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厦门大学

硕士学位论文

漳江口红树林区鱼类主要群落
结构特征的研究

The Main Community Structure Characteristics of Fishes in
Zhangjiang Estuary Mangrove National Nature Reserve

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摘要

本研究于 2013 年 8 月、11 月、2014 年 3-4 月、5-6 月在漳江口红树林保护区三条断面进行了夏、秋、冬、春四个季节的采样,分析了漳江口红树林区鱼类的种类组成、优势种、生态类群和物种多样性及其季节变化和空间分布,探讨了主要优势种四季的体长变化特征和代表种在不同断面的体长特征,并用多元统计分析方法(聚类分析、非度量多维标度分析 nMDS、相似性分析检验 ANOSIM、相似性比例分析 SIMPER)分析了鱼类群落结构的时空变化特征。此外,本文还初步探讨了漳江口红树林区做为鱼类产卵场、索饵场和庇护所的可能性和价值。主要研究结果如下:

(1) 漳江口红树林区鱼类共 90 种,隶属于 10 目 34 科,均为硬骨鱼类。其中鲈形目鱼类最多,共计 20 科 58 种,占总种数的 64.44%,鲈形目中又以鰕虎鱼科的种类最多,共 23 种。潮沟(CG 断面)和潮滩(HC 断面和 DT 断面)种类数分别为 23 种和 85 种,潮沟和潮滩均有出现的物种有 20 种。

(2) 根据栖息水层,漳江口红树林区底层鱼类最多,共 51 种,占总种类数的 56.67%,中上层鱼类有 29 种,占 32.22%,近底层鱼类共 8 种,占 8.89%;从适温性上看,暖水性鱼类共 68 种,占总物种数的 75.56%,暖温性鱼类共 20 种,占总物种数的 22.22%;从食性上看,动物食性的鱼类有 55 种,占 61.11%,其次是杂食性种类,共 25 种,占 27.78%,植食性种类最少。

(3) 每个季节优势种有差异。花鲮(*Clupanodon thrissa*)、棱鲮(*Liza carinata*)和尼罗罗非鱼(*Oreochromis mossambicus*)在四个季度均为优势种。夏季优势种为花鲮、棱鲮、尼罗罗非鱼、灰鳍鲮(*Chelon melinopterus*)、褐篮子鱼(*Siganus fuscescens*)、七丝鲚(*Coilia grayii*)和眶棘双边鱼(*Ambassis gymnocephalus*);秋季优势种为长鳍凡鲮(*Moolgarda cunnesius*)、花鲮、棱鲮、灰鳍鲮和尼罗罗非鱼;冬季优势种为黄吻棱鲮(*Thryssa vitrirostris*)、长鳍凡鲮、斑鲮(*Konosirus punctatus*)、花鲮、棱鲮、尼罗罗非鱼和中华小公鱼(*Stolephorus chinensis*);春季优势种为花鲮、棱鲮、尼罗罗非鱼、粗鳞鲮(*Chelon subviridis*)、黄鳍鲷(*Acanthopagrus latus*)、日本花鲈(*Lateolabrax japonicas*)、七丝鲚、灰鳍鲮、鲮(*Platycephalus indicus*)和鲮(*Liza haematocheila*)。

(4) 潮沟优势种为尼罗罗非鱼、爪哇拟鰕虎鱼 (*Pseudogobius javanicus*)、灰鳍鲷、斑纹舌鰕虎鱼 (*Glossogobius olivaceus*)、中华乌塘鳢 (*Bostrychus sinensis*) 和棱鲷, 基本为底层和近底层鱼类。潮滩优势种有斑鲷、长鳍凡鲷、花鲷、黄吻棱鲷、灰鳍鲷、棱鲷、尼罗罗非鱼和七丝鲷, 大部分为中上层鱼类。红树林潮沟和潮滩鱼类体长有所差异。同一种鱼在潮滩的平均体长一般大于潮沟的平均体长, 如灰鳍鲷、棱鲷、爪哇拟鰕虎鱼等。但弹涂鱼在潮沟和潮滩的平均体长大小差异不大, 且大部分为性成熟个体。

(5) 根据不同季节和采样断面鱼类生物量的聚类分析和 nMDS 排序结果, 可以将漳江口红树林区鱼类群落划分为三个组: 底层杂食性鱼类为优势的地方性鱼类群落; 以黄吻棱鲷、花鲷、棱鲷和七丝鲷为中上层优势类群, 长鳍凡鲷等为底层优势类群, 冬季数量较多的季节性鱼类群落; 以花鲷、棱鲷、七丝鲷、日本花鲷等为中层优势类群, 以鲷和尼罗罗非鱼等为底层优势类群, 春季和夏季数量较多的季节性鱼类群落。

(6) 通过对鱼类体长特征的分析, 本文探讨了漳江口红树林区作为鱼类产卵场、索饵场和庇护所的可能。漳江口红树林区存在大量的近岸中上层鱼类的幼鱼, 主要是鲷科和鲷科鱼类。漳江口红树林对于长鳍凡鲷、灰鳍鲷、粗鳞鲷、鲷鱼、鲷鱼等下海产卵的鲷科鱼类而言, 更重要的可能是育幼的作用。对于河口种, 如鰕虎鱼科、双边鱼科的鱼类来说, 红树林既是其产卵场又是育幼场。漳江口红树林可能具备成为鱼类索饵场的条件。此外, 漳江口红树林的存在能在一定程度上降低鱼类被捕食的风险。

(7) 漳江口红树林区鱼类以近海小型鱼类占优势, 包括鲷科、鲷科和鲷科等经济鱼类。这些鱼类在不同季节, 为寻求产卵或育幼等目的而出现在漳江口红树林内, 并在其生长发育的不同时期, 在漳江口红树林潮沟、红树林潮滩以及东山湾之间进行生境的转移。漳江口红树林区的鱼类对东山湾渔业资源具有一定的补充作用。

关键词: 漳江口; 红树林; 鱼类; 群落结构特征

Abstract

The study was based on the fish surveys in Zhangjiang Estuary Mangrove National Nature Reserve. The samplings were held in August, November 2013 and march-April, May-June 2014. The fish species composition, dominant species, ecological group and biodiversity characteristics and seasonal variation and spatial dynamics were described. The body length distribution of main dominant species in 4 seasons and the body length distribution of typical species in 3 sections were analyzed. And the spatio-temporal patterns of fish community was discussed by mathematical methods such as Cluster analysis, non-metric Multi-Dimensional Scaling analysis (nMDS), analysis of similarity (ANOSIM) and similarity of percentage (SIMPER). Furthermore, we preliminarily discussed the value of Zhangjiang estuary mangrove ecosystem as spawning grounds, feeding and shelter grounds. The main results are as follows:

(1) 90 species were collected from Zhangjiang Estuary Mangrove National Nature Reserve, belonging to 34 families of 10 orders and all species are teleostean. Perciformes was the most abundant order, with 58 species of 20 families accounting for 64.44% of the sample. Gobiidae exhibited the highest diversity as in total of 23 species. There were 23 and 85 species in creek (CG section) and mudflat (HC section and DT section) respectively and they share 20 species.

(2) Based on the inhabiting depth, there were three fish types, including 51 demersal species, 29 pelagic species, 8 near-demersal species which accounting for 56.67%, 32.22% and 8.89% respectively. 68 warm water species accounting for 75.56% of the total number of species, and 20 temperate water species accounting for 24.44%. 55 carnivorous fish took up to 61.11%, 25 omnivorous fish accounting for 27.78% and the phytophagous fish was the least.

(3) The dominant species varied with seasons. *Clupanodon thrissa*, *Liza carinata* and *Oreochromis mossambicus* were the dominant species all the year around. The dominant species in summer were *Clupanodon thrissa*, *Liza carinata*, *Oreochromis mossambicus*,

Chelon melinopterus, *Siganus fuscescens*, *Coilia grayii* and *Ambassis gymnocephalus*. The dominant species in autumn were *Moolgarda cunnesius*, *Clupanodon thrissa*, *Liza carinata*, *Chelon melinopterus* and *Oreochromis mossambicus*. The dominant species in winter were *Thryssa vitrirostris*, *Moolgarda cunnesius*, *Konosirus punctatus*, *Clupanodon thrissa*, *Liza carinata*, *Oreochromis mossambicus* and *Stolephorus chinensis*. The dominant species in spring were *Clupanodon thrissa*, *Liza carinata*, *Oreochromis mossambicus*, *Chelon subviridis*, *Acanthopagrus latus*, *Lateolabrax japonicas*, *Coilia grayii*, *Chelon melinopterus*, *Platycephalus indicus* and *Liza haematocheila*.

(4) The dominant species in creek were *Oreochromis mossambicus*, *Pseudogobius javanicus*, *Chelon melinopterus*, *Glossogobius olivaceus*, *Bostrychus sinensis* and *Liza carinata*, which were almost demersal and near-demersal species. The dominant species on mudflat were *Konosirus punctatus*, *Moolgarda cunnesius*, *Clupanodon thrissa*, *Thryssa vitrirostris*, *Chelon melinopterus*, *Liza carinata*, *Oreochromis mossambicus* and *Coilia grayii*, most of which were pelagic species. The body length distributions of species were different between creek and mudflat. The mean body length of species on mudflat was generally longer than the one in creek, such as *Chelon melinopterus*, *Liza carinata* and *Pseudogobius javanicus*. But the mean body length of *Periophthalmus novaeguineensis* has little difference in creek and mudflat, most of which were mature individuals.

(5) Based on the cluster analysis and non-metric multidimensional scaling, three community styles were identified: the locally community, in which the dominant species were demersal and omnivorous fishes; the seasonal community occurred mostly in winter, that the dominant pelagic fish were *Thryssa vitrirostris*, *Clupanodon thrissa*, *Liza carinata* and *Coilia grayii*, and the dominant demersal fish were *Moolgarda cunnesius*; the seasonal community occurred mostly in spring and summer, that the dominant pelagic fish were *Clupanodon thrissa*, *Liza carinata*, *Coilia grayii* and *Lateolabrax japonicas*, and the dominant demersal fish were *Platycephalus indicus* and *Oreochromis mossambicus*.

(6) According to the fish body length distributions, we discussed the possibilities of Zhangjiang estuary mangrove ecosystem as the spawning, feeding and shelter grounds of fish. The species in Zhangjiang estuary mangroves were primarily inshore

pelagic juvenile fish and were mainly Mugilidae and Clupeidae. For catadromous species of Mugilidae such as *Moolgarda cunnesius*, *Chelon melinopterus*, *Chelon subviridis*, *Mugil cephalus* and *Liza haematocheila*, the more important value of mangrove was nursery. As for estuary species such as Gobiidae and Ambassidae, who spend the whole life in mangrove ecosystem. It is likely that they use mangrove ecosystem as spawning grounds and nurseries. Zhangjiang estuary mangroves may have the conditions as feeding sites. In addition, the existence of Zhangjiang estuary mangrove ecosystem can reduce the predation risk partly.

(7) The dominant species were mainly inshore pelagic economic fish with small size, such as Clupeidae, Engraulidae and Mugilidae. These fishes occurred in mangrove ecosystem in different seasons in order to spawning or raising the young and may shift between habitats (mangrove creek, mangrove mudflat and Dongshan Bay) during the different ontogenetic stages. The juvenile fish in Zhangjiang estuary mangrove ecosystem played a role of recruitment to Dongshan Bay fishery resources.

Keywords: Zhangjiang estuary; mangroves; fish; community structure

目录

摘要.....	I
Abstract.....	III
目录.....	VI
Contents	IX
第一章 绪论.....	1
1.1 研究背景及选题意义.....	1
1.2 鱼类群落生态学的研究进展.....	2
1.2.1 生物群落及鱼类群落的概念.....	2
1.2.2 物种多样性与优势种.....	2
1.2.3 鱼类群落的时空格局.....	4
1.3 红树林区鱼类生态学的研究进展.....	6
1.3.1 红树林与鱼类的关系.....	6
1.3.2 红树林区鱼类群落时空格局.....	7
1.3.3 红树林与近海渔业的联系.....	8
1.4 研究内容和思路.....	9
1.4.1 研究内容.....	9
1.4.2 研究思路.....	9
第二章 材料和方法	11
2.1 研究区域概况.....	11
2.1.1 自然环境概况.....	11
2.1.2 渔业资源概况.....	13
2.2 研究方法.....	14
2.2.1 采样时间与站位.....	14
2.2.2 采样方法和样品处理.....	15
2.2.3 数据处理.....	15

第三章 结果与分析	17
3.1 鱼类物种组成、生态类群及物种多样性.....	17
3.1.1 物种组成.....	17
3.1.2 生态类群.....	21
3.1.3 生物多样性指数.....	22
3.2 季节变化.....	23
3.2.1 种类组成的季节变化.....	23
3.2.2 优势种的季节变化.....	24
3.2.3 主要优势种的体长组成.....	25
3.2.4 生物多样性指数的季节变化.....	33
3.3 潮沟和潮滩生境对鱼类的吸引.....	33
3.3.1 潮沟和潮滩生境的鱼类组成与物种多样性.....	33
3.3.2 潮沟和潮滩生境的鱼类生态类群.....	36
3.3.3 潮沟和潮滩生境的鱼类优势种.....	37
3.3.4 代表种在潮沟和潮滩生境下的体长特征.....	38
3.4 红树林区鱼类群落的时空分布格局.....	42
第四章 讨论.....	45
4.1 漳江口红树林区鱼类的特点分析.....	45
4.1.1 鱼类种类组成.....	45
4.1.2 季节变化.....	46
4.1.3 空间分布.....	48
4.1.4 时空分布.....	49
4.2 漳江口红树林作为鱼类产卵场、索饵场和庇护所的分析.....	51
4.2.1 产卵场.....	51
4.2.2 索饵场.....	53
4.2.3 庇护所.....	54
4.3 漳江口红树林区鱼类与东山湾渔业资源的联系.....	55
第五章 小结与展望	57

5.1 研究结论.....	57
5.2 创新之处.....	59
5.3 不足与展望.....	59
参考文献.....	61
致谢.....	75

厦门大学博硕士论文摘要库

Contents

Abstract in Chinese	I
Abstract in English.....	III
Contents in Chinese	VI
Contents in English.....	IX
Chapter 1 Introduction	1
1.1 Research background and significance	1
1.2 Research progress on ecology of fish	2
1.2.1 Concepts of biocenosis and fish community	2
1.2.2 Species diversity and dominant species	2
1.2.3 Spatiotemporal patterns of fish community	4
1.3 Research progress on ecology of fish in mangroves.....	6
1.3.1 The relationship between mangroves and fishes.....	6
1.3.2 Spatiotemporal patterns of fish community in mangroves	7
1.3.3 The connection between mangroves and inshore fishery	8
1.4 Objective and framework of study.....	9
1.4.1 Objective	9
1.4.2 Framework	9
Chapter 2 Materials and methods	11
2.1 General situation of research areas	11
2.1.1 Natural environment situation.....	11
2.1.2 Fishery resources situation.....	13
2.2 Research methods	14
2.2.1 Time and sites of sampling	14
2.2.2 Sampling methods and sampling treatment	15
2.2.3 Data processing	15

Chapter 3 Results and analysis	17
3.1 Species composition, ecotype and species diversity	17
3.1.1 Species composition	17
3.1.2 Ecotype	21
3.1.3 Biodiversity index	22
3.2 Seasonal changes	23
3.2.1 Seasonal change of species composition	23
3.2.2 Seasonal change of dominant species	24
3.2.3 Standard length distribution of dominant species	25
3.2.4 Seasonal change of biodiversity index	33
3.3 The attractive of creek and mudflat to fish	33
3.3.1 Species composition and species diversity in creek and mudflat ..	33
3.3.2 Ecotypes in creek and mudflat	36
3.3.3 Dominant species in creek and mudflat	37
3.3.4 The standard length distribution of typical species in creek and mudflat	38
3.4 Spatiotemporal patterns of fish community	42
Chapter 4 Discussion	45
4.1 Characteristic of fish stocks in Zhangjiang estuary mangroves	45
4.1.1 Species composition	45
4.1.2 Seasonal changes	46
4.1.3 Spatial distribution	48
4.1.4 Spatiotemporal patterns	49
4.2 The analysis of mangroves as spawning, feeding and shelter grounds of fishes in Zhangjiang estuary mangroves	51
4.2.1 Spawning ground	51
4.2.2 Feeding ground	53
4.2.3 Shelter ground	54
4.3 The connection between the fish stocks in Zhangjiang estuary mangroves	

and the fishery of Dongshan Bay	55
Chapter 5 Conclusion and Prospects	57
5.1 Conclusion	57
5.2 Innovation	59
5.3 Questions and prospects.....	59
References.....	61
Acknowledgement	75

第一章 绪论

1.1 研究背景及选题意义

海洋是人类赖以生存和发展的基础。海洋生物资源是人们重要的蛋白质来源，它为世界众多人口提供着食物和生计。但随着海洋开发力度的加剧，部分渔业资源遭到过度捕捞，加上海洋环境污染、生境破坏和气候变化等影响，世界范围内大部分海域的渔业资源都受到了不同程度的破坏。据 2014 年 FAO 发布的《世界捕捞渔业和水产养殖产量》显示，自 1996 年全球海洋捕捞产量达到最高值后，全球海洋渔业产量维持在一个相对稳定的状态，基本不再增长。2011 年，FAO 评估海洋鱼类种群的可持续发展水平时发现，71.2% 的鱼类种群处于生物学可持续发展水平内，28.8% 的鱼类种群处于过度捕捞状态。1974 年至今，全球渔业资源种群中，渔获量排名世界前 10 位的种群多数已被完全开发甚至过度开发 (FAO, 2014)，世界渔业资源面临着衰退的趋势。目前，在长期大规模的开发下，我国近海如黄渤海、东海及南海也出现了不同程度的过度捕捞现象 (郑奕, 2007)。因此，如何合理利用和开发海洋生物资源是我们急需解决的问题。

作为“世界四大最富生物多样性的海洋生态系统之一”的红树林生态系统，以其高生产率、高分解率和高归还率的特性为周围水域输送了大量初级生产力 (林鹏, 1997)，是很多海洋生物的食物来源 (Odum 和 Heald, 1975; Thayer 等, 1987; 徐姗楠等, 2010)。而且红树林复杂的根系结构，为鱼类提供了良好的庇护所 (Health 等, 1993)。因此，红树林被认为是很多鱼类优良的栖息地，具有成为鱼类育幼场的条件 (Robertson 和 Duke, 1987)。2002 年，全球捕捞产量中约 3×10^7 t 的渔获量是来自红树林区 (FAO, 2004)。另外，生活在红树林区的鱼类大多为海洋河口物种，这些鱼类在生活史的某个阶段会进入红树林，红树林的存在对近海渔业有着一定的促进作用 (Staples 等, 1985; Manson 等, 2005a)。因此，红树林区鱼类群落结构的研究对近海渔业的可持续发展具有重要意义。

漳江口红树林是福建省最重要的国家级自然保护区之一，蕴含着丰富的水生生物资源，其下游为闽南最大的海湾—东山湾，将漳江口红树林保护区作为研究区域，具有一定的典型性和代表性。对漳江口红树林区鱼类群落多样性及群落时

空动态的研究旨在更好地了解漳江口红树林区的鱼类资源现状, 以期为漳江口红树林的保护及东山湾渔业资源的修复提供理论依据, 这对近海渔业的可持续发展研究具有重要意义。

1.2 鱼类群落生态学的研究进展

群落生态学的研究内容主要包括: 群落的组成和结构; 群落的性质与功能; 群落内的种间关系; 群落的发展及演替; 群落的丰富度、多样性与稳定性; 群落的分类和排序等。本文主要将焦点放在鱼类群落的多样性和时空格局上。

1.2.1 生物群落及鱼类群落的概念

一般认为生物群落是指一定生境里各种生物种群构成的结构单元。这个结构单元由植物群落、动物群落和微生物群落组成, 内部存在着复杂的物质循环和能量流动, 具有明显的营养结构和代谢类型(钱迎倩和马克平, 1994; 孙濡泳, 2001; 沈国英等, 2010)。

鱼类群落是特定水域内鱼类种群相互结合的一种结构单元, 鱼类与周围环境及其它物种相互依赖、相互作用, 组合成具有内在联系与结构特点的整体单元(Evans 等, 1987; 殷名称, 1993)。生态系统中的物质运输和能量流动都是通过生物群落来实现的。通过对鱼类群落结构的研究, 可以了解生态系统的健康状况和变化规律(Rice, 2000, 2003; Rochet 和 Trenkel, 2003; Harrison 和 Whitfield, 2006), 而通过对鱼类群落结构的时间和空间格局的研究, 可以为渔业资源的管理和可持续发展提供科学依据(Mahon 等, 1998; Link 等, 2002)。

1.2.2 物种多样性与优势种

生物多样性是指地球上各种生命形式的资源, 这些来源包括海洋、陆地及其他水生生态系统及其所构成的生态综合体, 生物多样性包括物种多样性、遗传多样性和生态系统多样性。物种多样性主要是从分类学、生物地理学和系统学的角度对特定区域内的物种状况进行研究(马克平, 1993)。

生物多样性的测度最开始主要集中在群落中种-面积、种-多度的关系研究上(Arrhenius, 1921)。1943 年 Williams 提出了多样性指数的概念, 之后便有不同

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