学校编码：10384　　分类号_____密级_____
学号：20051302224　　UDC _____

厦门大学

硕　士　学　位　论　文

深圳湾福田红树林湿地大型底栖动物群落环境效应研究

Environmental Effect on macrofaunal community in the Futian Mangrove Wetland of Shenzhen Bay

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论文提交日期：2008 年 11 月
论文答辩时间：2008 年　月
学位授予日期：2008 年　月

答辩委员会主席：_____
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2008 年 11 月

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摘　要

选取国际湿地公约保护对象、国际《生物多样性公约》重点保护对象、我国唯一处在城市腹地的国家级自然保护区——广东内伶仃岛-福田自然保护区为研究区域，于 2005-2007 年对福田红树林区观鸟屋、凤塘河口和沙嘴码头三条断面（A、H、F 断面）进行了大型底栖动物的季度调查，结合理化因子，采用单变量和多变量的方法研究了大型底栖动物的群落生态，通过比较红树林内与林外之间、不同断面之间、不同季节之间以及年际之间大型底栖动物群落的差异，探讨了生态和环境因子对大型底栖动物群落的影响，为红树林湿地生态保护和研究提供依据和新思路。

主要研究成果如下：

1．2005-2007 年在福田红树林保护区定量采样共获得大型底栖动物 64 种，其中多毛类、甲壳类、腹足类、双壳类分别为 21 种、17 种、14 种、5 种。大型底栖动物总平均密度为 17792 ind•m^{-2}，以寡毛类所占比例最高。大型底栖动物总平均生物量为 111.46 g•m^{-2}，以腹足类所占比例最高。

2．2005-2007 年间福田红树林保护区大型底栖动物群落发生了一定变化。年平均密度 2005 年＞2006 年＞2007 年，年平均生物量 2007 年＞2005 年＞2006 年，年次级生产力 2005 年＞2007 年＞2006 年，上述三项变化趋势不同的原因是群落主要类群的变化，三年来多毛类和寡毛类密度组成所占比例相对下降，腹足类则相对上升。

3．大型底栖动物平均密度的季节差异是春季＞冬季＞秋季＞夏季，平均生物量季节差异则是冬季＞秋季＞春季＞夏季。数理统计软件分析表明，福田红树林湿地大型底栖动物的密度不存在显著的季节差异，但生物量存在显著的季节差异，而大个体的羽须鳃沙蚕(*Dendronereis pinnaticirrus*)和腺带刺沙蚕(*Neanthes glandicincta*)存在显著的季节差异。

4. A、H、F 断面平均密度分别为 17478 ind•m^{-2}、17676 ind•m^{-2}、18384 ind•m^{-2}，比较接近；A、H、F 断面平均生物量分别为 123.23 g•m^{-2}、112.43 g•m^{-2}、97.52 g•m^{-2}。数理统计软件分析表明，福田红树林湿地大型底栖动物的密度和生物量不存在显著的断面差异，但大个体的羽须鳃沙蚕、腺带刺沙蚕和溪沙蚕(*Namalycastis*

abiuma)存在显著的断面差异。

5．福田红树林保护区林外的密度、生物量、次级生产力较林内高，但没有达到显著差异。林内站的 *d* 值和 MPI 值高于林外站，*H'*值低于林外站。聚类分析和 MDS 标序结果表明，林内与林外的大型底栖动物群落种类组成有些差异，其结果与平均密度、生物量、次级生产力、*H'*和 MPI 值的差异是一致的，说明生境不同，大型底栖动物群落的种类组成存在差异。

6．大型底栖动物以及三种沙蚕的密度与总有机质含量有较高的相关系数或者显著相关，与盐度也有较高的相关系数。大型底栖动物密度和生物量与降雨量、气温、光照时数、相对湿度无显著相关，但三种沙蚕的密度和生物量与降雨量、气温和光照时数有较高的相关系数或者显著相关，说明种群对气候因子的响应比较敏感，而群落对气候因子的响应不敏感，这是因为群落由很多种群组成，各种生物对气候的响应不一样。

7．2005-2007 年福田红树林保护区大型底栖动物年平均次级生产力分别为 34.11 gAFDW•m^{-2}•yr、23.72 gAFDW•m^{-2}•yr、31.71 gAFDW•m^{-2}•yr；次级生产力组成与生物量组成一致。数理统计软件分析表明，福田红树林保护区大型底栖动物的次级生产力不存在显著性的空间、季节和年际差异。

8．应用了丰富度指数 *d*、种类多样性指数 *H'*、大型底栖动物污染指数 MPI 和丰度生物量比较法（ABC 法）对研究区域进行环境污染状况评价，并对个别结果的差异进行了分析。生物指数显示，沿观鸟屋–凤塘河口–沙嘴码头三条断面大型底栖动物群落的 *d* 和 *H'*值依次降低，MPI 值依次升高，即污染程度逐渐加重；在四个季节中，夏季的 *d* 和 *H'*值最低而 MPI 值最高，表明夏季污染较重。

关键词：大型底栖动物；环境效应；红树林湿地；深圳湾

Abstract

Choose the International Wetland Convention protected object, International Convention on Biological Diversity key protected object, the only national nature reserve in city hinterland——Guangdong Neilingding Futian National Nature Reserve as research area, Macrobenthos were studied at three transects, namely A (Guanniaowu), H (Fengtang outfall) and F (Shazui dock) transect from 2005 to 2007, combined environmental factors, the community ecology of macrofauna was studied by using univariate and multivariable statistics, and compare the differences of benthic community among mangrove area and non-mangrove area, different seasons and sampling stations of different transects, ecology and environmental factors that influenced on macrofauna community were discussed, the datas will provide evidences and new ideas for protection and research of mangrove wetland ecology.

The main results are as follows:

1. Sixty-four species of macrofauna were identified in Futian mangrove reserve from 2005 to 2007. Among them, twenty-one species of polychaetes, seventeen species of crustacean, fourteen species of gastropods and five species of bivalve. The aggregate average density of macrofauna is 17792 ind•m^{-2}, oligochaetes is the highest of all. The aggregate biomass of macrofauna is 111.46 g•m^{-2}, gastropods is the highest of all.

2. There were some changes in macrofauna community of Futian mangrove reserve from 2005 to 2007. The highest annual average density is in 2005, the lowest is in 2007, the highest annual average biomass is in 2007, the lowest is in 2006, and the highest annual secondary production is in 2005, the lowest is in 2006, the reason of above different trends is that the change of major groups in community, the density components of polychaetes and oligochaetes decreased in the past three years, while gastropods increased.

3. In terms of the seasonal difference of average density of macrofauna, spring was the highest, winter was the second, autumn was the third, summer was the lowest, while the seasonal difference of average biomass of macrofauna, winter was the highest,

autumn was the second , spring was the third, summer was the lowest. Mathematical statistics analysis showed that there was no obvious seasonal density difference of macrofauna in Futian mangrove wetland, but biomass was, and there were obvious seasonal differences of biger individual *Dendronereis pinnaticirrus* and *Neanthes glandicincta.*

4. The average density of A transect was 17478 ind•m^{-2}, B transect was 17676 ind•m^{-2} and F transect was 18384 ind•m^{-2}， while the average biomass of A transect was 123.23 g•m^{-2}, B transect was 112.43 g•m^{-2} and F transect was 97.52 g•m^{-2}. Mathematical statistics analysis showed that there was no obvious transect density and biomass difference of macrofauna in Futian mangrove wetland, but there were obvious transect differences of big bodysize *Dendronereis pinnaticirrus, Neanthes glandicincta* and *Namalycastis abiuma*.

5. The density, biomass and secondary production of non-mangrove area were higher than that of mangrove area. Magalef's index (*d*) and Macrofaunal Pollution Index (MPI) of mangrove area were higher than that of non-mangrove area, while Shannon-Wiener diversity index (*H'*) of mangrove area was lower than that of non-mangrove area. Cluster analysis and MDS alalysis showed that there were some differences of community species composition of macrofauna in mangrove area and non-mangrove area, which was consisted with average density, biomass, secondary production, Shannon-Wiener diversity index (*H'*) and Macrofaunal Pollution Index (MPI), it can be concluded that the species composition of macrofauna community would be different in the distinct habitats.

6. There were obvious relationship among the density of macrofauna and three kinds of clamworms and TOM and salinity. There were no obvious relationship between density and biomass of macrofauna and rainfall, air temperature, illumination time and relative humidity, but there were obvious relationship between density and biomass of three kinds of clamworms and rainfall, air temperature and illumination time, it can be concluded population was sensitive to weather response, but community was not, because community is compose of a lot of population, different creatures have different response to the weather.

7. The annual average secondary production of macrobenthos in Futian mangrove reserve were 34.11 gAFDW•m^{-2}•yr、23.72 gAFDW•m^{-2}•yr and 31.71 gAFDW•m^{-2}•yr from 2005 to 2007 respectively. The composition of secondary production and biomass were consistent. Mathematical statistics analysis showed that there were no obvious spatial, seasonal and annual secondary production differences of macrobenthos in Futian mangrove reserve.

8. Magalef's index (*d*), Shannon-Wiener diversity index (*H'*), Macrofaunal Pollution Index (MPI), and Abundance biomass comparison method (ABC) were applied to environmental pollution situation evaluation of research area, and the difference of some results were analysed. The biological index showed that Magalef's index (*d*) and Shannon-Wiener diversity index (*H'*) of macrofaunal community of three transects, Guanniaowu was the highest and Shazui dock was the lowest, in terms of Macrofaunal Pollution Index(MPI), Shazui dock was the highest and Guanniaowu was the lowest, namely pollution level was aggravated gradually. Of the four seasons, Magalef's index (*d*) and Shannon-Wiener diversity index (*H'*) of summer were the lowest and Macrofaunal Pollution Index (MPI) was the highest, it indicated that pollution was more serious in summer.

Keywords: Macrofauna; environmental effect; mangrove wetland; Shenzhen Bay