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大黄鱼声学特性和声驯养研究

Research on acoustic characteristics and acoustical culture for large yellow croaker

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摘　要

　　大黄鱼是我国特有的优质、高值经济鱼类，是目前中国网箱养殖的主要鱼类之一。近年来，随着海洋运输、港口建设、水下爆破工程作业等日益频繁，浅海网箱养殖环境日益恶化，大黄鱼养殖出现死亡率高、生长缓慢、成熟个体小型化、抗逆性差的种质退化现象，严重制约了大黄鱼养殖业的健康发展。本课题拟从鱼类声学角度出发，深入分析大黄鱼的声学特性，探索在开放海域中开展大黄鱼声学驯养的方法，有效改善大黄鱼种群质量，为大黄鱼养殖提供一种更加健康、高效和安全的生产模式。

研究主要内容：

1、采用水下光学、声学相结合的监测手段，应用短时傅立叶变换、连续小波变换等时频联合分析的信号处理方法提取大黄鱼发声信号参数，研究不同成长阶段大黄鱼在不同状态下的发声特性，建立发声信号特征参数与行为活动之间相对应的数据库；

2、通过回放已记录的大黄鱼的各种声学信号或者发射具有不同频率、样式和强度的人工合成信号开展大黄鱼的声应激性研究，测定大黄鱼的声学响应灵敏度，培训大黄鱼对特定声学信号的条件反射；

3、设计一套大黄鱼的声学驯养系统和用于监测大黄鱼野外声学驯养效果的远程、实时监测系统；

4、在以上工作取得积极成果的基础上，尝试开展野生大黄鱼的声学引诱、驯化和受培训大黄鱼的声学驯养实验，获取大黄鱼声学驯养的第一手资料。

通过海上现场养殖网箱、室内育苗场的实验，较为全面地了解了大黄鱼在自由游动、进食、产卵、受惊吓等状态下发出的不同声学信号；描绘了大黄鱼的声学响应灵敏度曲线；观察到大黄鱼对不同声信号刺激的应激反应；验证了大黄鱼对声信号具有记忆能力以及对大黄鱼实施野外声学驯养是切实可行的；此外，还建立了一个用于估计大黄鱼鱼群量的声学反向散射积分模型；研制了一套基于双频环形多波束探测技术的鱼群量远程实时监测系统，通过了海上现场实验测试。

　　　　大黄鱼；声学特性；声驯养；鱼群监测

Abstract

Large yellow croaker is a kind of high-quality, high-value fish, and is one of the major cage-cultured fish in China. In recent years, with the rapid development of the marine transportation, port construction and underwater engineering, the cage-cultured environment in shallow sea is increasing deterioration. As a result, The genetical characterization decline of cage-cultured large yellow croaker, such as decreasing of disease-resistance, quality, adaptability to environment and miniaturizaiton of sex mature body size, became more and more serious. It has seriously hampered the healthy development of the aquaculture industry of large yellow croaker. To the problem, this paper intends to explore the feasibility of acoustic domestication of large yellow croaker in the open sea, and to provide a new fishery production mode of more healthy, efficient and safety.

The main contents:

1. The way combining of optics and acoustics was used to record the behaviors and vocalization of large yellow croaker. The parameters of the acoustic characteristics of large yellow croaker with the different ages and behaviors were extracted by the application of the digital signal processing methods of short-time Fourier transform and continuous wavelet transform. Then established a database related to the acoustic characteristics'parameters and behaviors of large yellow croaker.

2. To measure the acoustic response sensitivity of large yellow croaker by playing back the recorded fish vocalization or emitting synthetic signals with different frequencies, waveforms and intensities, and to train large yellow croaker to establish a conditioned reflex on a special acoustical signal.

3. To design an acoustical domestication system for large yellow croaker and a remote monitoring system to monitor the state of fish school and estimate the fish amount real time when the acoustic domestication in the open sea developes.

4. Based on the above works, try to carry out the acoustic lure and domestication of large yellow croaker in the open sea, and to obtain first-hand information on the acoustic domestication.

By means of the experiments in the field of breeding cages and nursery grounds, we had a more comprehensive understanding of the acoustic characteristics of large yellow croaker on the different behaviors, such as free swimming, feeding, spawning, and the frightened state, described the sensitivity curve of acoustic response, and proved the feasibility of acoustic domestication of large yellow croaker in the open sea. In addition, the paper established an acoustic backscatter integral model of large yellow croaker to estimate the amount fish stocks, and developed a remotely real-time monitoring system for large yellow croaker based on the technique of circular multi-beam detection with dual working frequencies.

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