Preliminary study on measuring activity of the red-spotted grouper, *Epinephelus akaara*, using a novel acoustic acceleration transmitter.

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ABSTRACT

It is difficult to directly observe the behavior of fish in the natural environment. Acoustic telemetry is a powerful tool used to clarify spatial movement patterns of several fish species in the natural habitats successfully over decades. Recently, a new type of transmitter installed with an accelerometer allows us to measure fish activities using acoustic telemetry. In this paper, we introduce preliminary results of the tank experiment using acoustic acceleration transmitters. We inserted an acoustic acceleration transmitter (AccelTag, Thelma Biotel, Trondheim, Norway) into the body cavities of red-spotted groupers (*Epinephelus akaara*) under anesthesia. During the tank experiment, we observed the fish activity simultaneously using a video camera. The result showed that the period during which the fish were active or inactive could be determined using the acceleration acoustic transmitters.

KEYWORDS: activity indices, sit-and-waiting type predator, telemetry

INTRODUCTION

Monitoring fish behavior in the natural environment is important to enable an understanding of their ecology. However, it is difficult to directly observe fish behavior underwater. Many tools have been used to understand fish behavior underwater including SCUBA, micro data-loggers and acoustic telemetry (Itani *et al*. 2005, Kayano *et al*. 2001, Tanaka *et al*. 2001). Recently, a novel acoustic transmitter with a tri-axis accelerometer has been developed and allows us to measure the acceleration from fish movement. Some studies have already used this acceleration transmitter to estimate fish activity in the field (Murchie*et al*. 2011, O'Toole *et al*. 2010).

Because the acoustic transmitter sends information through ultrasonic signals as a carrier, it cannot transmit too much information at one time. Thus, the information must be converted to simple acoustic signals prior to transmission. When converting the information into acoustic signals, we must choose the parameters which best describe the fish movement in order to understand the behavior of the target species. Furthermore, it is difficult to extract the specific behavior using only one pattern processing, because of the great diversity in fish ecology.

Although there are some recognized patterns of fish behavior, we focused on the sitting-and-waiting type predator in this paper. The sitting-and-waiting type predator is often associated with many kinds of commercially important fish species (e.g., flat fish, red-spotted grouper, etc.). Additionally, the movement pattern of the sitting-and-waiting predator might be relatively easy to extract by recording measurements of activity indices.

To estimate the activity indices, transversal direction and pitch angle were chosen for the same parameters as in Føre *et al.* (2011). Transversal acceleration fluctuation can reflect the tail beat when fish move their tails and generate locomotion. The pitch angle derived from the fish body angle will change when the fish swim. The objective of this study is to examine whether the acceleration of acoustic transmitters describe the activity of the sitting-and-waiting predator in the fish tank, using the red-spotted grouper (*Epinephelus akaara*) as a model species (Fig. 1). For this purpose, we attempted to compare the signal intervals of transmitters with the fish activity.

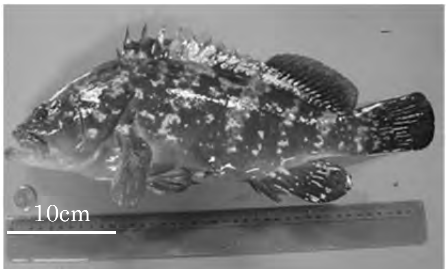

Fig.1. Red-spotted grouper used in the tank experiment

MATERIALS AND METHODS

The tank experiment was conducted on July 11, 2011. Two red-spotted groupers collected in Osaka Bay, Japan, were used in this experiment (Fig. 2).

The total body lengths of two fish were 42.7cm and 39.2cm and the body weights were 1140g and 870g, respectively. The continuous acceleration acoustic transmitters (AccelTag, ThelmaBiotel, Trondheim, Norway) used in this study were cylindrical, 9mm in diameter and 39mm long. The acoustic transmitters convert the 3-axes acceleration measured with the accelerometer into signal intervals and send the signals by the intervals corresponding to the activity indices. The signal intervals ranged from 1000 to 5000ms. The signal interval came close to 1000ms if the acceleration intensity was large while it came close to 5000ms if the acceleration intensity was small. An acoustic acceleration transmitter was surgically implanted into the fish abdominal cavity under anesthesia. After surgery, each tagged fish was released into the fish tank and monitored using a receiver (VR100, AMIRIX Systems Inc., Halifax, Canada) and video camera. The receiver recorded the signals of each transmitter that alternately emitted 66 and 72 kHz frequency. The video camera was set on the fish tank and recorded the fish behavior from the top of the tank. We used the video data to distinguish the periods when the fish was active or inactive. The data were collected over 30 min for each individual fish. We observed how the signal intervals changed when the fish were active and inactive.

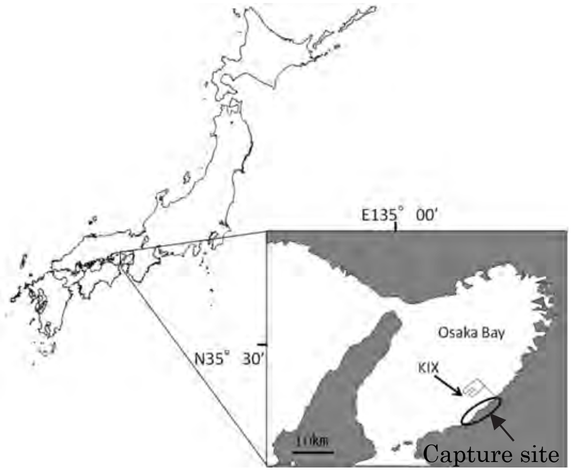

Fig.2. Location of Osaka Bay, Japan. The open circle shows the capture site around the Kansai International airport

RESULTS AND DISCUSSION

During the observation, the two fish with implanted transmitters displayed normal behavior in the tank. Because of this, we believed that they had recovered from the trauma of the surgery process. The maximum signal intervals were recorded at 4798ms, 4751ms, and the minimum values were 1021ms, 1048ms, respectively. The signal intervals were consistent, recorded at 5000ms intervals when the fish were inactive, while the intervals decreased into 1000ms periods immediately after they became active (Fig. 3). This pattern demonstrated that the signal intervals of acceleration transmitters reflected the change of fish movement from inactive to active (Fig. 3, 4). When fish stop moving, the signal intervals increased from 1000ms to 5000ms gradually, in spite of the fish completely stopping. This might be due to the time constant detecting the peak of the activity.

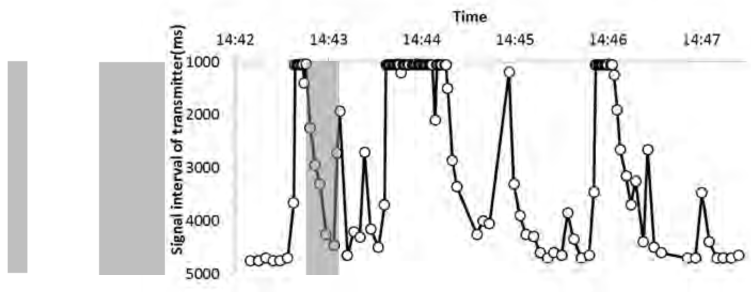

Fig. 3.The signal intervals of the acceleration acoustic transmitters (Fish#1).

The gray bands show the period when the fish was active. When the fish moves actively, the signal interval approaches 1000 ms. When the fish moves inactively, the signal interval increases and approaches 5000ms.

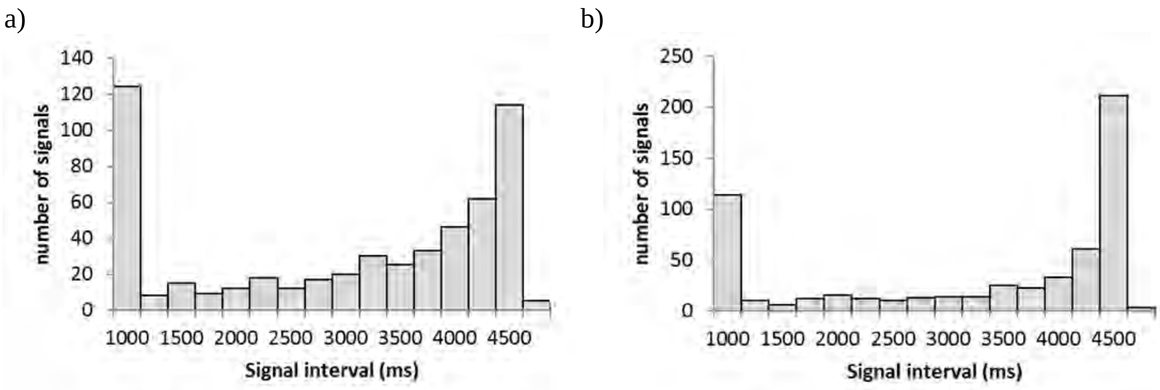

Fig.4. Histogram of signal interval of acceleration transmitter. a) fish #1 , b)fish #2 .

The half number (41%, 54%) for detection of signal intervals was more than 4000ms (Fig. 4). This suggests that red-spotted groupers were inactive during this half of the monitoring time. On the other hand, the detection number (28%, 25%) of approximately 1000ms grew larger because the transmission frequency got higher when the signal interval became shorter. In the histograms, the signals of 2000 to 3000ms intervals were not received often. This was because the calculating process of acoustic acceleration transmitters was too sensitive to detect the medium activity level. To estimate the amount of activity levels more gradually, the setting of calculating transmitting values should be adjusted to be less sensitive.

CONCLUSION

Our study showed that the period when the fish were active or inactive was determined using the acceleration acoustic transmitters. In this experiment, the setting converting the acceleration into acoustic signals was too sensitive to estimate the amount of activity level. However, the setting can be adjusted to be less sensitive in order to better reflect the medium activity indices.

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