第 21 卷第 10 期
2001 年 10 月

生　态　学　报
ACTA ECOLOGICA SINICA

Vol. 21, No. 10
Oct., 2001

深圳河口泥滩三种多毛类的数量季节变化及污染影响

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摘要：在深圳河治理工程环境影响评估研究中，将 1995 年 7 月至 1998 年 4 月在 3 个断面获得的 3 种多毛类的数量进行分析，得出深圳河口泥滩 A 断面和 RB 断面的小头虫有明显的季节变化，即冬季数量较其他季节高，秋季数量较其他季节低，ET 断面的小头虫数量没有明显的季节变化。RB 断面寡鳃齿吻沙蚕数量随时间推移有增加的趋势，与有机质含量的变化是相似的。寡鳃齿吻沙蚕和独毛虫的水平分布明显受盐度限制，盐度较低的 ET 断面寡鳃齿吻沙蚕数量较盐度较高的 A 断面和 RB 断面的低，独毛虫没有分布到 ET 断面。A 断面的独毛虫在养猪场废水注入时大量繁殖。文中探讨了溶解氧和有机质含量与 3 种小个体多毛类数量的关系。

关键词：小头虫；寡鳃齿吻沙蚕；独毛虫；季节变化；深圳河口

Distribution and polluting effects on *Capitella capitata*, *Nephtys oligobranchia*, *Tharyx* sp. on the intertidal mudflats in Shenzhen Estuary

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Abstract: There are two famous Natural Reserve, Mai Po Marshes Reserve and Futian Natural Reserve, in Shenzhen (Deep) Bay. Deep Bay is an internationally important site for waterfowl and mangrove. Environmental stress in Mai Po and Fu Tian mudflats, induced by the accumulation of anthropogenic contaminants, such as heavy metals, poly-chlorinated biphenyl (PCB) and PAHs from industrial effluents, has aroused great concern after the Hong Kong Government declared Mai Po a wetland of international importance under the Ramsar Convention in September 1995.

High clay content, rich organic matter and high density of macrofauna are three ecological characteristics on intertidal mudflats in Shenzhen estuary. *Capitella capitata*, *Nephtys oligobranchia* and *Tharyx* sp. are commom species of small individual polychaete of the intertidal mudflats in Shenzhen Estuary. *Capitella capitata* is a worldwide species and it is considered as indicator of pollution.

The data of three species of small individual polychaete got from July 1995 to April 1998 seasonly. Three transects including nine stations were designed for macrobenthic investigation. The study area was located in 114°00′18″E ～114°01′48″E, 22°29′51″N～22°31′66″N. Transect A includes stations A1, A2, A3 which are on the Shenzhen side of Shenzhen Bay. A3 is located near mangrove and the distances between A1 and A2, or between A2 and A3, were about 150 m. Transect RB and ET are on the Hong Kong side of the study area. Transect RB includes stations RBO, RB3 and 45O; Transect ET includes stations ET1,

基金项目：国家自然科学基金资助项目(39670135)
收稿日期：1999-11-1[illegible]；**修订日期**：2000-06-10
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ET2 and ET4. Seasonal sampling was conducted in January (winter), April (spring), July (summer) and October (autumn). To collect benthic samples, a plastic core of 10 cm diameter and 20 cm length was inserted into the sediment to a depth 20cm. The sediment collected was transferred to a plastic bag and labeled with sample number. A total of five replicates were collected at each station. To wash the samples, they were transferred to a bucket and water was added. The slurry was then swung manually and then poured gently through a 0.5 mm sieve. The benthos and sand retained on the sieve were then transferred into bottle with formalin and Rose Bengal by forceps. The specimens were taken to laboratory for identification and counting under a microscope. After counting, three species of polychaete were dried in an oven at 60℃ for 48 hours. Regression analysis used the software SPSS 10.0.

The seasonal variations of *Capitella capitata*, *Nephtys oligobranchia* and *Tharyx* sp. vary at three transects. *Capitella capitata* at transect A and transect RB had clearly seasonal variation. The quantities of *Capitella capitata* in winter were higher than that in other seasons in the same year. But there was no quantitative patterns for *Capitella capitata* at transect ET. There were increasing trends for the quantities of *Nephtys oligobranchia* at transect A and transect RB from July 1995 to April 1998, which was similar to the temporal patterns of organic matter. Regression analysis showed there was significant interrelation between the temporal patterns of organic matter and time. There was no any trend for the quantities of *Nephtys oligobranchia* at transect ET with the time going. The density and biomass of *Tharyx* sp. at transect A increased from July 1995 to April 1997, which may related to pig-cultural farms. There were many pig-culture farms near transect A before January 1997. The sewage of the pig-culture farms was discharged into the intertidal mudflat around transect A. There was no seasonal patterns for the density and biomass of *Tharyx* sp. at transect RB. *Tharyx* sp. was not found at transect ET during investigative period.

The distributions of *Capitella capitata*, *Nephtys oligobranchia* and *Tharyx* sp. on the intertidal mudflats in Shenzhen Estuary were different in various transects. The average density and biomass of *Capitella capitata* (average value of three years) at transect A three years were lower than those at transect ET. But the average density and biomass of *Nephtys oligobranchia* at transect A were higher than those at transect ET. The average density and biomass of *Tharyx* sp. at transect A was higher than that at transect RB. *Tharyx* sp. was not found at transect ET. Their distribution was related to salinity. *Tharyx* sp. is a species which lives in high mesohaline mud so it could not be found at transect ET and was occasionally found at transect RB. *Capitella capitata* and *Nephtys oligobranchia* could be found at three transects and could live in the range of 6ppt ~ 27ppt salinity. So *Capitella capitata* and *Nephtys oligobranchia* were considered as euryhaline species.

Some studies showed that macrofaunal community on the intertidal mudflats in Shenzhen Estuary was moderately disturbed from July 1997 to July 1998. For example, a large individual polychaete, *Dendronereis pinnaticirris*, was not found from July 1997 to July 1998. The density of *Capitella capitata* was low from July 1997 to April 1998, but the density of *Nephtys oligobranchia* was high at the same period. According to the temporal variations of *Capitella capitata* and *Nephtys oligobranchia*, it could be infered that *Nephtys oligobranchia* tolerated heavier disturbance than *Capitella capitata* did.

Key words:*Capitella capitata*; *Nephtys oligobranchia*; *Tharyx* sp.; seasonal variation; Shenzhen Estuary
文章编号:1000-0933(2001)10-1648-06 **中图分类号**:Q178 **文献标识码**:A

深圳河口泥滩沉积物颗粒细,富含有机质,栖息着一些高密度的多毛类[1,2]。其中大个体多毛类的数量受到多种环境因子的影响[3]。小头虫为吞咽型多毛类动物,吞食底表浮泥和底栖硅藻,小头虫又是厌氧动

物，能在溶解氧较低的情况下生活，孙道元[4]、何明海等[5]认为它可作为有机质污染指示生物。寡鳃齿吻沙蚕和独毛虫以有机质和碎屑为营养。独毛虫所属的丝鳃虫科的种类常栖息在污水沉积物中。有关寡鳃齿吻沙蚕的污染指示作用则未见报道。将深圳河口泥滩获得的 3 种小个体多毛类的数量动态进行分析，对了解 3 种小个体多毛类在高有机质含量区域的季节变化规律，探索小头虫、寡鳃齿吻沙蚕和独毛虫的污染指示作用，在海洋污染的生物学指标中具有特别重要的意义。

1　材料与方法

深圳河口泥滩 3 种小个体多毛类动物调查设 3 个断面 9 个取样站（图 1），与底栖动物取样站位是一致的。A 断面位于深圳福田一侧，包括 A1、A2 和 A3 3 个取样站；RB 断面和 ET 断面位于香港米埔泥滩内，RB 断面包括 RBO、RB3 和 450 3 个取样站；ET 断面包括 ET1、ET2 和 ET4 3 个取样站。以每年的 1 月份、4 月份、7 月份、10 月份分别代表冬季、春季、夏季、秋季。调查时，每个取样站用直径 10cm、深 20cm 的塑料管随机、连续采集 5 管泥样，分别装入塑料袋，带到岸边水塘处，倒入桶内，加水搅拌，用孔径 0.5mm 的套筛过滤，滤出的生物及余留的泥沙用含玫瑰红的 5%甲醛固定，带回实验室内分类和称干重。另取泥样测定总有机质（TOM），总有机质分析采用重铬酸钾-硫酸溶液氧化法。

回归分析采用国际通用统计分析软件 SPSS10.0 中的回归分析程序。

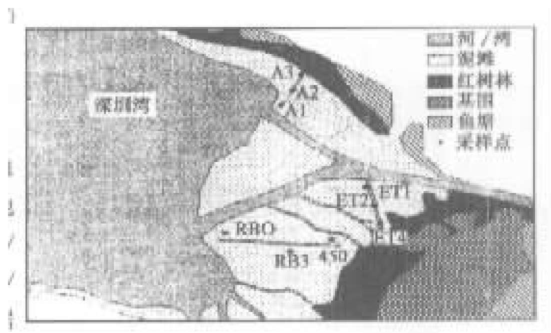

图 1　深圳河口泥滩 3 种小个体多毛类取样站位

Fig. 1　Sampling stations of *Capitella capitata*, *Nephtys oligobranchia* and *Tharyx* sp. in Shenzhen Estuary

2　结果

2.1　小头虫数量的季节变化及与时间的关系

A 断面的小头虫密度和干重生物量在 1996 年 1 月（冬季）、1997 年 1 月和 1998 年 1 月均较本年度其他月份的高（图 2），其数量分别为 459 ind/m² 和 129mg/m²、1554 ind/m² 和 397 mg/m²、153 ind/m² 和 39 mg/m²。RB 断面的小头虫密度和干重生物量在时间上呈锯齿状波动，1996 年 1 月和 1998 年 1 月均较本年度其他月份的高（图 3）。ET 断面小头虫的密度和干重生物量在 1997 年 1 月以前，锯齿状波动，在 1997 年 4 月（春季）最高，分别高达 10684 ind/m² 和 1641mg/m²（图 4），在此之后则很少采到。

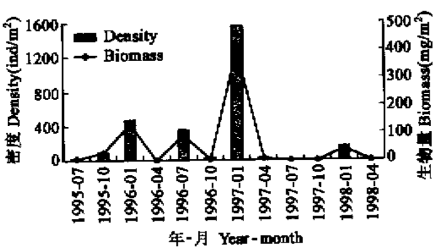

图 2　1995-07～1998-04 A 断面小头虫密度（ind/m²）和干重生物量（mg/m²）

Fig. 2　The density and biomass of *Capitella capitata* at transect A on mudflats in Shenzhen Estuary from July 1995 to April 1998

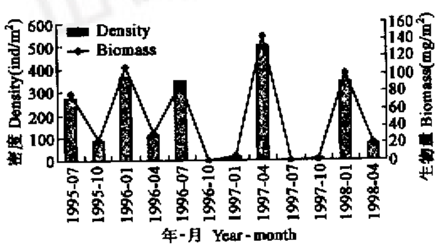

图 3　1995-07～1998-04 RB 断面小头虫密度（ind/m²）和干重生物量（mg/m²）

Fig. 3　The density and biomass of Capitella at transect RB on mudflats in Shenzhen Estuary from July 1995 to April 1998

从 3 个断面小头虫的总平均密度和总平均生物量看，ET 断面最高，分别为 2274 ind/m² 和 450 mg/m²；A 断面次之，分别为 224 ind/m² 和 58 mg/m²；RB 断面最低，分别为 176 ind/m² 和 50 mg/m²。3 个断面

的共同特点是 10 月份小头虫数量均很低或未采到。

2.2 寡鳃齿吻沙蚕数量的季节变化与时间的关系

A 断面 RB 断面的寡鳃齿吻沙蚕密度和生物量有随时间推移增加的趋势(图 5),但回归分析表明,A 断面寡鳃齿吻沙蚕密度和生物量与时间的相关系数为 0.420(时间以月为单位,$n=11$),1%水平无显著差异;RB 断面的寡鳃齿吻沙蚕密度和生物量有随时间推移增加的趋势(图 6),它们与时间的相关系数分别为 0.816 和 0.743,1%水平显著差异;ET 断面从 1996 年 10 月至 1997 年 4 月均有较高的密度和生物量(图 7),回归分析无相关关系(−0.088 和 −0.087)。3 个断面的寡鳃齿吻沙蚕总平均密度和总平均生物量物量表明,A 断面最高,分别为 767 ind/m^2 和 273 mg/m^2;RB 断面次之,分别为 549 ind/m^2 和 205 mg/m^2;ET 断面最低,分别为 125 ind/m^2 和 40 mg/m^2。

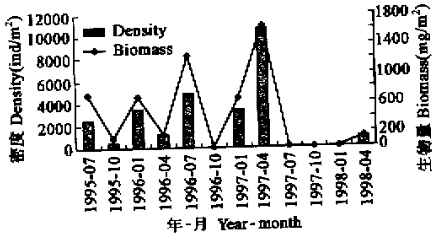

图 4 1995-07～1998-04.ET 断面小头虫密度(ind/m^2)和干重生物量(mg/m^2)

Fig. 4 The density and biomass of *Capitella capitata* at transect ET on mudflats in Shenzhen Estuary from July 1995 to April 1998

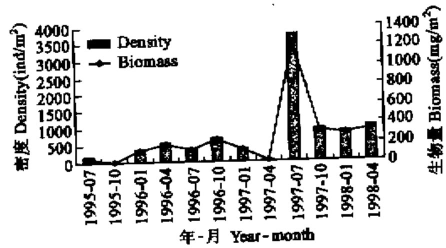

图 5 1995-07～1998-04A 断面寡鳃齿吻沙蚕密度(ind/m^2)和干重生物量(mg/m^2)

Fig. 5 The density and biomass of *Nephtys oligobranchia* at transect A on mudflats in Shenzhen Estuary from July 1995 to April 1998

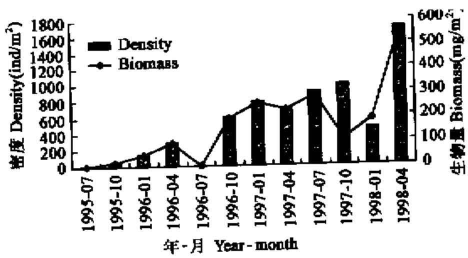

图 6 1995-07～1998-04RB 断面寡鳃齿吻沙蚕密度(ind/m^2)和干重生物量(mg/m^2)

Fig. 6 The density and biomass of *Nephtys oligobranchia* at transect RB on mudflats in Shenzhen Estuary from July 1995 to April 1998

2.3 独毛虫数量的季节变化及与时间的关系

A 断面独毛虫密度和干重生物量从 1995 年 7 月(夏季)至 1997 年 1 月(冬季)逐季上升,至 1997 年冬季达到最高,密度和干重生物量分别为 9665 ind/m^2 和 1981 mg/m^2,而后下降,至 1997 年 10 月(秋季)形成低谷,密度和干重生物量分别为 518 ind/m^2 和 113 mg/m^2(图 8)。RB 断面独毛虫数量比 A 断面的低 1 个数量级,没有明显的季节变化(图 9)。ET 断面没有独毛虫分布。

2.4 有机质含量的数量动态

3 个断面的有机质(TOM)含量随时间推移有增加的趋势(图 10),回归分析得出 3 个断面的有机质含量与时间(t)的相关系数分别如下:A 断面 0.914,RB 断面 0.777,ET 断面 0.557,1%水平均显著相关。

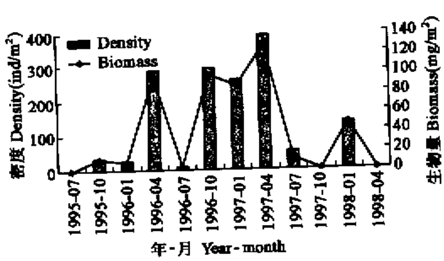

图 7 1995-07～1998-04ET 断面寡鳃齿吻沙蚕密度(ind/m^2)和干重生物量(mg/m^2)

Fig. 7 The density and biomass of *Tharyx* sp. at transect ET on mudflats in Shenzhen Estuary from July 1995 to April 1998

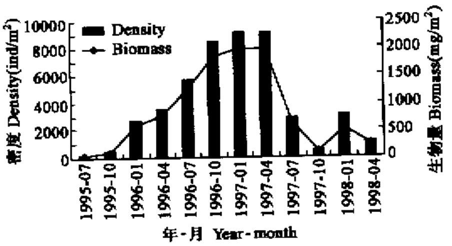

图 8　1995-07～1998-04 A 断面独毛虫密度(ind/m²)和干重生物量(mg/m²)

Fig. 8　The density and biomass of *Tharyx* sp. at transect A on mudflats in Shenzhen Estuary from July 1995 to April 1998

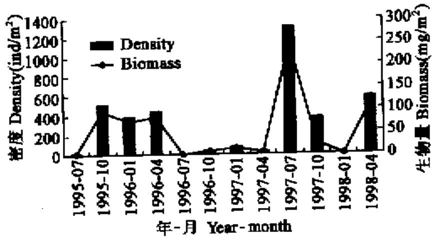

图 9　1995-07～1998-04RB 断面独毛虫密度(ind/m²)和干重生物量(mg/m²)

Fig. 9　The density and biomass of *Tharyx* sp. at transect RB on mudflats in Shenzhen Estuary from July 1995 to April 1998

3　讨论

3.1　溶解氧含量对 3 种小个体多毛类数量的影响

深圳河口泥滩 A 断面和 RB 断面的小头虫有明显的季节变化，即冬季的数量高于同年度其他季节的数量，这似乎与溶解氧含量有关。根据香港环保署深圳湾水质报告，靠近深圳河口的 DM1 取样站 1995 年和 1996 年的数据均表明，12 月至翌年 3 月的溶解氧含量在 3.5～7.5 mg/L 之间，而其他月份溶解氧多在 3.5 mg/L 以下。Reish 等[8,9]做过试验，溶解氧 1.2～1.6 mg/L 时，小头虫因不能摄食而死亡；溶解氧在 2.9 mg/L 时，小头虫能生活，但不能生殖；溶解氧在 3.4～4.0mg/L 时，小头虫能生殖并完成生活史；溶解氧在 4 mg/L 以上时，小头虫又逐渐减少。A 断面寡鳃齿吻沙蚕数量 1996 年 7 月比 1996 年 4 月和 1996 年 10 月低，RB 和 ET 断面寡鳃齿吻沙蚕数量 1996 年 7 月为全年 4 个季度最低，而 1996 年 7 月正是靠近深圳河口的 DM1 取样站溶解氧处于低值期(1.0 mg/L 以下)，可见，溶解氧含量低导致寡鳃齿吻沙蚕数量低。1996 年 7 月 RB 断面独毛虫数量为全年最低，但 1996 年 7 月 A 断面独毛虫数量呈上升趋势，因而独毛虫数量是否受溶解氧限制尚不能判断。

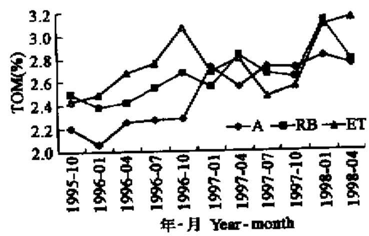

图 10　1995-10～1998-04 深圳河口泥滩 3 个断面的总有机质(TOM)含量

Fig. 10　The contents of organic matter at three transects on mudflats in Shenzhen Estuary from July 1995 to April 1998

ET 断面小头虫和寡鳃齿吻沙蚕数量没有季节变化规律，与盐度等环境因子变化较大有关。因为 ET 断面最靠近深圳河，海淡水交汇导致盐度变化较 A 断面和 RB 断面大。寡鳃齿吻沙蚕数量在 A 断面高，在 RB 断面次之，在 ET 断面最低，与盐度分布规律是一致的。独毛虫数量受盐度限制比寡鳃齿吻沙蚕更明显，独毛虫密度在 A 断面总平均为 3918 ind/m²，在 RB 断面为 316 ind/m²，而在 ET 断面从未发现过独毛虫。

3.2　有机质含量与 3 种小个体多毛类数量的关系

A 断面独毛虫的数量动态表明，适宜独毛虫繁殖和生长的有机质含量有一定范围，如 1995 年 10 月至 1997 年 1 月 A 断面独毛虫数量逐季上升，而这期间有机质含量也从 2.20%上升至 2.73%(图 10)，1997 年 4 月略有下降后维持在 2.70%以上，此后独毛虫数量也下降，说明总有机质含量在 2.70%以下有利于独毛虫生长繁殖，在 2.70%以上也能生长，但数量受到限制。但这种变化与养猪场废水影响关系更为密切。1997

年 1 月以前，在深圳福田红树林自然保护区附近有许多个体养猪场，这些养猪场的废水直接排入 A 断面附近泥滩，因此，从 1995 年 10 月至 1997 年 1 月，A 断面的小个体的独毛虫数量逐季上升，在 1997 年 1 月达到最高，为 9665 ind/m^2，可见，养猪场废水有利于独毛虫的繁殖。

A 断面和 RB 断面寡鳃齿吻沙蚕数量有随时间推移而增加的趋势，与有机质含量随时间推移增加是一致的，可见寡鳃齿吻沙蚕数量与有机质含量有正相关关系。Pearson 等[7]认为，有机物输入是近岸沉积环境内动物变化的主要原因。Cohen 等[6]指出，小头虫(*Capitella* sp1.)幼体在很高有机质含量时不能一致地选择底质。Selck 等[10]描述，随着外加聚合物浓度的增加，小头虫(*Capitella* sp1.)排泄率下降。深圳河口泥滩有机质含量高，对小头虫数量的影响必然存在。

致谢：本研究受到北京大学、汇亚环保顾问公司、环境科学顾问(亚洲)有限公司、世界自然(香港)基金会、深圳市治河办、广东内伶仃福田国家级自然保护区等单位的大力支持，香港米埔的底栖动物由环境科学顾问(亚洲)有限公司和安诚环保顾问有限公司采集，在此一并表示衷心感谢！

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