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Research on the Auditory Characteristics of Fish

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Abstract

There are more than 30,000 fish species discovered so far, but only a small part have been studied so far. People have always wanted to clarify the relationship between the hearing sensitivity of a fish and its evolution and classification, but it is still impossible to accurately predict the auditory characteristics of a fish based on the available data. It is necessary to grasp the auditory characteristics of the target fish species before establishing an acoustic domestication marine ranch. Judging from the available data, bone swim bladders such as Cyprinus are the most sensitive to hearing, swim bladder fish without maws, such as plaice adults, have poor hearing perception, and other non-bone swim bladders such as cod-shaped adults have poor hearing sensitivity. Somewhere in between.

Keywords

Fish; Acoustic; Auditory.

1. Introduction

Two thousand years ago, the ancient Roman scholar and naturalist Gaius Plinius Secundus wrote in his "Natural History": Fish have no external ears, and there are no holes related to hearing in their bodies, but they do. Hearing the sound can confirm this. Every day the fish farmers clap their hands while throwing bait into the water in order to gather the fish in groups. The effect is very good. In addition, it is further mentioned that mullet (Myxocyprinus asiaticus), pike (Esociformes), and cod (Gadus) are the most sensitive of hearing among fishes, but they are less and less in the shallow sea [1]. The famous British fishing enthusiast Walton also found that if a person can gently walk to the fishing place, the fish will not notice the sound of the angler's walking, and will not be scared away.

The earliest research on fish hearing may be done by G. H. Parker in 1903. He first scientifically explained that fish can perceive sounds. Karl Von Frisch, who won the Nobel Prize for discovering bees dancing[2-3], and his student Dijkgraaf did a lot of research on fish hearing, and proposed for the first time fish hearing threshold and The measurement method of signal discrimination ability.

However, the systematic study of fish hearing started from "Marine Bioacoustics" (1964) and "Marine Bioacoustics II" (1967) edited by Dr. William N. Tavolga in the 1960s. In two monographs, he delineated the research scope for today's marine biological acoustics: hearing, sound propagation theory, hydroacoustics, etc. He also particularly emphasized that researchers should conduct research on all aquatic organisms that have an impact on the marine acoustic environment, from invertebrates to marine mammals. Since the publication of these two books, the field of marine bioacoustics has developed unprecedentedly[4]. The introduction of psychology, population biology, evolution, biomechanics, acoustics, mathematical models and other disciplines has allowed Dr. Tavolga to

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answer some of the questions in the two monographs, but new questions are emerging one after another, such as the differences in the auditory organs of different fish species How do auditory organs such as inner ear, lateral line and fish swim bladder coordinate to produce hearing; how fish can distinguish the direction of the sound source and determine the location of the sound source in a complex underwater acoustic environment, and so on, these have not been fully grasped so far.

2. The auditory characteristics of fish

There are more than 30,000 fish species discovered so far, but only a small part have been studied so far[5]. People have always wanted to clarify the relationship between the hearing sensitivity of a fish and its evolution and classification, but it is still impossible to accurately predict the auditory characteristics of a fish based on the available data. It is necessary to grasp the auditory characteristics of the target fish species before establishing an acoustic domestication marine ranch.

The study of fish's auditory characteristics is mainly to study the threshold of hearing and the critical ratio.

Hearing threshold refers to the minimum sound pressure value at which fish can hear a sound, which is the most basic in fish hearing research. The main methods of testing hearing threshold are[6-10]:

1. Electrocardiogram (ECG) is used as a conditioned sound and an electric shock as an unconditional stimulus to domesticate the fish, so that the fish can remember the sound, and then only the sound is played. According to the electrocardiogram ((Or operculum movement) to determine the fish’s response to sound;

2. Auditory brainstem response (ABR) derives the action potential of the nerve from the fish’s central nervous system, and judges the fish’s response according to the change in the potential Stimulus response;

3. Behavior method (behavior method), combined with sound and bait or props intimidation, using fish's conditioned reflex (bait lure or escape from props) to judge fish response to stimuli. In recent years, the first two methods have been used more frequently.

Judging from the available data, bone swim bladders such as Cyprinus are the most sensitive to hearing, swim bladder fish without maws[11], such as plaice adults, have poor hearing perception, and other non-bone swim bladders such as cod-shaped adults have poor hearing sensitivity. Somewhere in between.

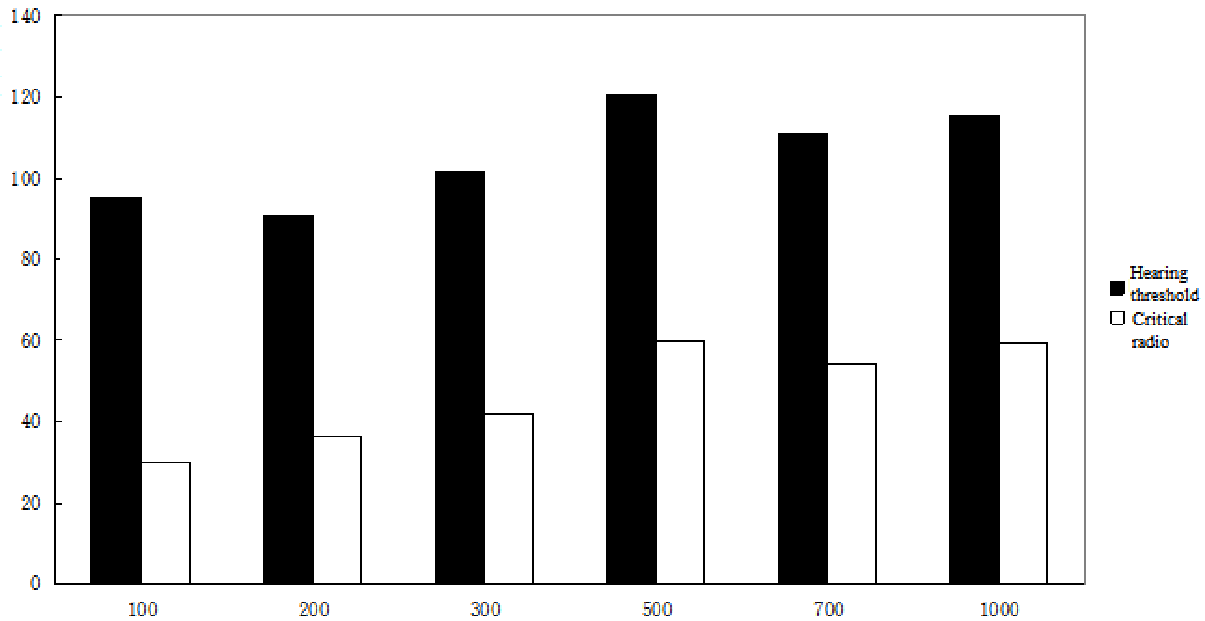

Fig 3-1 The Critical radio and hearing threshold of Sebastes schlegeli

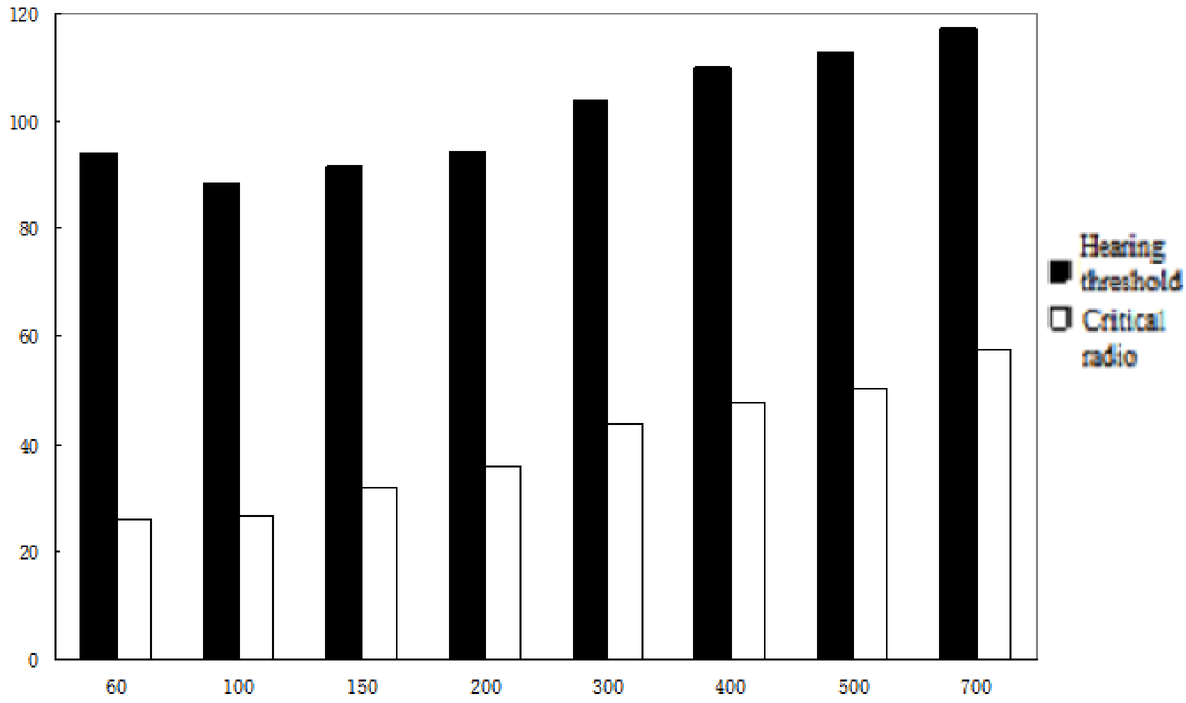

Fig 3-2 The Critical radio and hearing threshold of Limanda aspera

The ocean is different from the experimental pool, and the noise situation is very different, especially when we want to build the shallow water area of the sound domesticated ocean ranch. When the environmental noise sound pressure reaches 70 dB, the critical ratio of the target fish species must be considered. The ratio is equal to the difference between the hearing threshold under the interference of white noise and the white noise, which represents the relationship between fish hearing and noise. Generally speaking, the critical ratio increases with the increase of the sound frequency. It is about 15-30 dB in the frequency range below 500 Hz that this article focuses on. That is to say, the signal intensity is 15-30 dB greater than the noise intensity[12], and the target fish species It is possible to distinguish the signal in a noisy environment.

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