生物多样性 BIODIVERSITY SCIENCE

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•综述•

中国海域多毛类环节动物物种多样性研究进展

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摘要: 多毛类环节动物是海洋底栖生物群落的重要类群之一, 在海洋生物监测、海水养殖、底栖食物链网、生态评估和生态修复中起着重要的作用。本文根据我国学者首篇记述中国海域多毛类物种文献、首次发表新种文献和首篇博士论文的年份, 将中国海域多毛类环节动物物种多样性研究分为3个阶段。第一阶段(1933–1961年)我国学者尚未发现新种, 但记述了几十种多毛类; 第二阶段(1962–2007年)发现了49新种, 但没有专门的博士和硕士论文; 第三阶段(2008–2022年)发现了120新种, 有博士和硕士论文。从1933年至2022年, 我国学者发现的新种和新记录种数量呈上升趋势, 但在不同时间段, 特别是在第二阶段有较大波动。目前, 我国多毛类物种多样性研究存在一些科、属、种的分类地位存疑, 一些科、属的分类亟待研究, 一些新种未被世界海洋物种目录(World Register of Marine Species)接受等问题。鉴于存在的问题, 本文建议在我国加强多毛类数据库建设, 加强多毛类物种多样性、遗传多样性和环境DNA研究。

关键词: 多毛类; 物种多样性; 新种; 新记录; 中国海域

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Progress on the species diversity of polychaete annelids in the sea areas of China

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ABSTRACT

Background & Aims: Polychaetes constitute a vital component of the marine benthic community, playing an important role in the marine biological monitoring, mariculture, benthic food chain web, ecological assessment and ecological restoration. This study categorizes the investigation into species diversity of the polychaete annelids in the Chinese sea regions into three chronological stages based on the year of the initial species description, the publication of new species, and the inception of doctoral these on the subject.

Progress: During the first stage (1933–1961), Chinese scholars documented numerous polychaete species, although no new species were identified. The second stage (1962–2007) witnessed the discovery of 49 new species, although no dedicated doctoral or master's theses were produced. The third stage led to the identification of 120 new species, with doctoral or master's theses. From 1933 to 2022, the number of new species and new records found by Chinese scholars showed an ascending trajectory, albeit with substantial fluctuations across different time spans, particularly notable in the second stage.

Proposal: At present, the study of polychaete species diversity in China encounters challenges related to the classification of certain families, genera, and species, with some requiring urgent attention. Furthermore, species families and genera demand in-depth exploration, while certain new species await acknowledgment from the World

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Register of Marine Species. Addressing these existing problems, this paper proposes to enhancement of the polychaete database and the argumentation of research pertaining to species diversity, genetic diversity, genetic variability, and environmental DNA in the Chinese context.

Key words: polychaete; species diversity; new species; new record; sea areas of China

多毛类环节动物是海洋底栖生物群落的重要类群之一, 在海洋生物监测、海水养殖、底栖食物链网、生物监测、生态评估和生态修复中起着重要的作用(吴宝铃等, 1997; 纪莹璐等, 2012)。多毛类环节动物在我国海域常见, 但与软体动物、甲壳动物和棘皮动物相比, 多毛类环节动物的形态分类研究进展缓慢(周进和李新正, 2011)。随着2007年世界海洋物种目录World Register of Marine Species (简称WoRMS)上线, 以及我国学者增加对多毛类的分类研究, 收录了大量中国近海多毛类环节动物物种多样性研究成果。本文根据收集的多毛纲环节动物的分类文献, 包括期刊论文、专著、论文集、博士和硕士论文, 将中国近海多毛类环节动物物种多样性研究历史大致分为3个阶段: (1)第一阶段(1933–1961年)。从我国学者首次专篇记述中国近海多毛类物种(高哲生, 1933)至我国学者首次发表多毛类新种前的1961年。(2)第二阶段(1962–2007年)。从我国学者首次发表多毛类新种(吴宝铃, 1962)至首篇多毛类分类博士论文出现前的2007年。(3)第三阶段(2007–2022年)。从首篇多毛类分类博士论文(周进, 2008)至发表本文前的2022年。本文还分析了中国近海多毛类环节动物分类研究存在的问题, 如一些科、属的分类亟待研究, 一些科、属的分类地位有待厘清, 一些新种未被世界海洋物种目录(WoRMS)接受等, 提出了在我国建立多毛类数据库的重要性, 并需要加强专业交流, 加强多毛类遗传多样性和环境DNA研究。

1 中国近海多毛类物种多样性研究的三个阶段

1.1 中国近海多毛类物种多样性研究的第一阶段(1933–1961年)

1933年, 我国学者首次记述了采自青岛近岸的12种多毛类, 其中1未定种(高哲生, 1933)。1933年和1934年, 国外学者Takahasi (1933)记述了中国台湾淡水沙蚕一新种, 即长须缘目沙蚕(*Namalycastis longicirris*), Monro (1934)记述了采自厦门和福州沿海的双齿围沙蚕(*Perinereis aibuhitensis*), 以及采自厦门的中国臭海蛹(*Travisia chinensis*)。1948年, 集美校友论著记述了多毛类31种, 其中10未定种(梁慧文等, 1948)。1958年, 外国学者乌沙科夫(乌沙科夫, 1958)报道了采自黄海的特叶须虫(*Paralacydonia paradoxa*), 即拟特须虫, 该文由我国学者吴宝铃先生翻译, 吴浩然校对。1959年, 我国学者编著的第一部多毛类专著《中国动物图谱环节动物(附多足类)》出版, 收录了多毛类41种(陈义, 1959), 同年, 高哲生等报道了华北沿海的多毛类环节动物54种, 其中29种在我国是第一次报道(高哲生等, 1959)。

1933年记述的青岛沿海12种多毛类(高哲生, 1933)以及1948年记述的厦门沿海31种多毛类(梁慧文等, 1948), 其中鉴定到种的合计29种, 对照WoRMS, 拉丁文属名和种名变更的以及存在误拼的有17种, 如拟短角沙蚕(*Nereis mictodonta*)变更为拟短角围沙蚕(*Perinereis mictodonta*), 为属名变更; 岩虫(*Marphysa iwamusi*)拉丁文种名变更为*sanguinea*; 锥唇吻沙蚕(*Glycera onomichis*)拉丁文种名拼写有误, 应为*onomichiensis* (表1)。

1.2 中国海域多毛类物种多样性研究的第二阶段(1962–2007年)

根据查寻到的期刊文献和论文集(赫列勃维奇和吴宝铃, 1962; 吴宝铃, 1962; 乌沙科夫和吴宝铃, 1962; 吴宝铃和陈木, 1963, 1964, 1966, 1977, 1981; Sun et al, 1978; 吴宝铃等, 1980a, b, 1981a, b, 1993; 陈木和吴宝铃, 1980; 吴启泉, 1984; 何明海和吴启泉, 1986, 1988; 何明海, 1987; 郑凤武和吴启泉, 1987; 吴启泉和何明海, 1988; Mackie, 1990, 2000; Mackie & Hartley, 1990; 赵晶和吴宝铃, 1991; 赵晶等, 1991, 1993; 沈寿彭和吴宝铃, 1993a, b; Westheide et al, 1994; Ding et al, 1997; Wu et al, 1998), 未查寻到专门研究多毛类的博士和硕士论文, 从1962年至2007年发现的多毛类环节动物有49新种和27新记录种(不包括专著收录的新种和新记录种)。第二阶段发现新种和新记录种有以下现象: (1) 1962–1966年, 吴宝铃与乌沙科夫、赫列勃维奇、

表1　第一阶段(1933–1958年)在中国海域被记录的多毛类及其学名在WoRMS的修订

Table 1　The polychaetes recorded in the sea areas of China in the first stage (1933–1958) and their scientific name revised in WoRMS

序号Order	原学名 Original scientific name	在WoRMS的修订情况 Revised in WoRMS	修订后学名 Scientific name after revised
1	栗色卡罗虫 *Carobia castanea*	属名修订 Genus name revised	栗色仙须虫 *Nereiphylla castanea*
2	拟短角沙蚕 *Nereis mictodonta*	属名修订 Genus name revised	拟短角围沙蚕 *Perinereis mictodonta*
3	岩虫 *Marphysa iwamusi*	种名修订 Species name revised	岩虫 *Marphysa sanguinea*
4	华丽丝鳃虫 *Cirratulus grandis*	属名修订 Genus name revised	华丽须鳃虫 *Cirriformia grandis*
5	冠沙蠋 *Arenicola cristata*	种名修订(同物异名) Species name revised (synonym)	巴西沙蠋 *Arenicola brasiliensis*
6	帕沃尼纳缨鳃虫 *Sabella pavonia*	种名拼写应是 *pavonina* The species name should be *pavonina*	帕沃尼纳缨鳃虫 *Sabella pavonina*
7	长脆鳞虫 *Lepidasthenia longissima*	种名修订 Species name revised	饭氏脆鳞虫 *Lepidasthenia izukai*
8	方背鳞虫 *Polynoe squamata*	属名修订 Genus name revised	方背鳞虫 *Lepidonotus squamata*
9	锥唇吻沙蚕 *Glycera onomichis*	种名拼写应是*onomichiensis* The species name should be *onomichiensis*	锥唇吻沙蚕 *Glycera onomichiensis*
10	双齿沙蚕 *Nereis aibuhitensis*	属名修订 Genus name revised	双齿围沙蚕 *Perinereis aibuhitensis*
11	锐足沙蚕 *Nereis oxypoda*	属名修订 Genus name revised	锐足全刺沙蚕 *Nectoneanthes oxypoda*
12	独齿沙蚕 *Nereis cultrifera*	属名修订 Genus name revised	独齿围沙蚕 *Perinereis cultrifera*
13	中华齿吻沙蚕 *Nephthys sinensis*	属名修订 Genus name revised	中华内卷齿蚕 *Aglaophamus sinensis*
14	单眼索沙蚕 *Lumbriconereis ocellata*	属名修订 Genus name revised	单眼索沙蚕 *Lumbrineris ocellata*
15	浮华须鳃虫 *Audouinia dasylophia*	未被收录, 属名修订 Not recorded, genus name revised	浮华须鳃虫 *Cirriformia dasylophia*
16	扁蛰虫 *Loimia medusa vannulifilis*	取消亚种名 Cancel the subspecies name	扁蛰虫 *Loimia medusa*
17	多伪刺缨虫 *Potamilla polyopthalmes*	种名拼写应是*polyophthalmos* The species name should be *polyophthalmos*	多伪刺缨虫 *Pseudopotamilla polyophthalmos*

陈木等学者发现了多毛类13新种, 仅1962年就发现了9种。(2) 1967–1976年和2001–2007年, 我国学者没有发表多毛类新种和新记录种。(3) 1984–1993年, 我国学者发现的多毛类新种数呈上升趋势, 从1984年的1种上升到1993年的5种。(4)从1994年至2007年仅发现4新种, 分别在1994年、1997年、1998年和2000年各发现1种。(5) 1991–2007年期间发现的多毛类新记录种数高于1962–1990年期间发现的多毛类新记录种数(图1)。

第二阶段我国学者出版了4部专著。《中国近海沙蚕科的研究》收录了81种, 其中包括10个新种和1个新亚种(吴宝铃等, 1981b)。《中国近海多毛环节动物》描述了我国近海多毛环节动物356种, 其中新记录120种(杨德渐和孙瑞平, 1988)。《中国动物志•多毛纲I•叶须虫目》收录了153种(吴宝铃等, 1997)。《中国动物志•多毛纲II•沙蚕目》收录了5科203种, 其中包括3新种和32新记录种(孙瑞平和杨德渐, 2004)。此外, 还有一些专门记述某海区多毛类物种的期刊文献, 如1963年, 吴宝铃和杨德渐记述了囊须虫属(*Saccocirrus*) 9种, 其中葛氏囊须虫(*S. gabriellae*)和

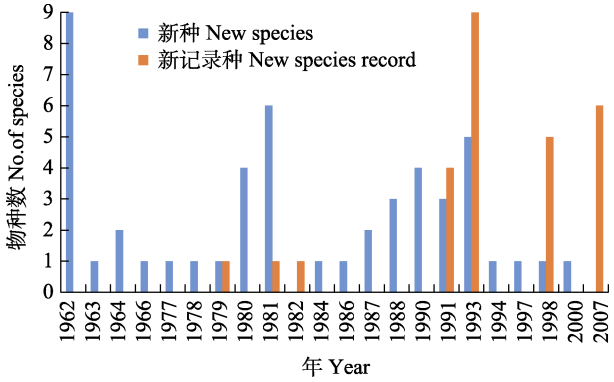

图1　我国学者1962–2007年在中国海域发表的多毛类新种和新记录种

Fig. 1　New species and new record species published in China offshore polychaetes by Chinese scholars from 1962 to 2007

大囊须虫(*S. major*)在我国海域有分布(吴宝铃和杨德渐, 1963); 记述了西沙群岛及其附近海域多毛类68种, 其中47种在我国是新记录(吴宝铃和陈木, 1985a, b, c); 黄海多毛类裂虫科18种, 其中9种在我国是首次记录(孟凡等, 1993a); 海南岛海区的多毛类157种(孟凡等, 1993b, 1994); 中国海缨鳃虫科8

种, 其中4种为我国首次记录(孙瑞平和类彦立, 2007; 类彦立和孙瑞平, 2007)。

1.3 中国海域多毛类物种多样性研究第三阶段(1977–2006年)

根据查寻到的期刊文献、论文集、博士和硕士论文(Muir & Bamber, 2008; Zhou et al, 2008; 周进, 2008; Nishi & Hsieh, 2009; Zhou et al, 2009a, b; 周进等, 2010; Zhou & Li, 2009; Cai & Li, 2011a, b, c; Sun & Qiu, 2012, 2014; Li et al, 2012; 吴旭文, 2013; Sui & Li, 2013a, b, 2014; Wu et al, 2013a, b, 2015; Hsueh & Li, 2014, 2016, 2017; Zhang et al, 2015a, b, 2018, 2022; Ye et al, 2015; Wang & Li, 2016; Sun & Li, 2017, 2018; Zhang & Qiu, 2017; Wu & Xu, 2017; Liu et al, 2018; 王跃云, 2017; Lin et al, 2018, 2019; 孙悦, 2018; Liu et al, 2018; Zhang & Hutchings, 2018; Hsueh, 2018, 2019; 杨德援, 2019[①]; Wang et al, 2019; Hsueh, 2020a, b, 2021, 2022; Sun et al, 2021, 2022; Radashevsky, 2022; Yang et al, 2022), 2008年至2022年发现的多毛类环节动物有120新种和50新记录种(不包括专著收录的新种和新记录种)。第三阶段发现新种和新记录种有以下现象: (1) 2017–2019年每年发现的多毛类新种均在14种以上。(2)每年均有发现新种或新记录种。(3) 2008年、2013年和2017年发现的新记录种均在8种以上(图2), 主要发表于博士论文。

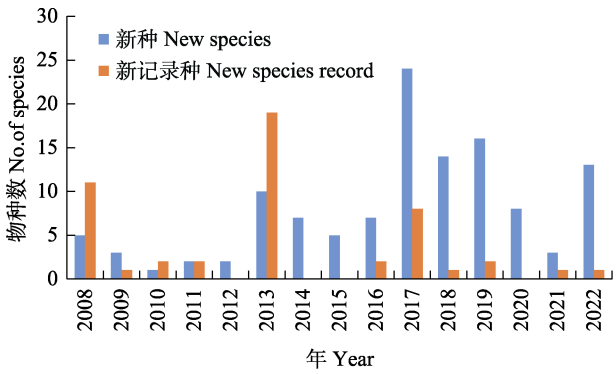

图2 我国学者2008–2022年在中国海域发表的多毛类新种和新记录种

Fig. 2 New species and new record species published in China offshore polychaetes by Chinese scholars from 2008 to 2022

在第三阶段, 有5篇博士论文和2篇硕士论文专门研究多毛类分类, 它们主要涉及异毛虫科和海稚虫科(周进, 2008)、索沙蚕科(蔡文倩, 2010[②])、矶沙蚕科和欧努菲虫科(吴旭文, 2013)、双栉虫科和蛰龙介科(隋吉星, 2013)、磷虫科和竹节虫科(王跃云, 2017)、仙虫科和锥头虫科(孙悦, 2018)、海蛹科和臭海蛹科(杨德援, 2019[①])。

在第三阶段, 我国学者出版的多毛类专著只有1部, 即《中国动物志•多毛纲(三)•缨鳃虫目》, 记述了179种, 其中1新种和61新记录种(杨德渐和孙瑞平, 2014)。一些海洋生物书籍也收录了多毛类, 《中国海洋生物名录》收录多毛类1,065种(刘瑞玉, 2008), 《中国海洋物种多样性》收录多毛类1,105种(黄宗国和林茂, 2012), 《深圳湾底栖动物生态学》收录多毛类67种(蔡立哲, 2015)。除了多毛类专著和海洋生物书籍外, 一些期刊论文也专门记述多毛类, 如Wang & Wang (2019)记述了中国海域的47种多毛类。

在第三阶段, 多毛类环节动物增加不少属。如索沙蚕科, 1988年的专著仅收录2个属, 即鳃索沙蚕属(*Ninoe*)和索沙蚕属(*Lumbrinereis*) (杨德渐和孙瑞平, 1988), 而2010年已描述了10个属, 即叉颚索沙蚕属(*Augeneria*)、可爱索沙蚕属(*Eranno*)、荷氏索沙蚕属(*Helmutnereis*)、科索沙蚕属(*Kuwaita*)、露索沙蚕属(*Loboneris*)、单颚索沙蚕属(*Lumbrinerides*)、索沙蚕属、鳃索沙蚕属、荷尖索沙蚕属(*Scoletoma*)和斯索沙蚕属(*Sergioneris*) (蔡文倩, 2010[②]; Cai & Li, 2011a, b, c)。又如不倒翁虫科, 1988年的专著仅收录不倒翁虫属(*Sternasis*) 1个属(杨德渐和孙瑞平, 1988), 2014年起增加了彼得不倒翁属(*Ptersenaspis*) (Salazar-Vallejo et al, 2014; Wu & Xu, 2017)。

在第三阶段还进行了多毛类环节动物复合种研究。太平洋稚齿虫(*Prionospio pacifica*)属于*Prionospio steenstrupi*组群的复合种(Zhou & Li, 2009)。香港岩虫(*Marphysa hongkongensa*)是岩虫(*Marphysa sanguinea*)的复合种(Wang et al, 2018)。

综上所述, 第一阶段我国学者尚未发现新种, 但记述了几十种多毛类, 第二和第三阶段分别发现了49新种和120新种。我国学者发现的新种和新记

① 杨德援 (2019) 中国海多毛纲海蛹科和臭海蛹科的形态分类学研究. 硕士学位论文, 厦门大学, 厦门.

② 蔡文倩 (2010) 中国海索沙蚕科分类学和动物地理学研究. 硕士学位论文, 中国科学院研究生院(海洋研究所), 青岛.

录种呈上升趋势, 但在不同时间段, 特别是在第二阶段有较大波动; 第三阶段发现的新种和新记录种数多, 主要因为有专门研究多毛类分类的博士论文和硕士论文。

2 中国海域多毛类环节动物分类研究存在的问题

2.1 中国海域一些多毛类科、属、种被修订

几十年来, 中国海域一些多毛类科、属、种被修订, 这里列举部分。本文表1罗列了学名修订以及存在误拼的有17种。1933年记述的岩虫*Marphysa iwamusi* (高哲生, 1933), 1948年修订为*Marphysa sanguinea* (梁慧文等, 1948)。1981年吴宝铃和陈木发现的新种中华旋鳃虫(*Spirobranchus sinensis*)被WoRMS认为是*Spirobranchus maldivensis* Pixell, 1913的同物异名。黄色才女虫(*Polydora flava*)已被修订为黄色双才女虫(*Dipolydora flava*) (李新正和甘志彬, 2022)。龙介虫科的新记录种根管虫(*Ficopomatus cf. macrodon*)是在深圳市郊人工淡水河底的石块上发现的(林烁宇等, 2009), 但后来确定为新种, 即深圳根管虫(*Ficopomatus shenzhensis*) (Li et al, 2012)。

在我国原来的不倒翁虫属(*Sternaspis*)仅收录1种, 即不倒翁虫(*S. sculata*), 但后来认为这个物种在我国不存在, 在我国海域存在的有中华不倒翁虫(*S. chinensis*)、刘氏不倒翁虫(*S. liui*)、辐射不倒翁虫(*S. radiata*)、多刺不倒翁虫(*S. spinosa*)、孙氏不倒翁虫(*S. sunae*)和吴氏不倒翁虫(*Sternaspis wui*) 6种(Wu et al, 2015; Wu & Xu, 2017)。在我国原来的毛鳃虫科只收录1种, 即梳鳃虫(*Terebellides stroemii*), 但这个物种被认为是错误记录, 而新发现的有广东梳鳃虫(*T. guangdongensis*)、异位梳鳃虫(*T. ectopium*)和杨氏梳鳃虫(*T. yangi*) 3种(Zhang & Hutchings, 2018)。我国被广泛报道的多毛类物种欧努菲虫*Onuphis eremita* Audouin & Milne Edwards, 1833为错误记录, 该种在中国海并无分布, 绝大部分标本应鉴定为入江欧努菲虫(*O. iriei*), 少数为中华欧努菲虫(*O. chinensis*)、福建欧努菲虫(*O. fujianensis*)、乌氏欧努菲虫(*O. uschakovi*)及色斑欧努菲虫(*O. variolata*) (吴旭文和徐奎栋, 2020)。沈寿彭和吴宝铃(1990年)建立了特矶沙蚕科, 包括特矶沙蚕属(*Euniphysa*)、类矶沙蚕属(*Paraeuniphysa*)和异矶沙蚕属(*Heterophysa*) 3属, 但后两个属及其属内的物种之间不能反映它们之间的演化关系, 因此, 在中国近海只保留特矶沙蚕属, 并归入矶沙蚕科(吴旭文, 2013)。

2.2 有些新种尚未被WoRMS接受

在第二和第三阶段, 有25新种尚未被WoRMS接受(表2), 其中17新种是博士和硕士论文发表, 有8新种是在期刊论文发表。近20年来增加了不少多毛类属和种, 导致分类体系变化大, 因此我国学者建立了中国近海多毛纲底栖类群目与科水平的分类检索表(葛美玲等, 2018)。

2.3 多毛类环节动物分子系统发育和DNA条形码研究起步较晚

我国对多毛类环节动物分子系统发育研究开始于2000年。郭美贞等(2003)提出了分子遗传在多毛类种别判定上的应用。廖秀珍和林荣澄(2006)应用分子系统发育学的方法, 以多毛类18S rDNA和线粒体细胞色素C氧化酶亚单位I (*COI*)基因序列片段为分子标记, 结合形态学特征对双齿围沙蚕、方背鳞虫(*Lepidonotus squamatus*)、梯斑海毛虫(*Chloeia parva*)、岩虫和四索沙蚕(*Lumbrineris tetraura*)的分类地位进行了探讨。分子遗传学研究表明, 蠕虫动物是由多毛类动物派生而来, 并且成为多毛类的1个内群, 与小头虫科的亲缘关系很近, 应该是由共同祖先进化来的, 这符合蠕虫动物体节二次消失的假说(韩洁和林旭吟, 2007)。大多数环节动物线粒体控制区存在茎环结构, 蛋白质编码基因的氨基酸序列系统发育树表明, 寡毛纲和蛭纲聚为单独一支, 构成了一个单系群; 多毛纲的所有个体聚为一支, 呈单系发育, 而后与星虫纲先聚为一支, 最后共同与蠕虫纲聚为一支, 最终这三个纲构成一单系群(李石磊等, 2015)。线粒体*Cytb*基因序列可用于双齿围沙蚕的分子鉴定(岑万等, 2019)。

我国对多毛类环节动物DNA条形码开始于2010年。线粒体*COI*基因是多毛类物种鉴定的有效DNA条形码标记, 但其他基因如16S rDNA可作为互补遗传标记(Zhou et al, 2010)。针对多毛类环节动物在浙江沿海潮间带进行了多次定性采样, 并对多毛类环节动物4个科8个物种, 样本进行了形态学鉴定以及线粒体*COI*基因DNA序列分析, 结果表明

表2　第二和第三阶段(1962–2022年)未被WoRMS接受的多毛类新种

Table 2　New species of polychaeta was not accepted by WoRMS in the second and third phases (1962–2022)

年Year	作者	学名	科Family
1962	乌沙科夫和吴宝铃 Ushakov & Baoling Wu	特大背肛虫 *Notopygos supragigas*	仙虫科 Amphinomidae
1984	吴启泉 Qiquan Wu	海南截锥虫 *Nainereis hainanensis*	锥头虫科 Orbiniidae
1987	郑凤武和吴启泉 Fengwu Zheng & Qiquan Wu	福建全刺沙蚕 *Nectoneanthes fujianensis*	沙蚕科 Nereididae
2008	周进等 Jin Zhou et al	冠奇异稚齿虫 *Parapriospio cristata*	海稚虫科 Spionidae
2008	周进 Jin Zhou	凸双鳃锥虫 *Dispio protubero*	海稚虫科 Spionidae
2008	周进 Jin Zhou	深蓝光稚虫 *Spiophanes fuscatus*	海稚虫科 Spionidae
2010	周进等 Jin Zhou et al	邻近才女虫 *Polydora vicina*	海稚虫科 Spionidae
2013	隋吉星 Jixing Sui	异鳃扇栉虫 *Amphicteis heterobranchia*	双栉虫科 Ampharetidae
2013	隋吉星 Jixing Sui	广东头蛰虫 *Neramphitrite guagndongensis*	蛰龙介科 Terebellidae
2013	隋吉星 Jixing Sui	青岛新蛰虫 *Neoleprea qingdaoensis*	蛰龙介科 Terebellidae
2017	王跃云 Yueyun Wang	粗壮襟节虫 *Clymenella crassa*	竹节虫科 Maldanidae
2017	王跃云 Yueyun Wang	青岛等须虫 *Isocirrus qingdaoensis*	竹节虫科 Maldanidae
2017	王跃云 Yueyun Wang	红带花节虫 *Petaloproctus cerasinus*	竹节虫科 Maldanidae
2018	孙悦 Yue Sun	西沙背肛虫 *Notopygos xishaensis*	仙虫科 Amphinomidae
2018	孙悦 Yue Sun	广西简锥虫 *Letioscoloplos guangxinensis*	锥头虫科 Orbiniidae
2018	孙悦 Yue Sun	南海简锥虫 *Letioscoloplos nanhaiensis*	锥头虫科 Orbiniidae
2018	孙悦 Yue Sun	中华矛毛虫 *Phylo sinensis*	锥头虫科 Orbiniidae
2019	杨德援 Deyuan Yang	蔡氏软鳃海蛹 *Thoracophelia caii*	海蛹科 Opheliidae
2019	杨德援 Deyuan Yang	杨氏粘海蛹 *Ophelia yangi*	海蛹科 Opheliidae
2019	杨德援 Deyuan Yang	吴氏臭海蛹 *Travisia wui*	臭海蛹科 Travisiidae
2019	杨德援 Deyuan Yang	黄海臭海蛹 *Travisia huanghainensis*	臭海蛹科 Travisiidae
2022	孙悦等 Yue Sun et al	涠洲刺尖锥虫 *Leodamas weizhouensis*	锥头虫科 Orbiniidae
2022	薛攀文 Panwen Hsueh	和美阔沙蚕 *Platynereis hemeiensis*	沙蚕科 Nereididae
2022	薛攀文 Panwen Hsueh	基翠阔沙蚕 *Platynereis jihueiensis*	沙蚕科 Nereididae
2022	薛攀文 Panwen Hsueh	石门阔沙蚕 *Platynereis shihmenensis*	沙蚕科 Nereididae

*COI*基因序列可作为多毛类动物分类的条形码(姚瑞等, 2017)。应用ISSR (inter-simple sequence repeat)和线粒体*COI*基因序列对不同地理种群双齿围沙蚕遗传多样性的分析表明, 双齿围沙蚕群体的遗传多样性处于较高水平, 群体间的遗传分化较明显(王一枭等, 2014)。

3　中国近海多毛类环节动物物种多样性研究展望

3.1　一些多毛类科、属的分类亟待研究

我国学者编写的《中国动物志》三本多毛类专著共收录了我国近海多毛类535种(吴宝铃 等, 1997; 孙瑞平和杨德渐, 2004; 杨德渐和孙瑞平, 2014), 加上第三阶段发表的120新种和50新记录种, 共收录700多种, 但有些海洋生物书籍收录的多毛类均超过千种(刘瑞玉, 2008; 黄宗国和林茂, 2012)。仅我国南海, 记述的多毛类从2000年的661种, 至2016年已达1,257种(Paxton & Chou, 2000; Salazar-Vallejo et al, 2014; Glasby et al, 2016)。可见, 我国多毛类环节动物分类尚有不少研究空间。例如, 海女虫科在全世界已报道超过30个属250个有效种(Uchida et al, 2019), 中国海域海女虫科则仅记录12属31种(Ruta & Pleijel, 2006; Wang et al, 2023), 通过开展海女虫科分类研究, 在我国近海将发现该科新属或新物种。

3.2　多毛类数据库建设和专业交流的重要性

多毛类环节动物在海洋生态系统中的重要性不言而喻, 但对多毛类环节动物的研究远远不够, 原因在于从事多毛类环节动物研究的学者太少(周进和李新正, 2011)。虽然近百年来我国近海多毛类

环节动物已记述1千多种, 但我国多毛类环节动物分类尚有不少研究空间, 有些科、属、种的分类仍然存疑, 如需要核实有些新种为什么未被WoRMS接受。

随着2007年世界海洋物种目录WoRMS上线, 收录了大量海洋生物, 为国际上海洋生物多样性研究提供了良好的平台, 也为我国近海多毛类分类学者提供了与外国学者交流的平台。不过, 我国需要建立自己的多毛类数据库, 这些数据库需要包括更多的照片和视频, 更完善的形态、生态和遗传多样性的描述, 我国多毛类数据库的建立, 也可以为国内学者提供学习和交流的平台。今后, 我国有关海洋底栖生物学会的学术会议, 应该设立多毛类分类专场, 让年轻学者有专门的交流机会和空间, 也应该鼓励年轻人多参加多毛类国际会议, 以便促进我国近海多毛类环节动物多样性研究。

3.3 加强多毛类环节动物分子系统发育和DNA条形码研究

未来在多毛类环节动物分类学的研究中, 分子生物学技术将是传统形态分类方法的一个重要辅助手段(周进和李新正, 2011), 实际上近期的一些研究已经开始形态分类与分子生物技术结合进行(Wang et al, 2022; Yang et al, 2022)。对多毛类资源进行开发、利用和保护, 都要求对形态相似的物种进行确切的划分。然而, 仅依赖形态学分类显然难以满足这些要求, 因此建立一套基于遗传信息的快速、高效、精确并且国际化的多毛类物种鉴定标准, 这对提高海洋生物资源调查和海洋生态系统评估的效率和科学性具有深远的意义(姚瑞等, 2017; 赵欢等, 2018)。近年来随着分子生物学的发展, 环境DNA技术已经成为一种新的水生生物调查方法, 其主要被用来进行生物入侵的防治、濒危物种的保护、生物多样性的评价以及生物量的评估等(单秀娟等, 2018; Ji et al, 2022)。我国多毛类环节动物分子系统发育和DNA条形码研究起步较晚, 应该加强研究。

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