记述小蚓类5科38属82种,其中有新种6种,新记录属2属,新记录种13种,亚种提升为种1种,包括南极两新种亦暂时纳入。在新种中,除颤蚓科的2种即巨毛盘丝蚓(*Bothrioneurum grandisetosum* sp. nov.)、球茎似水丝蚓(*Limnodriloides bulbopenitus* sp. nov.)(南极)外,有4种属于线蚓科,即扁毛半线蚓(*Hemienchytraeus planisetosus* sp. nov.)、短囊半线蚓(*Hemienchytraeus brachythecus* sp. nov.)、无囊线蚓(*Enchytraeus athecatus* sp. nov.)和缺刻丝线蚓(*Lumbricillus incisus* sp. nov.)(南极)。线蚓科的研究过去在我国属于空白,文中共记载我国该科动物8属21种,从而改变了中国线蚓科寡毛类种类贫乏的传统观点。

对中国小蚓类的区系分布问题亦进行了研究。聚类分析显示,中国淡水小蚓类的区系与英国、前捷克斯洛伐克、前苏联、北美洲和日本较相近,而与印度、非洲有较大差别,与南美洲、大洋洲、贝加尔湖相去甚远。就中国而言,淡水小蚓类在黑龙江水系和新疆有较多全北区的成分,而在长江和珠江等水系有较多的东洋区种类,南北间的过渡地带大体在黄河流域一带。到目前为止,淡水小蚓类中有13种仅在中国有过报道,其中9种被认为是长江水系的土著种。

定量研究工作的重点放在线蚓科,因为有关该科生物学的研

究在我国至今仍属空白。调查结果表明,中国线蚓科动物的现存量甚大,与欧洲的研究结果不相上下。如湖南衡山线蚓的密度为 24 000 $ind\cdot m^{-2}$(13 000～58 000 $ind\cdot m^{-2}$),生物量为 2.1 $g\cdot m^{-2}$(0.2～8.9 $g\cdot m^{-2}$),武汉珞珈山线蚓密度的年均值为 15 300 $ind\cdot m^{-2}$,生物量为 0.66 $g\cdot m^{-2}$。

同时,对线蚓的周年动态亦进行了研究。1993 年 10 月—1994 年 9 月,珞珈山线蚓个体的平均大小在 1—8 月变化不大,在 9—12 月体长和体重成直线上升。种群密度在 6 月达到最高峰,而在 8 月密度最小,原因是干旱。生物量在 6 月达到最大值,在 11 月又达到另一个高峰,最低值出现也在 8 月。性熟线蚓全年均可见到,5—7 月最多。

在与环境因素的相互关系方面,线蚓的密度与海拔高度呈现抛物线型关系,与森林凋落物、土壤有机质含量、土壤含水量和温度、蚯蚓的生物量呈正相关,与土壤钾含量呈负相关。

关键词:中国,小蚓类,线蚓科,颤蚓科,新种,新记录,区系分析,现存量,南极

Summary

The present paper embodies the results of a comprehensive investigation of Microdrile oligochaetes (Annelida, Oligochaeta) of China carried out in 1990—1994. Qualitative and quantitative samples were taken from localities in Shaanxi, Henan, Hubei, Hunan Provinces and Guangxi Autonomous Region. As a part of the author's work, findings from the Great Wall Station of China in Antarctica are provisionally involved.

At the beginning of the paper, a systematic account of 82 microdrile species belonging to 5 families and 38 genera is presented (see the list). 6 species of 5 genera among them are described as new to science. 13 species of 12 genera are regarded as new recorded species in China. A new combination of the Naididae is also re-described. The diagnoses of the new species including 2 antarctic ones will be given in the hindmost section of the present summary. In addition to the new forms, it should be pointed out that species of the Enchytraeidae constitute a major part of the findings. It demonstrates that the widely accepted opinion referring to the rarity of Enchytraeidae in our country should be modified.

The characteristics of freshwater microdrile fauna of China is analyzed mainly by means of fuzzy clustering. In worldwide scale, it reveals that the microdrile fauna of China is close to that of England, former Czechoslovakia, former Soviet Union, North America and Japan, less similar to India and Africa, and even lesser to South America and Oceania (fig. 4 – 7). Dealing with China itself, there

are some Holartic taxa in Heilongjiang Basin and Xinjiang Autonomous Region, while those in Changjiang and Zhujiang Basins are more or less Oriental. A transition zone between south and north seems to lie in Huanghe Basin (fig. 4 – 8). Of the entire microdrile fauna, there are 13 freshwater species reported only from China, including 9 species being regarded as endemic to Changjiang Basin (fig. 4 – 4).

With reference to the quantitative research, more emphasis was laid on the Enchytraeidae, owing to the fact that the previous biological studies of this form were exceptionally few in China.

Standing crop of the enchytraeids is expressed in terms of population density ($ind \cdot m^{-2}$) and biomass ($g \cdot m^{-2}$); the latter was weighed directly or calculated from the length-weight equation given below (fig. 5 – 1):

$$W_E = 4.61 L_E^{2.34} \quad R^2 = 0.948\,3 \quad n = 23 \quad p < 0.01$$

where W_E—wet weight in μg,

L_E—length in mm.

Results indicate that enchytraeids in China are as abundant as that in the Europe. In Mt. Hengshan, the standing crop of the white worms might reach 24 000 (13 000 ~ 58 000) $ind \cdot m^{-2}$ in density and 2.1 (0.2 ~ 8.9) $g \cdot m^{-2}$ in wet biomass (tab. 5 – 1). In Luojiashan of Wuhan, the annual density and biomass were also high, up to 15 300 $ind \cdot m^{-2}$ and 0.66 $g \cdot m^{-2}$ respectively.

An annual investigation of Enchytraeidae was made in Luojiashan of Wuhan from October, 1993 to September, 1994. It showed that:

1) The average size of enchytraeids had no significant difference from January to August, but increased sharply from September to December (fig. 5 – 2).

2) The population density reached the maximum (56 160 ind·m^{-2}) in June, and dropped to the minimum (1 600 ind·m^{-2}) in August because of the drought. Mature worms occurred all the year, with high abundance from May to July (fig. 5-3).

3) The population biomass (wet weight) had two maxima in the year, one (1.82 g·m^{-2}) in June, another (1.38 g·m^{-2}) in November. The minimum (0.02 g·m^{-2}) occurred also in August (fig. 5-4).

The vertical distribution of the worms was also studied. Some aspects are worthy of mention:

1) The relationship between annual density and elevation in Mt. Hengshan is as follows (fig. 5-5):

$$MD_E = 166H - 0.087H^2 - 64\,230 \quad R^2 = 0.995\,9 \quad n = 4 \quad p = 0.036\,4$$

where MD_E—annual density of enchytraeids in ind·m^{-2},

H—height above sea level in m (600~1 290 m).

2) The relationship between density and sampling depth may be generally expressed as (fig. 5-6):

$$N_E (\text{or } N_{ME}) = \mathrm{a} \cdot d^{\mathrm{b}}$$

where d—sampling depth in cm,

a, b—constants, $0 < \mathrm{b} < 1$,

N_E—density in total in ind·m^{-2} (0—d cm),

N_{ME}—density of mature worms in ind·m^{-2} (0—d cm).

The power b may be considered as an estimate of aggregation of the worms, i.e. the smaller the b value, the more worms in the upper layer. Based on the b value, worms were determined to have obviously aggregated upwards in July and October, but less aggregated in January and April. The mature worms tended to distribute more evenly in different depth of soil.

Concerning the environmental factors influencing the standing crops of Enchytraeidae, some equations are given as follows:

1) In Mt. Hengshan, the relations of annual worm density to forest litter, organic matter or potassium content in soil are expressed as following equations (fig. 5 - 7~8):

$MD_E = 1.287 \times 10^{-5} FL^3 + 3\,390$ $R^2 = 0.896\,2$ $n = 5$ $p = 0.014\,67$

$MD_E = 0.285\,8\ OM^5 + 3\,982$ $R^2 = 0.871\,1$ $n = 5$ $p = 0.020\,45$

$MD_E = 16\,320 - 4\,812SK$ $R^2 = 0.797\,9$ $n = 5$ $p = 0.041\,19$

where MD_E—annual density in ind·m^{-2},

FL—forest litter in g·m^{-2},

OM—organic matter in%,

SK—potassium content in%.

2) In Luojiashan of Wuhan, humidity and temperature influenced enchytraeid density may be described as (fig. 5 - 9~10):

$D_E = 0.014\,72SW^{3.389}ST^{1.471}$ $R^2 = 0.511\,2$ $n = 12$ $p = 0.039\,9$

$D_{ME} = 117.2SW + 90.21ST - 2\,548$ $R^2 = 0.563\,3$ $n = 12$ $p = 0.024\,0$

where D_E—density in total in ind·m^{-2},

D_{ME}—density of mature worms in ind·m^{-2},

SW—water content of soil in%,

ST—temperature of soil surface in ℃.

3) Relationship between enchytraeids and megadriles (earthworms) in Mt. Hengshan was calculated as (fig. 5 - 12):

$D_E = 2\,128.69B_{MEG} + 2\,606.64$ $R^2 = 0.791\,4$ $n = 6$ $p = 0.017\,61$

$B_E = 0.399\,6B_{MEG} - 1.916$ $R^2 = 0.711\,9$ $n = 6$ $p = 0.034\,71$

where D_E—enchytraeid density in ind·m^{-2},

B_E—enchytraeid biomass (wet weight) in g·m^{-2},

B_{MEG}—megadrile biomass (wet weight) in $g \cdot m^{-2}$.

At the end of this summary, the author presents diagnoses of the new species. Types are deposited in Institute of Hydrobiology, Chinese Academy of Sciences. (This thesis is not to be regarded as a publication in the sense of the International Code of Zoological Nomenclature, and new scientific names mentioned in it must not be cited in any form)

1. *Hemienchytraeus* (*Hemienchytraeus*) *planisetosus* Xie, Wang et Liang, sp. nov. (fig. 3-1; tab. 3-1~2)

l (length) (preserved) = 3.0~6.2 mm (holotype: 4.5 mm), l (living) = 7~8 mm. s = 32~45 (holotype: 39).

Head pore large. No dorsal pores. Setae 2 per bundle; straight with ental hook; distal end flat and concave in anterior segments (approximately before XVIII), but needle-shaped posteriorly. Clitellum in XII—1/2 XIII.

Brain truncated posterior, length 1.5 times as width. Septal glands 3 pairs in IV—VI, all united dorsally; one pair of secondary glands in anterior of V and VI. A pair of small postpharyngeal bulbs. Peptonephridium with short and stout stem, bifurcated twice. Stomachal dilatation gradual. Dorsal vessel originating from XIII—XIV. Nephridia from 7/8 onwards, with efferent duct originating from mid-ventral of postseptal part anteriorly, the rest postero-ventral. Coelomocytes spindle and nucleate.

Sperm funnel slender, length 4~5 times as width, with collar inconspicuous. Vas deferens confined to XII, long and irregularly coiled. Penial bulb large, opening ventro-laterally at mid XII. Testes in XI, sac absent. No seminal vesicle. No egg sac. Usually 2 eggs present.

Spermatheca free, extending to VII—IX (holotype: IX), without accessory glands. Ectal duct opening at 4/5. Ampulla club-shaped.

Spermatozoa not found.

Holotype: Mature, whole mount in Canada balsam, collected from evergreen forest, Cangjingdian, Mt. Hengshan (27.3 °N, 112.7 °E), Hunan Province (April 25, 1991); ca. 1 000m above sea level.

Paratype: 11 specimens in total, from type locality; 4 whole mounts, the rest in 10% formalin.

Other materials: 1 mount in glycerine.

2. *Hemienchytraeus* (*Hemienchytraeus*) *brachythecus* Xie, Wang et Liang, sp. nov. (fig. 3-3; tab. 3-4)

l (preserved) (mature) = 5.9 ~ 10 mm (holotype: 7.8 mm), s = 34 ~ 37; l (immature) = 4.7 ~ 5.6 mm, s = 30 ~ 33.

Head pore conspicuous. No dorsal pores. Setae straight with ental hook, 2 per bundle. Clitellum in Ⅻ—1/2 XⅢ.

Brain incised deeply posterior, length ca. 1.5 times as width. Septal glands 3 pairs in Ⅳ—Ⅵ, all united dorsally; one pair of secondary glands in Ⅴ—Ⅵ. Peptonephridium with long stem, bifurcated twice, then branching into 3 ~ 4 twigs. No oesophageal and intestinal appendages. Stomachal dilatation gradual. Dorsal vessel originating from XⅢ. Nephridia from 6/7 onwards, anteseptal large; efferent duct originating from mid-ventral of postseptal part anteriorly, the rest postero-ventral. Coelomocytes abundant.

Sperm funnel twice as long as width; collar distinct, as wide as funnel. Vas deferens confined to Ⅻ, long and irregularly coiled. Penial bulbs well developed, opening ventro-laterally at mid Ⅻ. Testes one pair in Ⅺ, sac absent. No seminal vesicle. No egg sac. 1 ~ 2 eggs present.

Spermatheca confined to Ⅴ. Ectal duct swollen in the middle, with spermatozoa inside. Ampulla small, sub-spherical.

Holotype: Mature, whole mount in Canada balsam, collected from Fenqiu (35.1°N, 114.4°E), Henan Province (Sepetember 13 ~24, 1991).

Paratype: 33 specimens in total, 15 mature, from type locality; 3 whole mounts, the rest in 10% formalin.

3. *Enchytraeus athecatus* Wang, Xie et Liang, sp. nov. (fig. 3-7; tab. 3-5)

l (preserved) = 4.7~4.8 mm (holotype: 4.7 mm). s = 30.

Head pore present. No dorsal pores. Setae straight with ental hook, 2 per bundle, occasionally 3. Clitellum in Ⅻ—1/2 XⅢ.

Brain trapezoidal, posterior round, about twice as long as width. Peptonephridia one pair, extending to Ⅳ. A pair of small postpharyngeal bulbs closely attached to peptonephridia, with numerous nuclei. Septal glands 3 pairs in Ⅳ—Ⅵ, without dorsal connection, or with thin connection in first pair (holotype); no secondary glands. Stomachal dilatation gradual. No oesophageal and intestinal appendages. Dorsal vessel originating from clitellum. Nephridia from 6/7 onwards, with small anteseptal part and long postseptal; efferent duct originating from terminal of postseptal part. Coelomocytes round and nucleate.

Sperm funnel sub-spherical, with collar narrower than funnel. Vas deferens confined to Ⅻ, irregularly coiled. Penial bulbs one pair, large and spherical, opening ventro-laterally at mid Ⅻ. Seminal vesicles one pair in Ⅺ. No egg sac. 1~2 eggs present.

Spermatheca absent.

Holotype: Mature, whole mount in Canada balsam, collected from Juzizhoutou, Changsha (24.2°N, 116.1°E), Hunan Province (April 13, 1991).

Paratype: 1 whole mount, from type locality.

Other localities: Terrestrial habitats, rarely in fresh waters. Mt. Hengshan, Hunan Province; Fenqiu, Henan Province; Guangxi Autonomous Region; collected '91 - '93.

4. *Lumbricillus incisus* Wang et Liang, sp. nov. (fig. 3 - 8; tab. 3 - 7)

l (preserved) = 5.5 ~ 8.0 mm (holotype: 8.0 mm), l (living) = 4 ~ 7 mm; w (width) = 0.2 ~ 0.3 mm. s = 32 ~ 50.

Body reddish when living. Prostomium round. Head pore at pro/peristomium. Setae sigmoid, without nodulus; preclitellar 2 ~ 5 per bundle, postclitellar 1 ~ 4. Clitellum in Ⅻ—ⅩⅢ.

Brain distinctly incised posterior, length nearly equal to width. A pair of small postpharyngeal bulbs present in Ⅲ. Stomachal dilatation gradual. Septal glands 3 pair in Ⅳ—Ⅵ, all united dorsally, with large ventral lobes. Glands enveloping nerve cord in ⅩⅢ—ⅩⅤ, with last smaller. Dorsal vessel originating from ⅩⅣ. Nephridia with small preseptal part and large postseptal; efferent duct originating from postero-ventral of postseptal part. Coelomocytes round or oval, transparent or semitransparent; abundant when living, but inconspicuous after preserved.

Testes enclosed in large seminal vesicles, extending over Ⅹ—Ⅺ; symmetrically lobed, ca. 8 per one side; lobes conical, fan-like arranged. Only one egg present. Sperm funnel 2 ~ 3 times as long as width, with collar equally wide. Vas deferens irregularly coiled in Ⅻ. Penial bulbs oval, slightly constricted in the middle, opening ventro-laterally at Ⅻ.

Spermathecae in Ⅴ, communicated with oesophagus by short ental duct. Ampulla spindle, with spermatozoa parallel or scattered.

Ectal duct short, with nuclei scare, opening ventro-laterally at 4/5. Glands at ectal pore completely surrounding ectal duct, wavily lobed, with a deep incision in the side near body wall.

Holotype: Mature, whole mount in Canada balsam, collected from sediment (4~6.5 m deep), West Lake (62°12′59″S, 58°57′52″W), Fildes Peninsula, King George Island, Antarctica (February 1,1993); water conductivity 45 $\mu S \cdot cm^{-1}$.

Paratype: 10 whole mounts (3 dissected), over 300 in 10% formalin, from type locality.

Other localities: two lakes in the vicinity of West Lake.

5. *Limnodriloides bulbopenitus* Wang et Liang, sp. nov. (fig. 3-18; tab. 3-11~12)

l (preserved) = 8~11 mm (holotype: 10 mm), w = 0.25~0.39 mm. s=43~53 (holotype: 53)

Body reddish when living. Prostomium round. Setae all bifid crotchets, with distal nodulus; distal prong shorter than proximal anteriorly (Ⅱ—Ⅸ or so), then longer posteriorly; preclitellar 2~3 per bundle, postclitellar 1~2 per bundle. Clitellum in Ⅸ—Ⅻ, with gland cells in transverse rows.

Pharyngeal glands in Ⅲ—Ⅴ, with first one smaller and denser. A pair of oesophageal diverticula in Ⅸ. No coelomocytes.

Sperm funnel conical, in front of 10/11. Vas deferens nearly as long as atrium, joining atrium apically. Atrial ampulla pear-shaped; prostatic pad spherical; atrial duct with more nuclei; prostate large and lobed, broadly attached to ventral of ampulla. Penis apple-shaped, enclosed in copulatory chamber. A pair of male pores ventro-laterally at mid Ⅺ.

Spermathecae paired in Ⅹ, with short ectal duct. Ampulla

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