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厦门大学

硕士学位论文

北部湾北部浮游生物生态学研究

Ecological studies on plankton in northern Beibu Gulf

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摘要

本文以“我国近海海洋综合调查与评价专项（908-01-ST09）”2006~2007年北部湾四个季节的调查数据为基础，开展了北部湾北部浮游生物生态学方面的研究。着重分析了北部湾北部浮游生物的种类组成、数量分布、优势种类、群落多样性和异质性，及影响浮游生物时空变化的环境因素，探讨了影响浮游生物群落变动的环境调控机制，其主要研究结果如下：

1. 北部湾北部浮游植物生态学研究

（1）北部湾北部浮游植物共计 273 种（含变种和变型），隶属 5 门 79 属。硅藻门和甲藻门为最优类群。广布性类群和亚热带近岸类群在调查区占据主导优势。营养盐是影响浮游植物种类组成的主要因素。

（2）北部湾北部浮游植物细胞丰度年均值（2207.3±6124.9）×10^4 cells/m^3，叶绿素 a 浓度年均值 1.9±1.3 mg/m^3，叶绿素 a 浓度的变化趋势与浮游植物总细胞丰度并不一致。盐度和营养盐是影响浮游植物丰度分布的主要因素。

（3）四个季节均出现的优势种为菱形海线藻（*Thalassionema nitzschioides*）。骨条藻（*Skeletonema* sp.）和棕囊藻（*Phaeocystis* sp.）分别在夏、秋两季于广西近岸大量繁殖，具有暴发赤潮的潜在可能。硅酸盐是影响骨条藻生长的限制因素，而磷酸盐是影响棕囊藻繁殖的主要因素。优势种类演替具有明显的季节性。

（4）根据聚类和排序结果，可将北部湾北部浮游植物划分为三个群落：广西近岸群落（JA）、广西远岸群落（YA）和琼州海峡入湾口群落（QZ）。营养盐分布和浮游植物群落结构受沿岸径流、粤西沿岸流和南海次表层水三支水系的推移和消长影响。

2. 北部湾北部浮游动物生态学研究

（1）北部湾北部浮游动物共计 464 种（类）[含浮游幼虫（体）]，隶属于 7 个门 19 个类群。水螅水母类和桡足类是优势类群。广温广盐类群和近岸低盐类

群在该海域占据主导地位，与少数的河口类群及大洋类群形成北部湾北部特有的浮游动物群落组成结构。地形特征、海流与水团的消长及浮游植物的生长与繁殖是影响浮游动物群落组成和水平分布推移的重要因素。

（2）北部湾北部浮游动物丰度年均值（183.5±142.9）ind/m^3，生物量年均值（139.5±116.8）mg/m^3。平面分布上，春、秋两季丰度分布呈远岸高近岸低的趋势，夏、冬两季则在近岸海域形成高丰度区。生物量的平面分布趋势与丰度的分布趋势基本一致。水深、温度及叶绿素 a 浓度是影响丰度分布的主要因素。

（3）肥胖软箭虫（*Flaccisagitta enflata*）、亚强次真哲水蚤（*Subeucalanus subcrassus*）、长尾类幼体（Macrura larvae）和蛇尾类长腕幼虫（Ophiopluteus larvae）在北部湾北部的优势性显著，优势种类演替具有明显的季节性。优势种类对于环境的适应能力较强。

（4）根据聚类和排序结果，可将北部湾北部浮游动物划分为三个群落：广西近岸群落（JA）、广西远岸群落（YA）和雷州半岛西沿岸群落（QZ）。这三个群落与沿岸径流、粤西沿岸流和南海次表层水的推移和消长密切相关。群落多样性、优势种类及指示种随季节变化而呈现差异性。

3. 营养盐-浮游植物-浮游动物的耦合关系

（1）骨条藻藻华区具有营养盐丰富，浮游植物种类数少、丰度高，浮游动物丰度较高的特点。临界区骨条藻藻华消亡，优势种转变为菱形海线藻。硅酸盐对骨条藻具有限制作用，亨生莹虾的高值区与骨条藻藻华区具有一定程度的重叠。

（2）棕囊藻藻华区为浮游动物生物量的低值区，藻华区内氮盐和磷酸盐的浓度低于浮游植物生长阈值。棕囊藻对营养盐的吸收率大小顺序为磷酸盐＞氮盐＞硅酸盐，磷酸盐是本调查区棕囊藻生长繁殖的主要限制因素。

关键词：北部湾北部；浮游植物；浮游动物；群落结构；海流与水团

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ABSTRACT

The species composition, abundance, biomass, dominate species, diversity and heterogeneity of plankton in northern Beibu Gulf was studied based on the samples of Beibu Gulf collected during 2006~2007. And impacts of seasonal variations of environmental factors on plankton community were discussed. The main results are as follows:

1. Ecological study on phytoplankton community in northern Beibu Gulf

(1) A total of 273 phytoplankton species were identified (included variety and form), which belonging to 5 phyla, 79 Taxa. Bacillariophyta and Pyrrophyta were the main phytoplankton groups in the survey area. The species number of zooplankton, varied seasonally, was highest in summer, followed by autumn, winter and spring. The cosmopolitan group and the subtrophic-inshore group were dominant in this area. Nutrient was the main factors on phytoplankton composition.

(2) The average of abundance was(2207.3±6124.9) $\times 10^4$ cells/m^3, varied in the order of summer, autumn, winter and spring. The average concentration of chlorophyll a was (1.9±1.3) mg/m^3, varied in the order of autumn, winter, summer and spring. The horizontal distribution of abundance and chlorophyll a was quite different. Salinity and nutrient were the main factors on phytoplankton abundance.

(3) *Thalassionema nitzschioides* dominated in four seasons. *Skeletonema* sp. and *Phaeocystis* sp. bloomed respectively in summer and autumn in the inshore of Guangxi with a potential of red tide. The limiting factor of *Skeletonema* sp. was silicate, while the limiting factor of *Phaeocystis* sp. was phosphate. The dominant species changed dramatically during four seasons.

(4) According to cluster and ordination methods, three phytoplankton communities could be distinguished as inshore community, the mouth of Qiongzhou

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Strait community and offshore community. The nutrient structure and phytoplankton community were influenced by runoff, the coastal water of western Guangdong and open sea water.

2. Ecological study on zooplankton community in northern Beibu Gulf

(1) A total of 464 zooplankton taxa were identified (including pelagic larvae), which belonging to 7 phyla, 19 Taxa. Hydromedusae and Copepoda were dominant taxa. The species number of zooplankton, varied seasonally, was highest in summer, followed by autumn, winter and spring. The wide-temperature-salinity group and the inshore low-salinity group which were dominant in this area formed a uniquely northern Beibu Gulf zooplankton community composition structure with few estuarine group and oceanic group. Topographic feature, currents and water masses, phytoplankton were the main factors on zooplankton composition.

(2) The average of abundance was (183.5±142.9) ind/m^3, while the average biomass was (139.5±116.8) ind/m^3. There was a gradual increase in the abundance from inshore to offshore in spring and autumn, while the abundance was high inshore in summer and winter. The abundance was the highest in autumn, followed by summer, winter and spring. Biomass horizontal distribution was similar with abundance, but varied differently during four seasons, in the order of spring, autumn, winter and summer. The correlation between abundance and environmental factors was significant. Depth, temperature and chlorophyll a were the main factors.

(3) *Flaccisagitta enflata*, *Subeucalanus subcrassus*, Macrura larvae and Ophiopluteus larvae dominated in northern Beibu Gulf especially. The dominant species changed dramatically during four seasons. The ecological adaptation of dominant species was wide.

(4) According to cluster and ordination methods, three zooplankton communities could be distinguished as inshore community, Leizhou Peninsula community and offshore community. All these communities were associated with terrestrial runoff,

the coastal water of western Guangdong and open sea water. The diversity, dominant species and the best indicator species of each community varied seasonally.

3. Coupling of nutrient, phytoplankton and zooplankton

(1) The characteristics of *Skeletonema* sp. bloom region was described as follows, nutrients concentration was high, species number of phytoplankton was low, while abundance of both phytoplankton and zooplankton were high. The *Skeletonema* sp. bloom was disappeared in the critical region and the dominant species was changed to *Thalassionema nitzschioides*. Silicate had limited effect on *Skeletonema* sp.. The high abundance region of *Lucifer hanseni* and *Skeletonema* sp. has had a certain degree of overlap.

(2) The bloom region of *Phaeocystis* sp. was overlapped with the low biomass region of zooplankton. The concentration of nitrogen and phosphate was lower than the threshold of phytoplankton. Phosphate was highest absorbed, followed by nitrogen and silicate. Phosphate had limited effect on *Phaeocystis* sp..

Key words: northern Beibu Gulf; phytoplankton; zooplankton; community structure; current and water masses

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