Sound characteristic of *Procambarus clarkii*

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**Abstract.** *Procambarus clarkii* is one of the freshwater lobsters which has its own characteristics. Those characteristics used to identify *Procambarus clarkii* in nature. One of those characteristics is the sound which can be determined using the bioacoustic method. This research uses the bioacoustics method to obtain the sound characteristics from *Procambarus clarkii* considering this species is invasive in Indonesia. Sound characteristic of this species are obtained by processing sound data into FFT value. The results of processing sound data from recording for three days show that *Procambarus clarkii* produces snap sound with an average frequency range from 0.3-0.4 kHz.

1. **Introduction**

Animals produce sound not just to communicate with each other. In certain species, they use sounds to navigate or hunting like bats. They transmit sound as a signal through the air so they can determine either their location or prey. In aquatic life, crustaceans produce sounds as antipredator [1]. The propagations of these sound are faster than in air because the speed of sound in water is 1500m/s. Crustaceans have developed various ways to produce sound even with their limited repertoire [2]. Snapping shrimp, *Alpheus heterochaelis*, even using sound that known as snap sound either to defend their territory or kill their prey [3]. Each sound produced by the crustacea has its own characteristic that distinguish between species. This is due the fact that crustaceans are one of the aquatic creatures that have their own sound characteristics after marine mammals and fishes with swimming bladder [4].

Passive acoustic methods are one of the methods that used in hydroacoustic. These methods used to listen or detect sound whenever the sound passing through measurement area [5]. Passive acoustic methods work better in water because its propagation not disturbed by underwater current [6]. One of the applications of these methods is bioacoustic. Bioacoustic is a discipline that focus on how sound produced by animals, sound dispersion, and how it received include neurophysiology and anatomy for producing sound [4]. This application helps us to determine sound characteristic of crustaceans considering that bioacoustic research is mostly done in marine mammals.

*Procambarus clarkii*, the object of present research is native freshwater lobster species to Mexico and USA that commonly found around the world [7]. This species can be found in almost every freshwater habitat such as lake, river, or swamp in Indonesia. Even nowadays, *P. clarkii* is categorized as an invasive species by Marine and Fisheries Ministry. This due the fact that *P. clarkii* has a very high adaptability to a new environment and its existence can endanger endemic species [8]. Bioacoustic method can be used to determine the location of *P. clarkii* in nature by knowing its sound characteristic. Therefore, this research aims to analyze *P. clarkii*’s sound characteristic using bioacoustic to determine its existence in nature.
2. Methods

This research using *P. clarkii*’s sound data recorded by [9]. This object was obtained in April 2018 from local fish market in Jatinegara. The sound data obtained by recording the sounds of a *P. clarkii* which has the highest sound intensity for three constructive days. It has 5.3cm carapace length and 8.4cm total length. The sound recording done by placing object in a plastic tank (24cm x 12cm x 25cm) in order to minimize noise. Sound recorded by using hydrophone type SQ3 (Figure 1), an underwater microphone, facing towards object at about 5cm which can record sound between 7Hz-220kHz. Hydrophone is an instrument that converts the sound in water so it can be either analyzed or played as an electrical signal [5].

![Figure 1. Hydrophone SQ3.](source: Hisyam 2018)

The sounds data that have been recorded using voice recorder in *.mp3* extensions, separated into each part of repeated sound pattern, which will be analyzed, using Wavelab 6 (www.steinberg.net) program. This separate sound data transformed and extracted into FFT (Fast Fourier Transform) value using spectrum analyzer in Wavelab 6 (www.steinberg.net) program. Data extracted to be separated data with form of extensions *.txt* every 1ms from the beginning to the ending of the repetitive sound pattern. The extracted data is filled in by sound frequency (Hz) and sound intensity (mV) from its FFT value. This data is then combined into single data each sound pattern using Ms. Excel. This data after that are smoothed by an average of each 10Hz. The sound intensity in mV from the smoothed data afterwards is converted into the decibel (dB) using:

$$dB = 20 \log \frac{V_{out}}{V_{in}}$$

In summary, this research procedure is displayed in a flow chart in the Figure 2.
3. Results and discussion

*P. clarkii* (Figure 3) that was observed to produce sound in water, produce snap sound repeatedly from its claws. It produces snap sound, like bubble popping, from time to time every feeding time at sunset. The snap sound is produced due to cavitation bubble. This bubble created by the impact of crustacean’s plunger of dactyl and driven into socket of the propodus [10]. Then the water that already inside the socket is pushed out and created cavitation bubble.

The graphs are created from each smoothed data to show the changes of sound intensity in every change of sound frequency (Figure 4). Each graph shows that the change pattern crated a peak on certain range of frequency. This peak is the main peak of snapping sound which at the same time the collapse of the cavitation bubble [3]. Seven to nine graphs show that the peak of sound intensity occurs at sound frequency between 0.3 kHz to 0.4 kHz (Fig 4b, 4c, 4d, 4f, 4g, 4h, and 4i). The other two graphs have sound intensity peak at frequency between 0.2 kHz to 0.3 kHz (Fig 3a and 3e). There are two peaks of
sound intensity in Figure 4d at frequency 0.3 kHz-0.4 kHz and 0.5 kHz-0.6 kHz. The result displayed by all graphs show *P. clarkii* produces snap sound with sound frequency between 0.3 kHz-0.4 KHz.

**Figure 4.** Relation between snap sound intensity (dB) and frequency (kHz).
Based on previous research conducted by [11] on snapping shrimps show that they have snap sound frequency between 3 kHz to 5 kHz. That result has big gap different from this research because of the morphology that lead to difference quality of cavitation bubble. Snapping shrimp such as *Alpheus heterochaelis* commonly found in coastal area. It has large snapping claw about half of its body size which can produce cavitation bubble with better quality. It mainly uses snap sound to hunting but crustaceans use it as an antipredator [1]. Also, in coastal area sound travel faster than in freshwater that mean in coastal area is noisier as well. Thus, snapping shrimp need to produce louder sound to compete. Even though the difference between in results, both results are snap sound because snap sound frequency generally between 0.1kHz to 200kHz [3].

4. Conclusion

*P. clarkii* produce snap sound as an antipredator. This sound is a result of the collapse of cavitation bubble that produced in impact from dactyl and propodus. *P. clarkii*’s snap sound frequency mostly range between 0.3 kHz to 0.4 kHz. With this result, *P. clarkii*’s existence can be determined using bioacoustic method.

5. References

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