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Detection of Shellfish in the Sediment Using Acoustic Coring System with 1-MHz Focus Probe

1-MHz 収束プローブ搭載の音響コアリングシステムによる堆積層内の貝の検出

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1. Introduction

Ruditapes philippinarum called *asari* in Japanese is one of the important clams as fishery resource in Asia, and it has purification function in water. However, the number of *asari* has dramatically reduced due to deterioration of their habitat [1]. Therefore, revealing their distribution and life in the sediment are required for ecological assessment of *asari*.

Adaptations of acoustic sensing to detect or identify aquatic organism have increased. For example, side scan sonar and high-resolution acoustic imaging sonar were used to map or monitor aquatic organisms on the seafloor [2, 3]. On the other hand, there are few studies of acoustic sensing to detect aquatic organisms in the sediment. In general, it is difficult to detect small object like shellfish in the sediment by standard acoustic sensing. Therefore, we have developed a new sensing method and succeeded to detect *asari* in the sediment using 1-MHz focus ultrasound [4]. Furthermore, we reported the importance of incident angle of acoustic wave for effective *asari* detection. Backscatters from the sediment surface often masks that from *asari*, however, oblique incident reduces backscatters from sediment surface.

The objective of this paper is to assess the backscatters from *asari* in the sediment through the three-dimensional acoustic image. The images are constructed with high-frequency ultrasound. In addition, acoustic coring system is introduced for efficient measurement. This system was constructed by Mizuno *et al.* [5]. The system enable us to measure backscatters from object automatically with high measurement precision.

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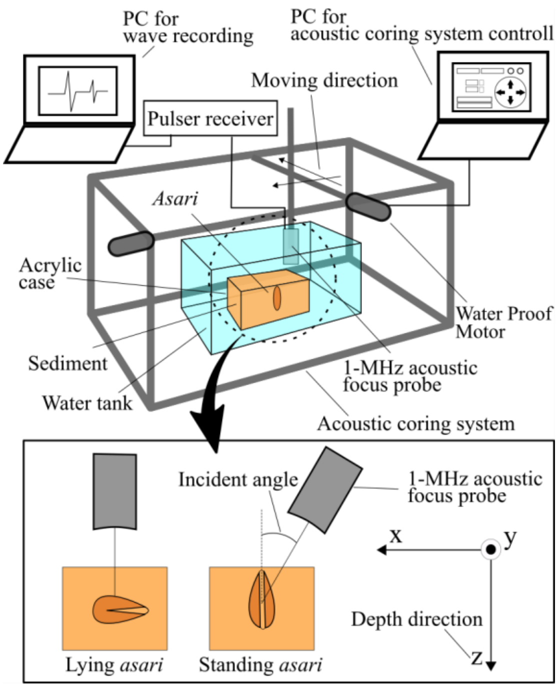

Fig. 1 Experimental set-up

2. Method and Materials

Experimental set-up is illustrated in **Fig. 1**. An acoustic focus probe 25 mm in diameter with a focal length of 38 mm (JAPAN PROBE CO., LTD.) that transmits a square pulse with a central frequency of 1-MHz was mounted on the acoustic coring system. This system automatically scans two-dimensional area along x and y directions with moving accuracy of 100 μm. An acrylic case was set in the water tank and filled with the sand gathered at *Shinji* Lake. The water was degassed. The inside of *asari* was filled with silicone rubber. The size of *asari* was 38 mm in a maximum length. One *asari* was artificially buried in sediment. The probe scanned square area (30 mm in x direction and 40 mm in y direction) at interval of 1 mm and the backscatters were recorded on a personal

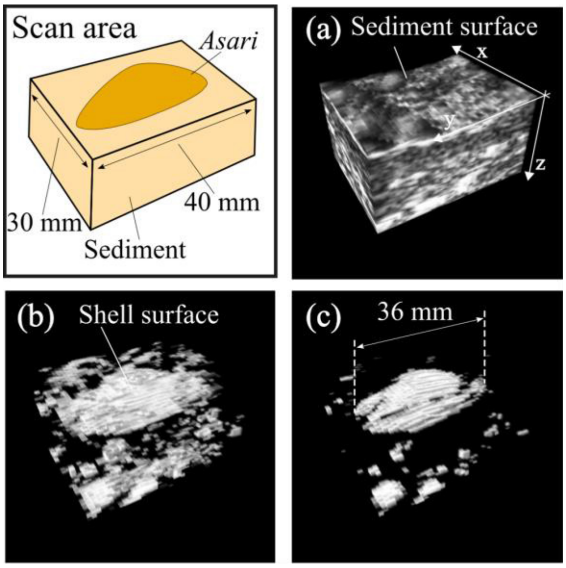

Fig. 2 Three-dimensional acoustic images of lying *asari* with 0° incident angle ultrasound. The images show the backscatters beyond the threshold value.

computer. Two types of experimental conditions were prepared. One is the detection of *asari* in a lying position with 0° incident angle ultrasound and the other is that in a standing position with 30° incident angle ultrasound.

3. Results and Discussion

Figure 2 shows three-dimensional acoustic images of lying *asari*. Stronger backscatters are shown as brighter levels. Here, sound attenuation caused in the sediment was corrected. Attenuation of pressure amplitude p follows exponential decrease depending on the z distance:

$$p = p_0 e^{-\alpha z} \quad (1)$$

where, p_0 is pressure at the sediment surface and α is the attenuation coefficient. The shell-shape can be clearly seen in Fig. 2 (c). The maximum length of shell in the image was 36 mm. It is close to the length directly measured (= 38 mm). **Figure 3** shows the three-dimensional acoustic images of standing *asari* with 30° incident angle ultrasound. The backscatters from shell surface of standing *asari* were also detected. However, shell surface shown in Fig. 3 is not as clear as that in Fig. 2. It is suggested that the characteristic shell-shape strongly affects the acoustic scattering from asari.

4. Conclusion and Future Work

In this study, we assessed backscatters from the *asari* in sediment through the three-dimensional

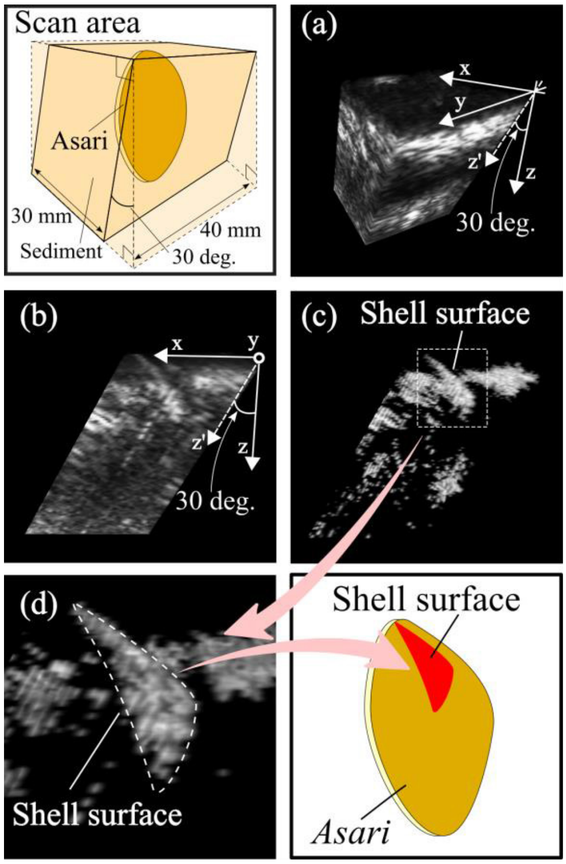

Fig. 3 Three-dimensional acoustic images of standing *asari* with 30° incident angle ultrasound. z' direction corresponds to the central axis of the probe. (a) and (b) show the hall scan area. (c) shows the backscatters beyond the threshold value.

acoustic image. The acoustic image provided us clearer image of *asari* than two-dimensional image. However, detection of standing *asari* was sensitive and the measurement method needs to be improved. We assume that the characteristic shape of *asari* and porous structure of sediment makes it difficult to make acoustic image. Thus, in future, we are going to reveal the mechanism of scattering in sediment and reflection from the shell through the experiment and the acoustic simulation. Our goal is to develop a new acoustic sensing system for *asari* detection. We strongly believe that this system largely contribute to fishery and hydrobiology field.

References

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