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Proceedings of Symposium on Ultrasonic Electronics, Vol. 30 (2009) pp. 167-168
18-20 November, 2009

Acoustic Characteristics of Pure Snapping Shrimp Noise Measured under Laboratory Conditions

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1. Introduction

The ambient noise in the ocean shows very different dependence on marine life as well as wind, rainfall, snow, hailstorm and shipping. The sources of ambient noise in the deep ocean are made clearly from the summary of a large amount of data measured in the 1940s[1)]. According to this summary the main sources of ambient noise were distant shipping and ocean surface wind. The ambient noise in the coastal sea is more complicated than the noise in the deep ocean due to the breaking wave and the marine life as well as the shipping and the wind. Since the biological noise due to the marine life has very high diurnal dependence and seasonal variation, it can greatly affect on a change of ambient noise than the others[2)]. Especially it is well known that the noises of dolphin and snapping shrimp affect on a sonar ping signal[2)]. In the coastal sea where the snapping shrimp lives, its noise always exists with ambient noise such as the shipping noise and the wind noise. Therefore the snapping shrimp noise can more influence on the ambient noise and the sonar detection performance than the dolphin noise. Because of this reason many researchers measured and analyzed the snapping shrimp noise[2-3)]. In this study, we analyzed typical temporal waveform and frequency spectrum of snapping shrimp noise measured under laboratory conditions.

2. Experimental Measurements

To analyze the snapping shrimp noise, we carried out collection of the snapping shrimps at sites on the coastal sea of Korea. **Figure 1** shows pictures of four species of snapping shrimps captured in the coastal sea of Korea.

A schematic diagram of the experimental setup for acoustic measurements of the snapping shrimp noise is shown in **Fig. 2**. Individual snapping shrimp was located at a center of anechoic water tank with a volume of 300 x 600 x 360 mm^3. A hydrophone (Reson, TC4013) was also lowered near the snapping shrimp. The snapping shrimp noise received from the hydrophone was amplified through a measuring amplifier (B&K 2636) and stored by a digital oscilloscope (LeCroy LT264M).

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Fig.1 Four species of snapping shrimps captured at sites on the costal sea of Korea.

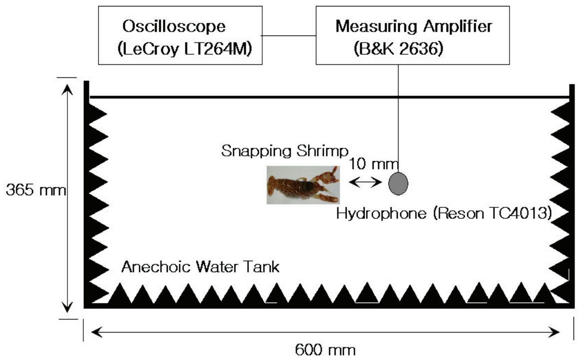

Fig.2 Experimental setup for measurement of snapping shrimp noise.

3. Results and Discussion

Figure 3 shows the typical temporal waveform and the time frequency spectrogram of snapping shrimp noise. The waveform has very sharp peak pressure amplitude, and then its spectrogram shows very broadband frequency response up to about 140 kHz. Recently, Versluis *et al.* were carried out an experiment to investigate the source of snapping shrimp noise[4)]. They reported that the snapping shrimp noise emitted by the collapse of a cavitation bubble that is generated by the high speed water jet resulting from the rapid claw(large claw) closure. Based on their report, we can understand that the amplitude curve at 0.85 ms in Fig. 3 is occurred by the snapper claw closure and the sharp peak amplitude at 1.2 ms occurred by the collapse of the cavitation bubble.

Figure 4 shows the typical temporal waveform for the noise of an individual snapping shrimp in Fig 1. As shown in Fig. 5, the snapping shrimp noise waveforms appeared similar shape each other. However, the necessary time to reach the collapse of cavitation bubble from the generation of the bubble due to the high speed water jet was different each other. This time means that the expanded cavitation bubble at initial time is the time required to be maximally compressed. Hence, a long duration time for compression of the cavitation bubble means that the cavitation bubble of large size can be produced by the fast water jet from the snapper claw. These facts can be easily confirmed in Ref. 1. Peak-to peak source levels of snapping shrimp noises in Fig. 4 varied from 204 to 219 dB re 1μPa

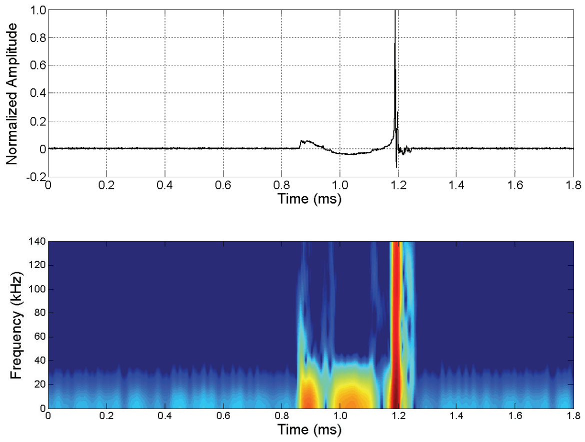

Fig. 3 Typical temporal waveform and time-frequency spectrogram of snapping shrimp noise.

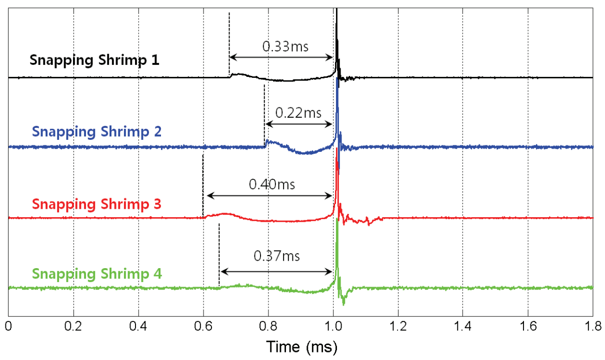

Fig. 4 Typical temporal waveforms for four species of snapping shrimp .

Figure 5 shows a frequency spectrum of snapping shrimp noise over the frequency range from 1 to 100 kHz. As shown in Fig. 5, the frequency response of snapping shrimp noise showed a little different aspect on the species of snapping shrimp. This can be caused by differences of the claw shape of snapper and the size of cavitation bubble. Generally, the spectrum of cavitation noise is composed with a fundamental frequency component and its harmonics[5]. This fact explains oscillation patterns in frequency spectra of the snapping shrimp noises in Fig. 5. The fundamental frequency for the noise of the snapping shrimp 1 in Fig. 5 was 3.5 kHz. It was 5 kHz for the snapping shrimp 2. For snapping shrimp 3 and 4, the fundamental frequency was 3 and 3.5 kHz, respectively. Since the large duration time for compression of the cavitation bubble in Fig 4 means the generation of large cavitation bubble, the fundamental frequency of the cavitation noise for the snapping shrimp 2 in Fig. 5 can be higher than those for other snapping shrimps. For snapping shrimp 3 it can be also lower than those for others.

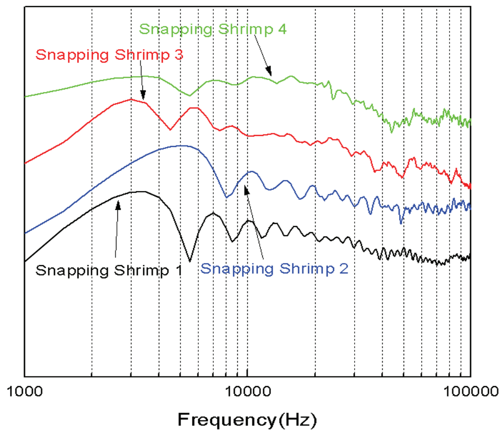

Fig. 5 Frequency spectrum of snapping shrimp noise

4. Conclusions

We investigated acoustic characteristics of the noises for four species of snapping shrimp. Individual noise waveforms appeared similar shape each other. However, their frequency spectra were differently appeared on the duration time for compression of the cavitation bubble.

Acknowledgment

This work was supported by the project "A study on acoustic characteristics of snapping shrimp noise" (PE98415) at Korea Ocean Research and Development Institute (KORDI).

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