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廈門大學

博士学位论文

拟穴青蟹 (*Scylla paramamosain*) 不同种群呼吸
代谢的比较研究

**Comparison of Respiratory Metabolism Among Different
Populations of Mud Crab *Scylla paramamosain***

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厦门大学博硕士论文摘要库

摘要

在以往的研究中,本课题组认为中国拟穴青蟹存在“南方种群”和“北方种群”,且这两个种群对环境温度的适应存在不同。为了证实这一观点,本研究在不同季节对拟穴青蟹南方种群与北方种群在宁波、漳州和儋州海区的个体进行鳃、肝胰腺和肌肉线粒体呼吸速率、细胞色素C氧化酶(CCO)、三磷酸腺苷酶(ATPase)、己糖激酶(HK)、丙酮酸激酶(PK)和乳酸脱氢酶(LDH)活性等呼吸代谢指标的比较研究,期望研究结果能进一步证实拟穴青蟹在我国的确存在南北两个不同的种群,为指导拟穴青蟹渔业和养殖的管理提供理论依据。本研究的主要结果如下:

1. 拟穴青蟹不同种群在其分布区中部呼吸代谢的比较

拟穴青蟹在我国分布区的中部海域其南北两个种群的呼吸代谢的季节变化都很明显,但季节变化的模式存在一定程度的不同。例如:南方种群鳃和肌肉线粒体呼吸速率的测定结果都表现为秋季明显高于冬、春和夏季,而这3个季节之间的差异则很小。北方种群鳃线粒体呼吸速率的测定结果表现为冬秋两季高于春夏两季,其肌肉的测定结果则表现为4个季节之间的差异较为不明显。对于南北种群在同一季节的比较,除了秋季无差异外,鳃、肝胰腺和肌肉的测定结果都表明南方种群与北方种群其呼吸代谢存在一定程度的差异。特别是在低温的冬季,北方种群其鳃测得的所有呼吸代谢指标(以琥珀酸或丙酮酸+苹果酸为底物测得的线粒体状态2和状态3呼吸速率,线粒体CCO、 Na^+K^+ -ATPase、 Ca^{2+} -ATPase和 $\text{Ca}^{2+}\text{Mg}^{2+}$ -ATPase活性)全部显著高于南方种群。

2. 拟穴青蟹不同种群低温季节呼吸代谢的比较

在低温季节,无论是南方种群还是北方种群,栖息于纬度较高的宁波海区的青蟹个体其鳃、肝胰腺和肌肉测得的呼吸代谢指标都大体上高于栖息于纬度较低的儋州海区的青蟹个体,位于分布区中部的漳州海区的青蟹个体则介于这两个海区之间。对于南北种群在同一海区的比较,3个海区的测定结果都表明低温季节北方种群的呼吸代谢高于南方种群,特别是在纬度越高的海区,两个种群之间的差异越为显著。在宁波海区,在测定的8项呼吸代谢指标中,鳃有7项、肝胰腺有5项、肌肉有4项测定指标的结果显示出北方种群的代谢水平显著高于南方种群。

在漳州海区，在同样的测定指标中，鳃有8项、肝胰腺和肌肉各有2项测定指标的结果显示出北方种群的代谢水平显著高于南方种群。在儋州海区，只有鳃线粒体呼吸速率和CCO活性的测定结果表现为北方种群个体的代谢水平显著高于南方种群的个体。

3. 拟穴青蟹不同种群高温季节呼吸代谢的比较

与低温季节相比，虽然夏季南方种群和北方种群其鳃、肝胰腺和肌肉测得的呼吸代谢指标在不同海区之间的差异都不太明显，但两个种群呼吸代谢在不同海区的变化模式不一致。对于南方种群，鳃和肌肉呼吸代谢指标的测定结果显示在任意两个海区之间的个体都无差异，肝胰腺呼吸代谢指标的测定结果显示在儋州海区的个体显著高于宁波海区的个体。对于北方种群，鳃和肌肉呼吸代谢指标的测定结果都表现为在宁波海区的个体显著高于在儋州海区的个体，肝胰腺呼吸代谢指标的测定结果则表现为在任意两个海区之间的个体都无差异。至于夏季南北种群在同一海区的比较，鳃和肌肉的测定结果都表现为在宁波和漳州海区中北方种群个体的呼吸代谢高于南方种群的个体，肝胰腺的测定结果则表现为在儋州和漳州海区中南方种群个体的呼吸代谢高于北方种群的个体。

根据上述研究结果，本研究可得出3个结论：（1）拟穴青蟹不同种群的一些呼吸代谢指标存在明显的时空变化。（2）拟穴青蟹南方种群与北方种群对环境温度的适应能力存在不同。（3）拟穴青蟹北方种群比南方种群更适合在低温环境中生活。

关键词：拟穴青蟹；不同种群；呼吸代谢；线粒体呼吸速率；酶活性

Abstract

In previous research, we thought that the mud crab (*Scylla paramamosain*) in China could be divided into “southern population” and “northern population” and these two populations had difference in the adaptive capacity to environmental temperature. To further confirm this viewpoint, the present study was set out to measure and compare mitochondrial respiratory rate and several respiratory enzyme activities (i.e. cytochrome C oxidase (CCO), adenine triphosphatase (ATPase), lactate dehydrogenase (LDH), pyruvate kinase (PK) and hexokinase (HK)) of gill, hepatopancreas and muscle between these two populations of *S. paramamosain* sampled from Ningbo, Zhangzhou and Danzhou site during different seasons. The outcomes of this research could provide scientific basis for both management of aquaculture and fisheries of *S. paramamosain* in China. The following results were obtained:

1. Comparison of respiratory metabolism among different populations of *S. paramamosain* collected from middle section of its distribution area

The changes in respiratory metabolism during seasonal acclimatization were pronounced for both southern and northern population collected from middle section of its distribution area, but the patterns of seasonal changes were different between these two populations. For example, for the crabs of southern population, the highest mitochondrial respiratory rates of gill and muscle were detected in autumn and little differences in mitochondrial respiratory rates were detected among other three seasons. For the crabs of northern population, the mitochondrial respiratory rates of gill in winter and autumn were higher than those in spring and summer, and variations in the mitochondrial respiratory rates of muscle over four seasons were less obvious. For comparison of a same season between southern and northern population, with the exception of autumn, all the results of gill, hepatopancreas and muscle showed that a certain degree of differences in respiratory metabolism were observed between southern and northern population. Especially in low temperature winter, all the

measuring respiratory metabolism indexes (i.e. state 2 and state 3 respiration rates measured using either succinate or pyruvate + malate as the substrate, mitochondrial CCO, Na⁺K⁺-ATPase, Ca²⁺-ATPase and Ca²⁺Mg²⁺-ATPase activities) in the gill of the crabs of northern population were significantly higher than those of the crabs of southern population.

2. Comparison of respiratory metabolism among different populations of *S. paramamosain* in low temperature season

Comparing crabs collected from 3 locations at different latitudes in low temperature season, a similar pattern of latitudinal variations was detected for both northern and southern population. That is, the highest and lowest respiratory metabolism indexes of gill, hepatopancreas and muscle were detected from the crabs collected from Ningbo (the highest latitude of all 3 sampling sites) and Danzhou (the lowest latitude of 3 sampling sites), respectively while the crabs collected from Zhangzhou were in-between. For a same collection site, when results of crabs of northern and southern population were compared, the respiratory metabolism of northern population was always higher than that of southern population in any sampling site in low temperature season. Especially at higher latitude, the differences of respiratory metabolism were more pronounced between southern and northern population. In Ningbo, among 8 measuring respiratory metabolism indexes, the results of 7 indexes of gill, 5 indexes of hepatopancreas and 4 indexes of muscle indicated that the metabolic levels of northern population were higher than those of southern population. In Zhangzhou, among the same measuring indexes, the results of 8 indexes of gill, 2 indexes of hepatopancreas and 2 indexes of muscle again indicated that the metabolic levels of northern population were higher than those of southern population. In Danzhou, only the measuring results of mitochondrial respiratory rates and CCO activity of gill showed that the metabolic levels of northern population were higher than those of southern population.

3. Comparison of respiratory metabolism among different populations of *S. paramamosain* in high temperature season

For both southern and northern population, the latitudinal changes in respiratory

metabolism indexes of gill, hepatopancreas and muscle were less pronounced in summer when compared to low temperature season, but the patterns of latitudinal changes were different between these two populations. For the crabs of northern population, the results in gill and muscle showed that the respiratory metabolism in Ningbo was higher than that in Danzhou, and no difference in the respiratory metabolism indexes of hepatopancreas was observed between any two sites. For the crabs of southern population, no difference in the respiratory metabolism indexes of gill and muscle was observed between any two sites, and the results in hepatopancreas showed that the respiratory metabolism in Danzhou was higher than that in Ningbo. When comparing between northern and southern population from a same location in summer, the results in gill and muscle showed that the respiratory metabolism in the crabs of northern population was higher than that of the crabs of southern population in both Ningbo and Zhangzhou, but the results in hepatopancreas showed that the respiratory metabolism in the crabs of southern population was higher than that of the crabs of northern population in both Danzhou and Zhangzhou,

According to result of above study, this study came to three conclusions: (1) Some respiratory metabolism indexes of different populations of *S. paramamosain* had obvious spatial and temporal variation. (2) Southern and northern population of *S. paramamosain* had difference in the adaptive capacity to environmental temperature. (3) Northern population of *S. paramamosain* adapted better to low temperature than southern population.

Keyword: *Scylla paramamosain*; Different population; Respiratory metabolism; Mitochondrial respiratory rate; Enzyme activity.

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