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MARINE ZOOLOGY LAB.

INHA UNIVERSITY

Vibroacoustic communications of the fiddler crabs *Austruca lactea*

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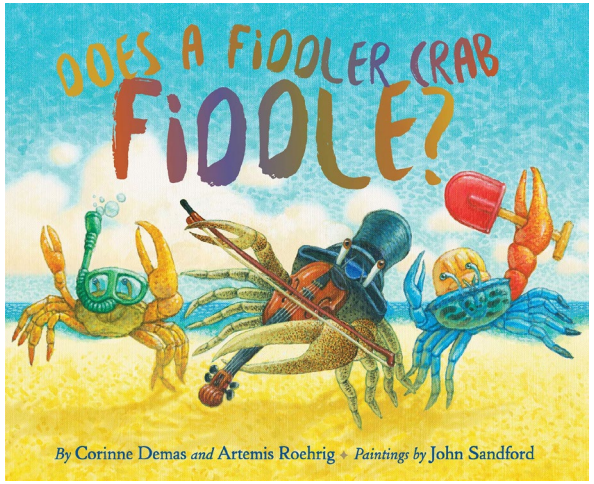
“ Vibroacoustic communications ”

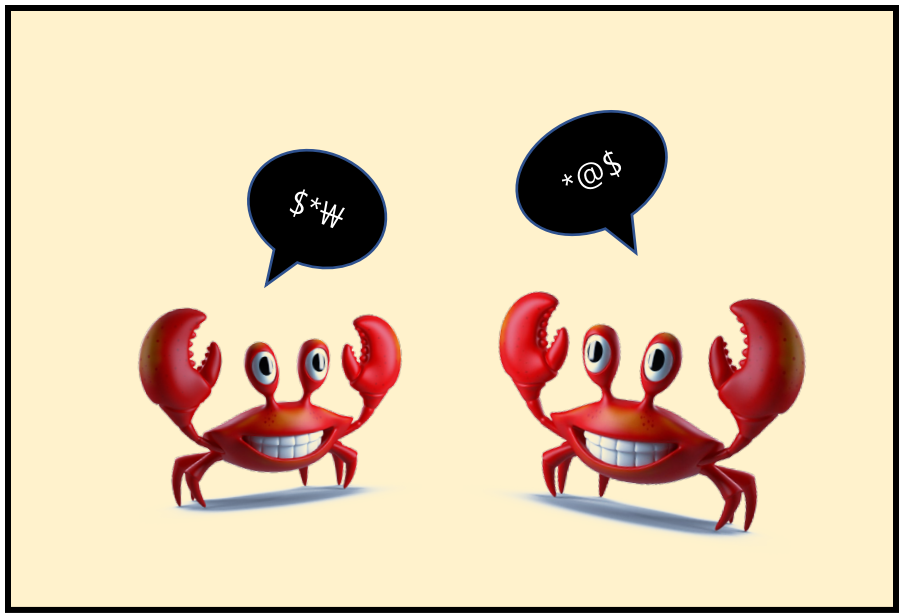
“ Vibroacoustic communications ”

Fiddler crab

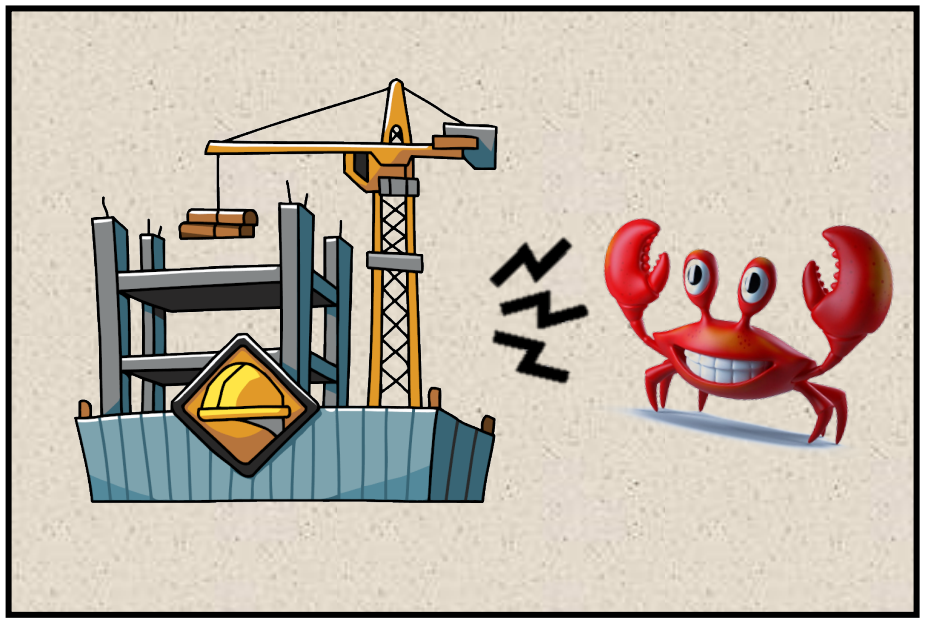


Study topic

① Communication



② Human disturbance (vibration)

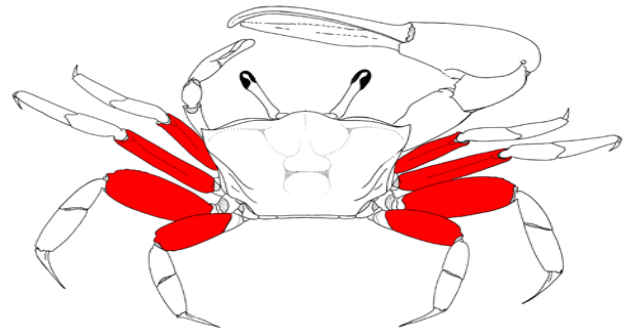


1. Fiddler crabs change their tunes depending on the contexts

Background Vibration mechanisms of Fiddler crabs

<Detection>

- Receptor : Barth's myochordotonal organ in the merus of the walking legs
- Substrate-borne vibration (transmit through solid objects) (Popper et al, 2001)
- Sensitive frequency ranges: **300-700Hz** (Salmon and Horch, 1973; Popper et al., 2001)



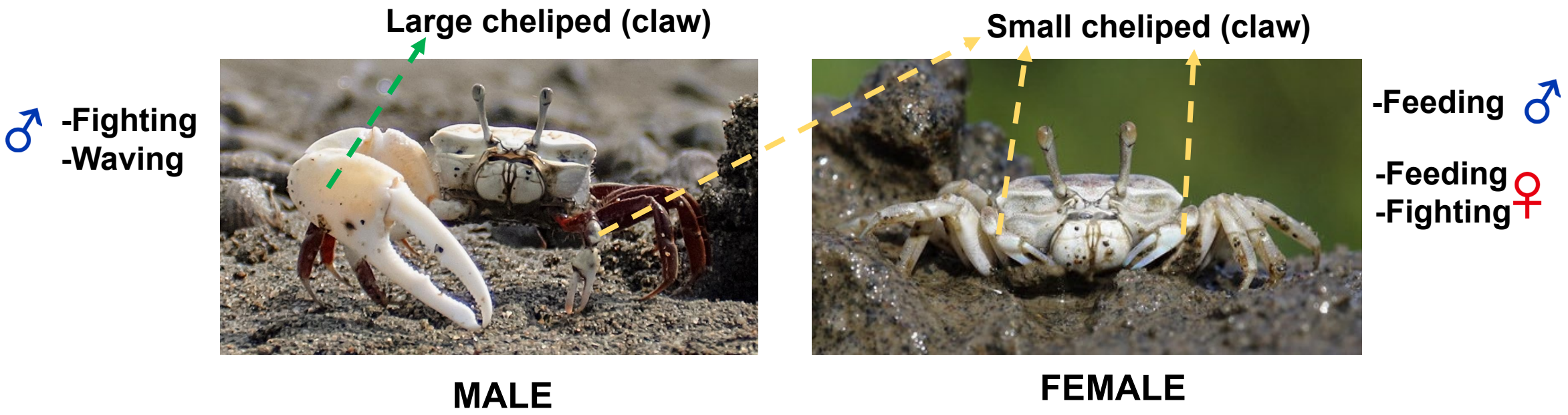
"MERUS"

<Production>

- Percussion of walking legs
- Vibrations of large claw
- Vibrational signals (Frequency range, repetition, amplitude) (Salmon, M. 1967; Takeshita, F., & Murai, M. 2016; Mowles, et al. 2017)

Background *Austruca lactea* (De Haan, 1835)

- **Classification** : Animalia Arthropoda Malacostraca Decapoda **Ocypodidae** ***Austruca***
- **Size** : about 14 mm (carapace width)
- **Habitat** : the upper intertidal zone in the Indo-Pacific
- **Remark** : Endangered species in South Korea
- **Behavior** : vibrational (seismic) communication ⋯



Background

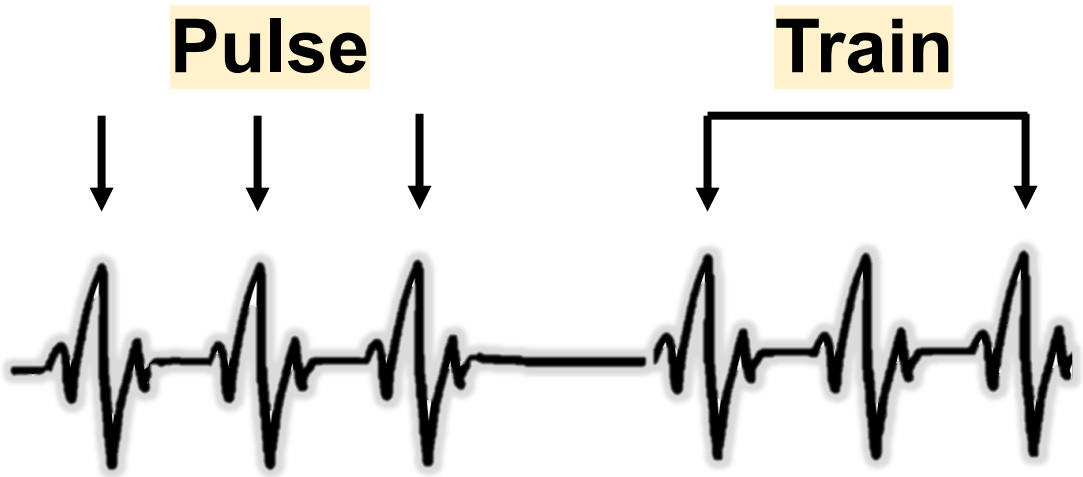
Vibrations of *A. lactea*

Yamaguchi, T. (2001)
Takeshita, F. & Murai, M. (2016)

<Drumming> = **Courtship behavior**

Background Vibrations of *A. lactea*

<Drumming signal>

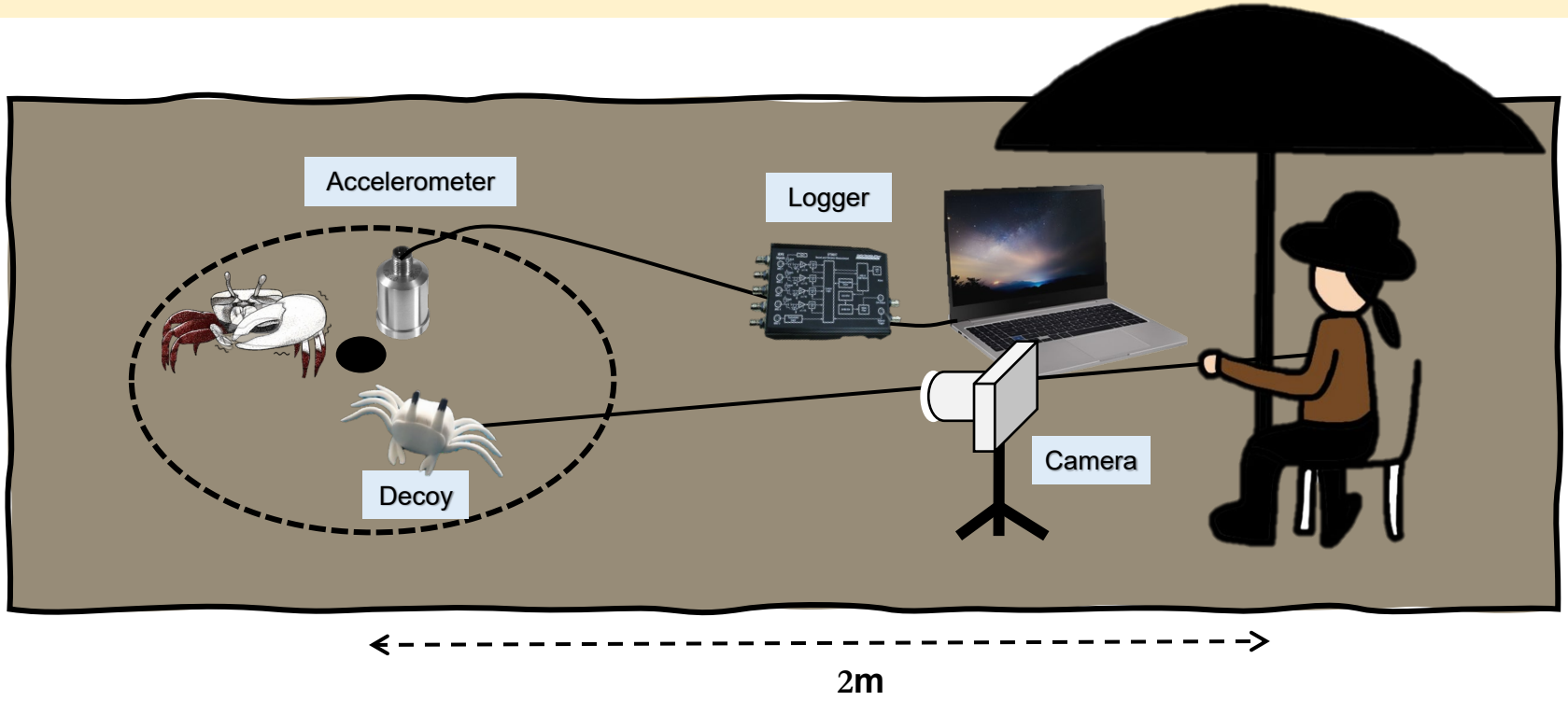


Study site

- Date: May to July in 2021 to 2022 (65 days)
- Time: Diurnal low tide

South korea | Incheon | Intertidal zone

Methods



< Material >

- ✓ Vibration recording: Accelerometer
- ✓ Video recording: Camera
- ✓ The Female decoy

< Data analysis >

- ✓ Band-pass filter → background noise
- ✓ Fast Fourier Transform (FFT) → Frequency
- ✓ Short-Time Fourier Transform (STFT) → Frequency

by MATLAB software (2020)

Methods vibration analysis indicators

① Pulse rate (pulses/s) → pulse velocity

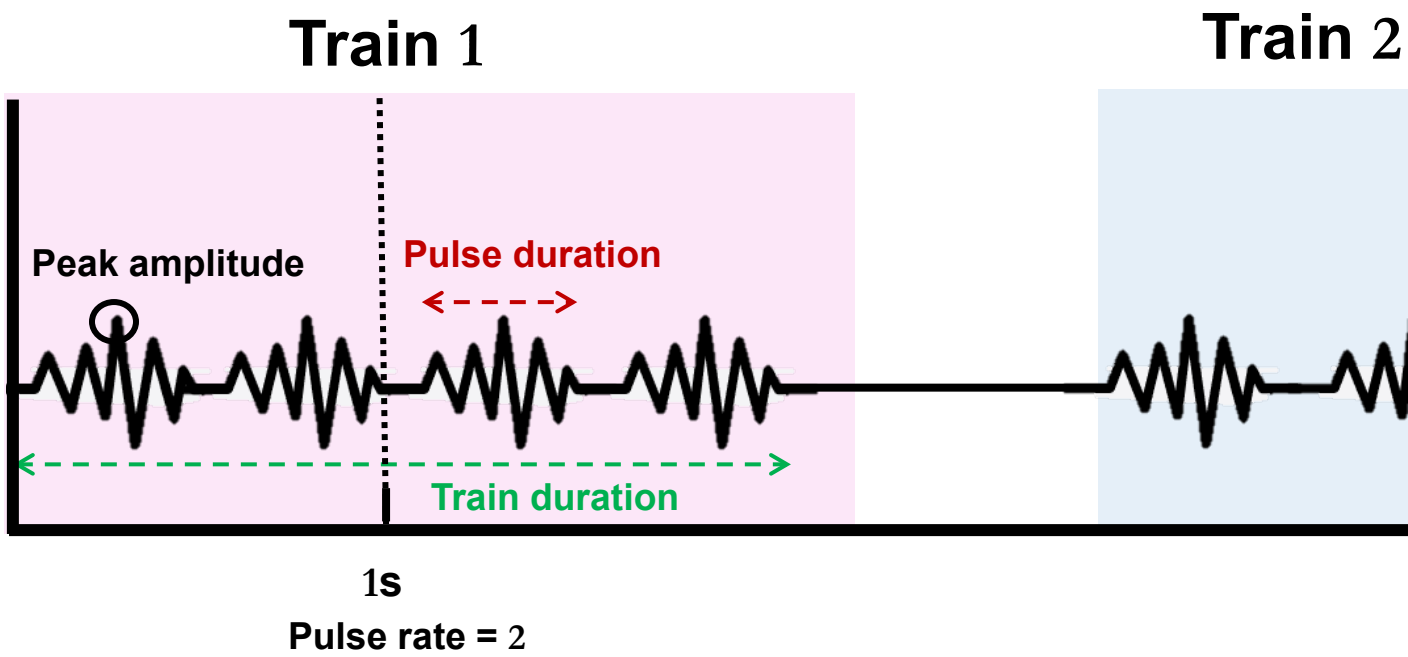
② Pulses per train

③ Train duration (s)

④ Pulse duration (s)

⑤ Peak amplitude (m/s^2)

⑥ Dominant frequency (Hz)

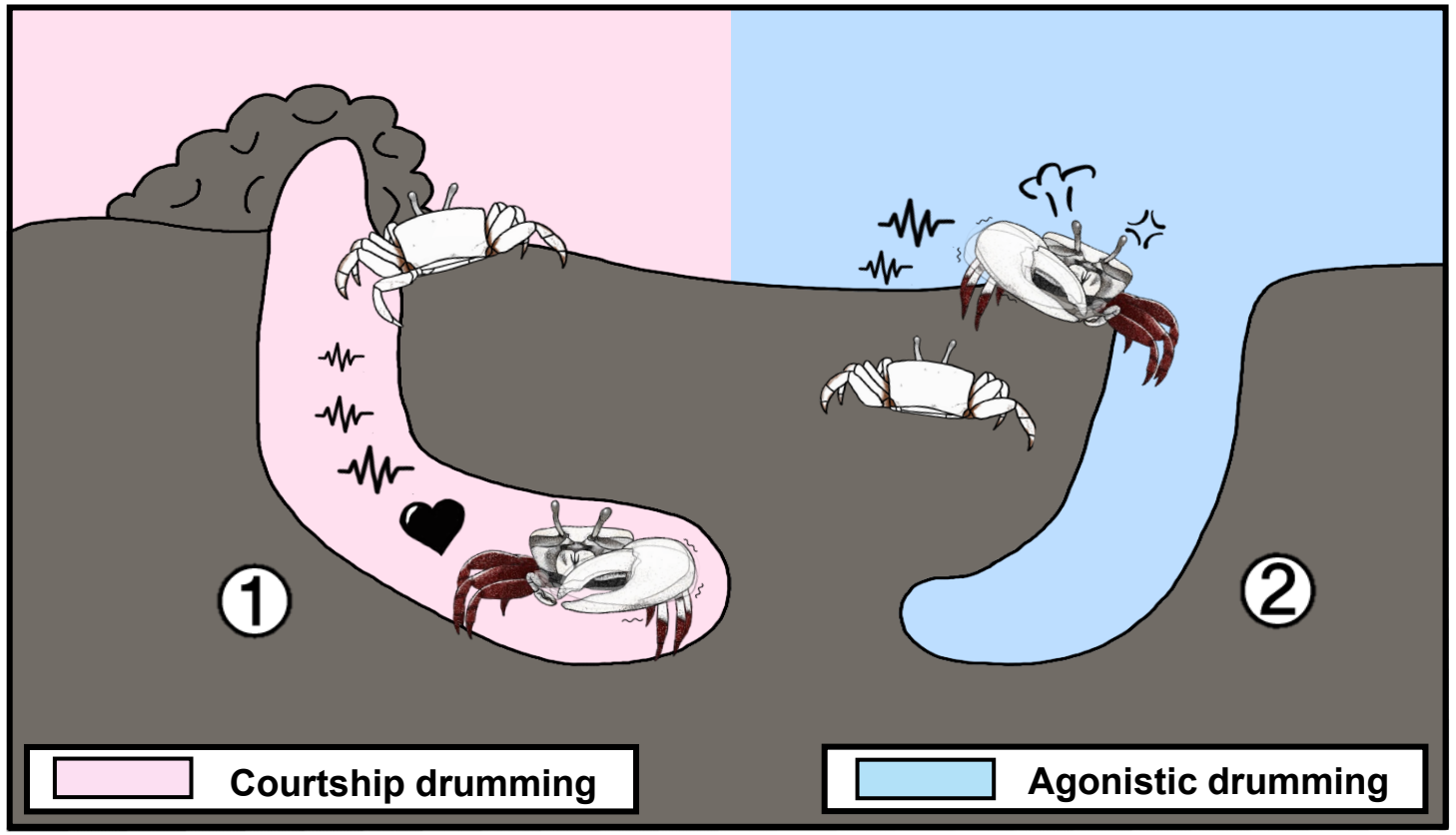


Results Drumming of *A. lactea*

Drumming

① Courtship drumming : inside the burrow (N = 33)

② Agonistic drumming : outside the burrow (N = 44)



Hypothesis & Prediction

➢Hypothesis

The male *A. lactea* will change their drumming signals depending on the courtship and agonistic situations.

➢Prediction

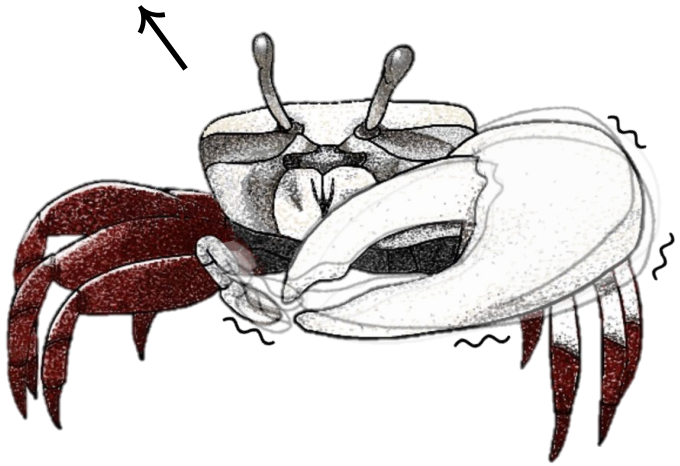
1. They will emit different pulse rate of drumming in the two contexts.
2. They will emit different pulses per train of drumming in the two contexts.
3. They will emit different pulse duration of drumming in the two contexts.
4. They will emit different train duration of drumming in the two contexts.
5. They will emit different frequency of drumming in the two contexts.

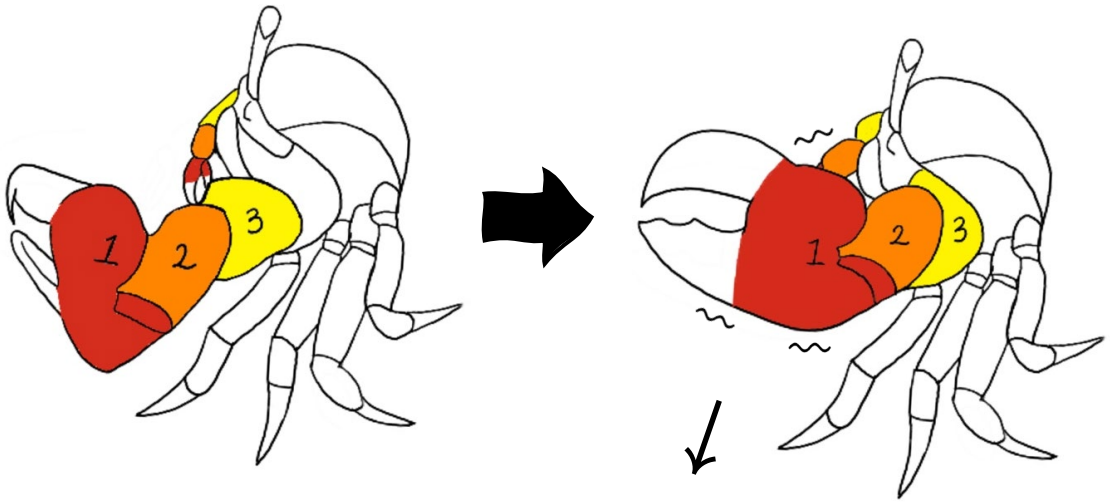
Results & Discussion

How to drum

※ Example of agonistic drumming

“ We drum using both **large** and **small chelipeds** ! ”



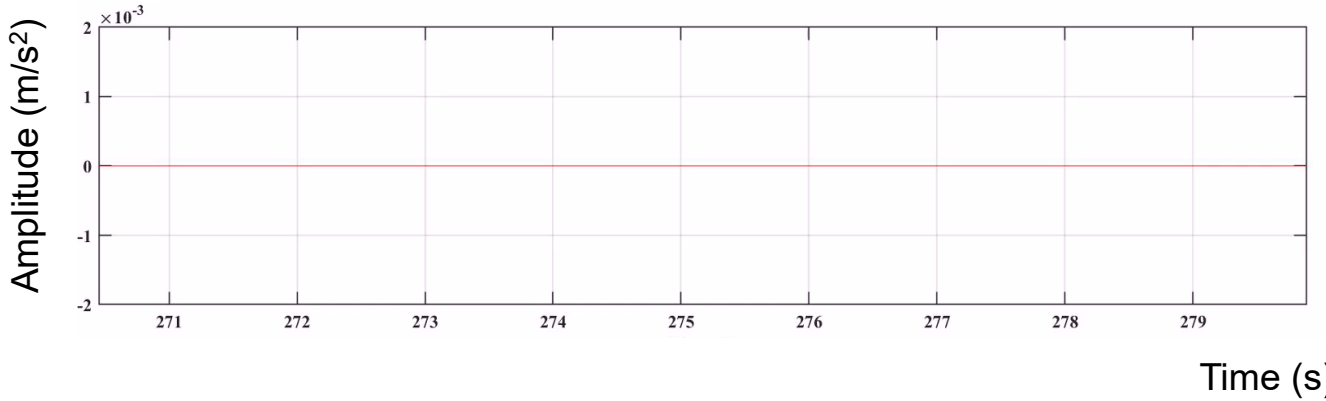


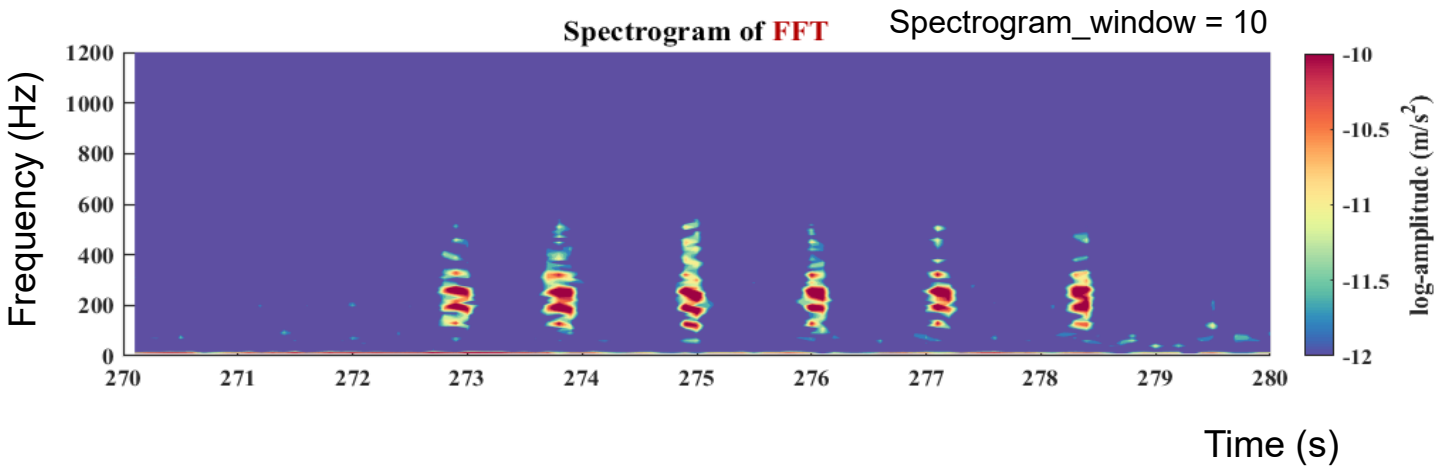
Especially by folding the **carpus (2)** between the **merus (3)** and **manus (1)**

Results & Discussion

How to drum

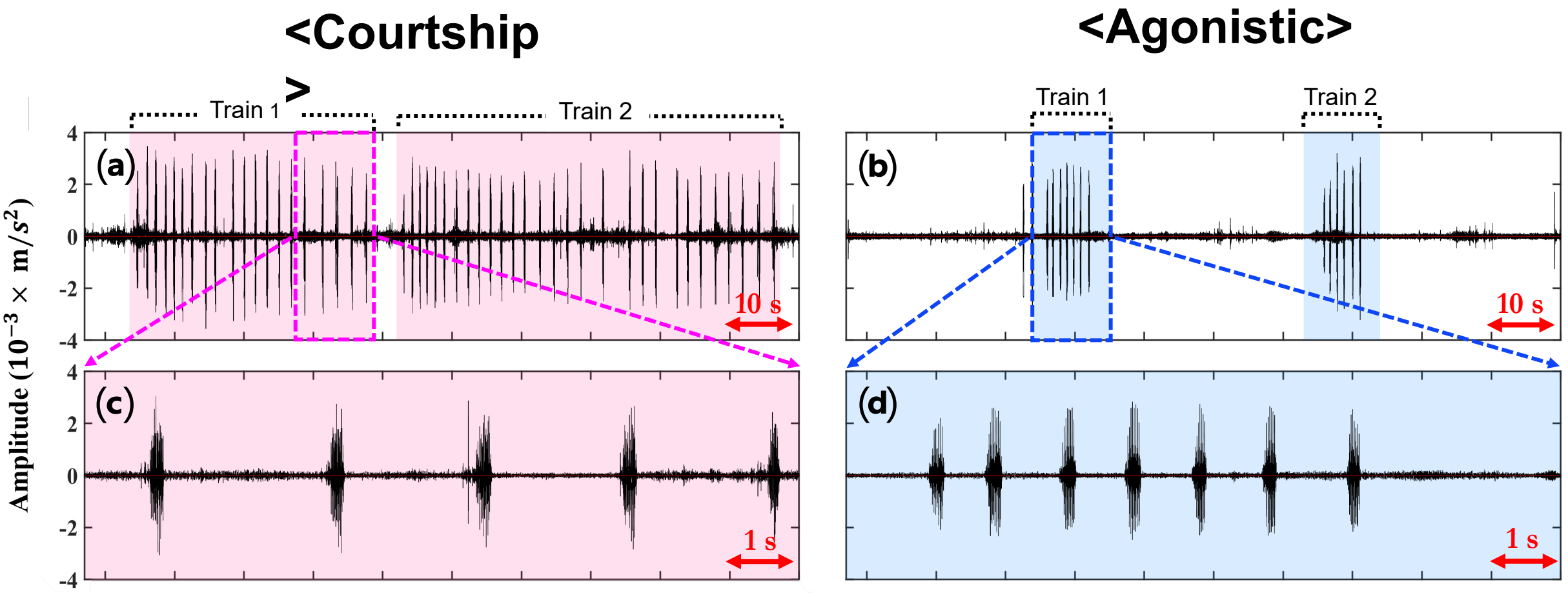
※ Example of agonistic drumming



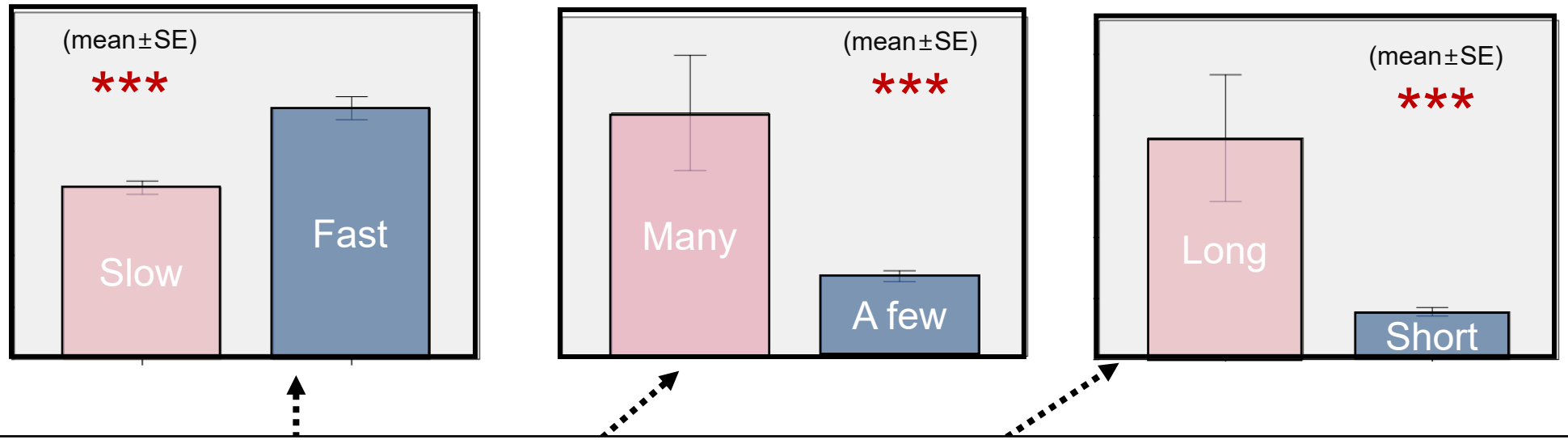


Results & Discussion

Courtship vs Agonistic drumming



Results & Discussion Courtship vs Agonistic drumming

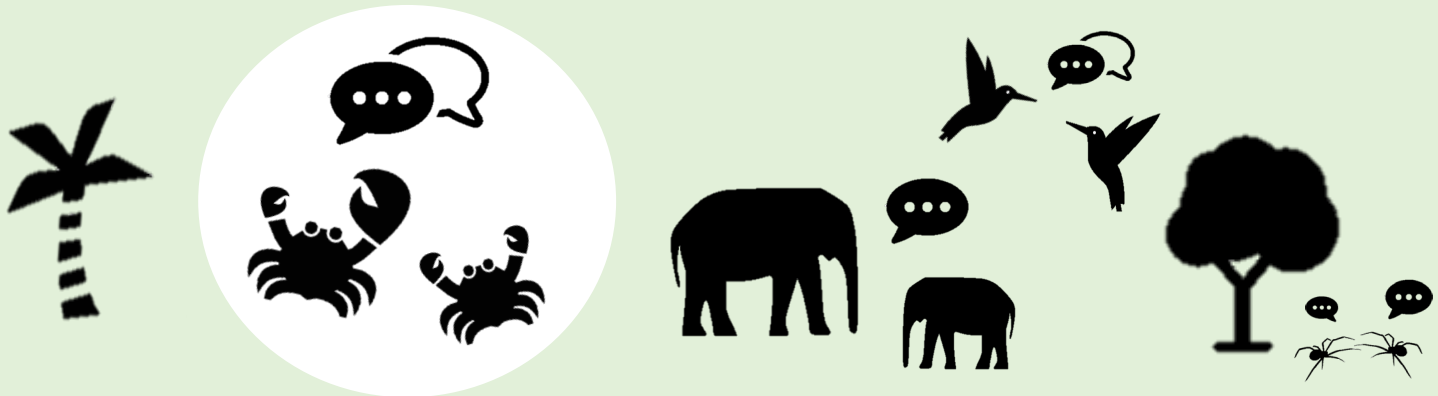


	Pulse rate (pulses/s)	Pulses per train	Train duration (s)	Pulse duration (s)	Dominant frequency (Hz)
Comparitive analysis (*p*)	< 0.0001***	< 0.0001***	< 0.0001***	0.269	0.104
z or *t*-score	-5.834	-5.021	-5.523	-1.105	1.647

Mann-Whitney *U* test / Unpaired *t*-test

Conclusions

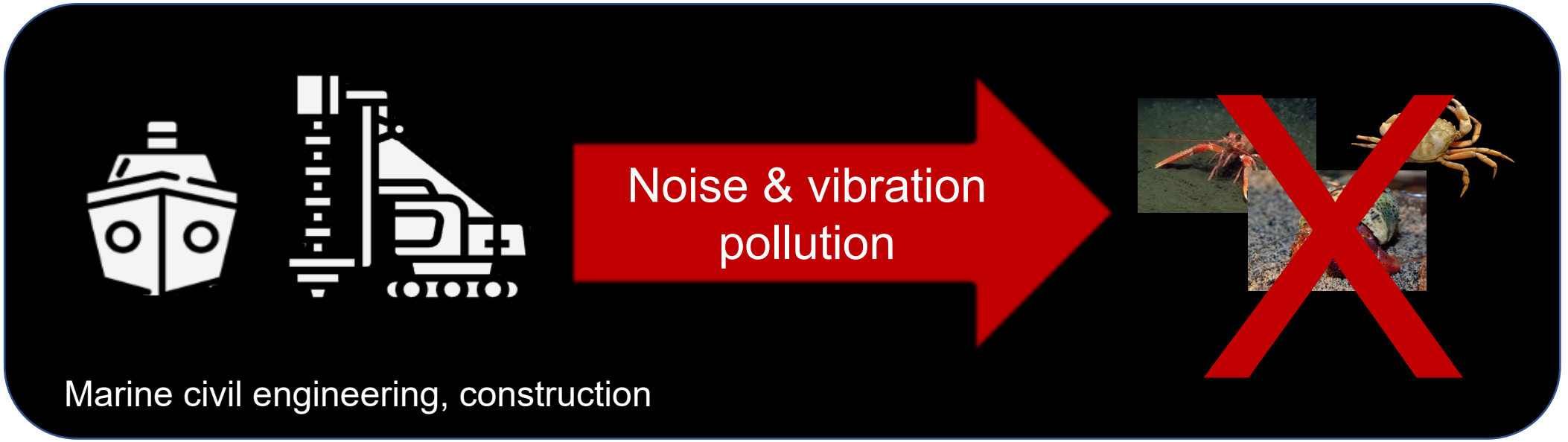
- *Austruca lactea* use drumming for courtship and agonistic behavior.
- There are remarkable differences of signal traits in two contexts.
- We provided the evidence that crabs might have evolved by manipulating their vibrational signals according to contexts.



2. Does construction vibrations alter seismic communications of male fiddler crabs (*Austruca lactea*) ?

Background

(Solan et al., 2016



→“**Endangered species, *Austruca lactea*”**

Hypothesis & Prediction

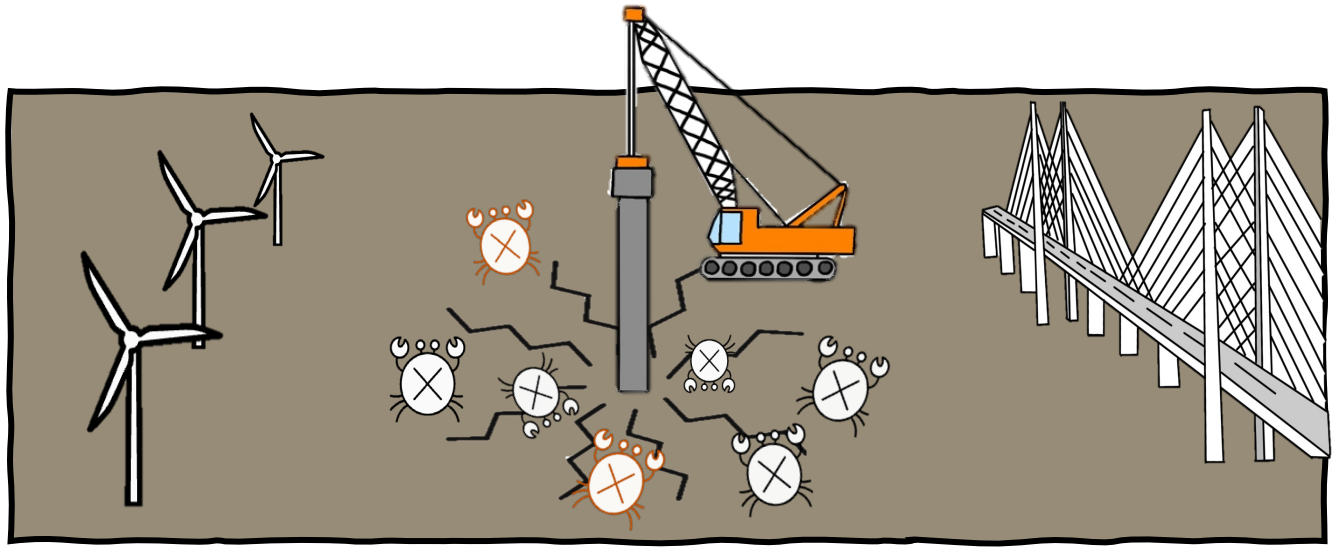
➢Hypothesis

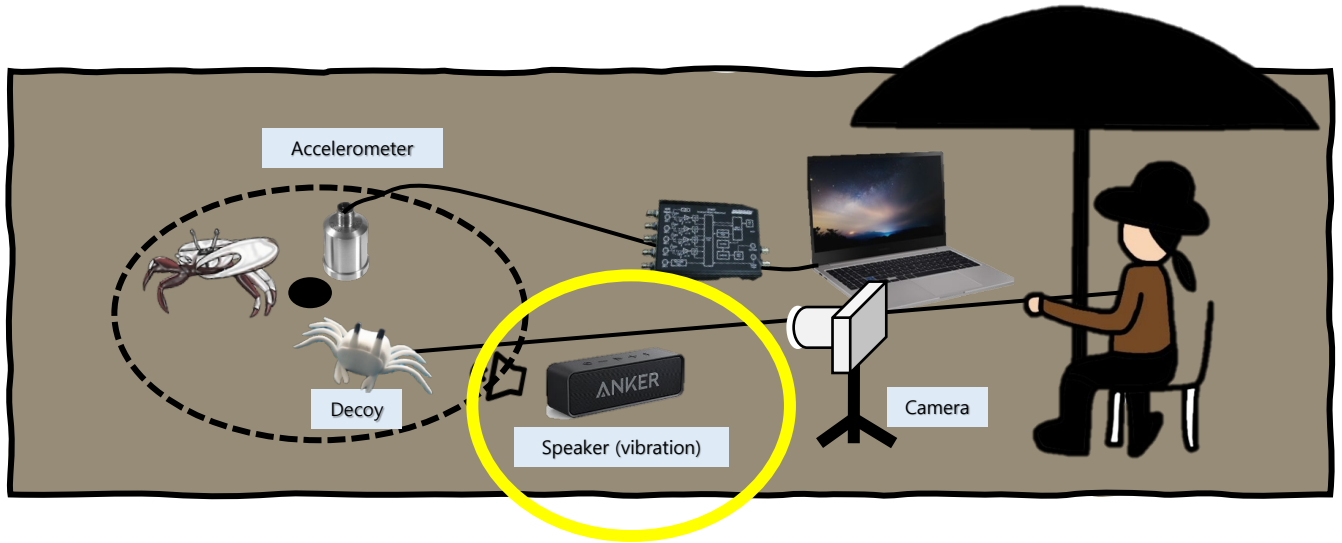
Construction vibrations will influence the vibrational communication of male *Austruca lactea.*

➢Prediction

1. Construction vibrations will change the pulse rate of drumming.
2. Construction vibrations will change the pulse duration of drumming.
3. Construction vibrations will change the peak amplitude of drumming.
4. Construction vibrations will change the dominant frequency of drumming.

Methods

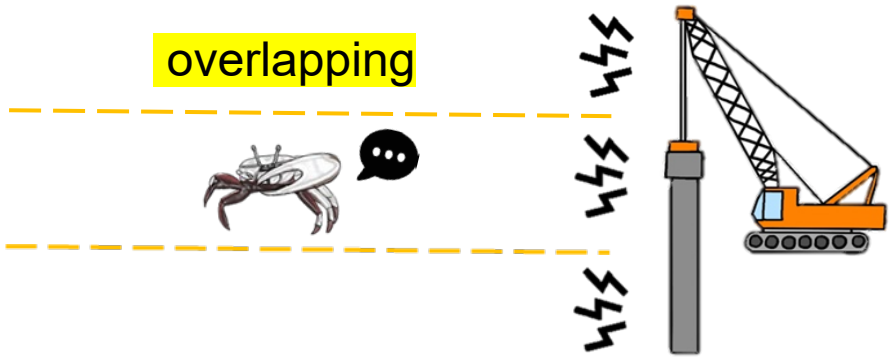




"Pile driving"

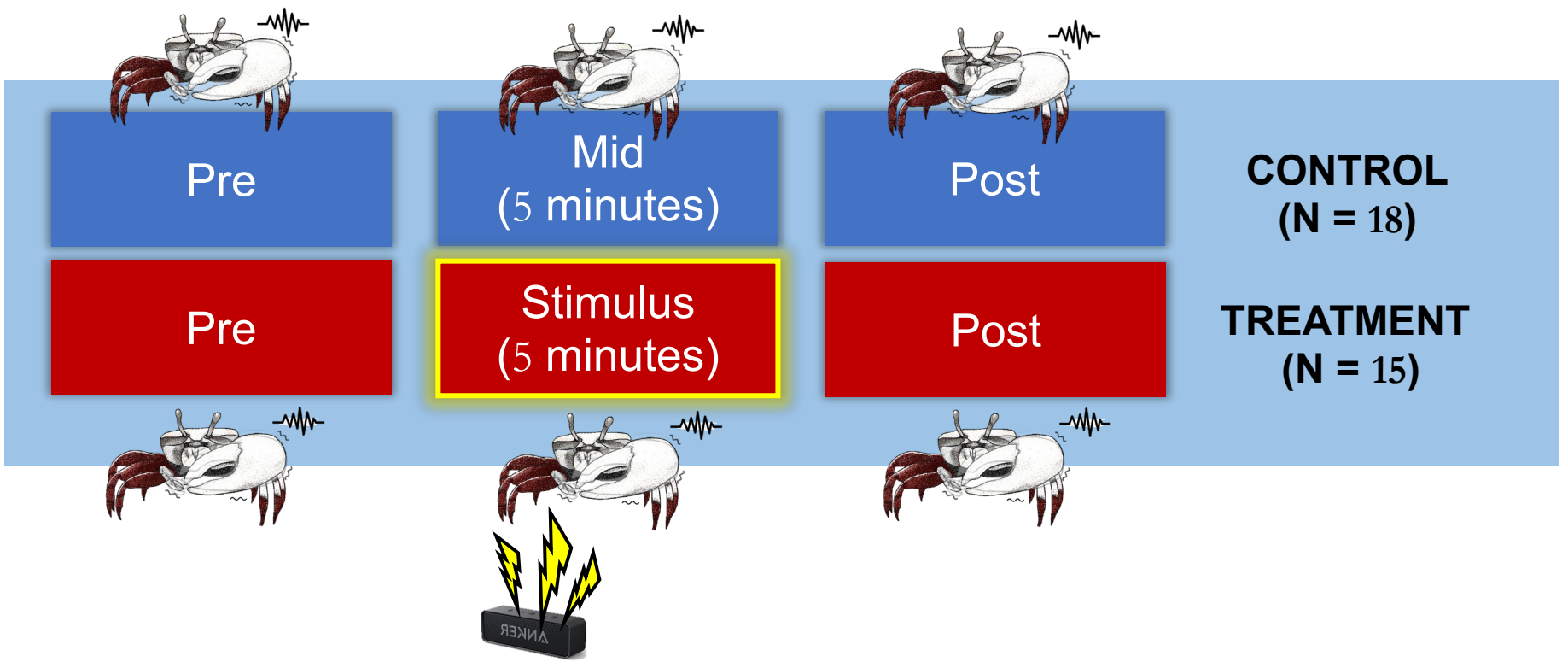
offshore wind turbine / bridge construction

→ It causes various range of frequencies.



→ We generate "250Hz" disturbance imitating the pile driving.

Methods



<Analysis index>

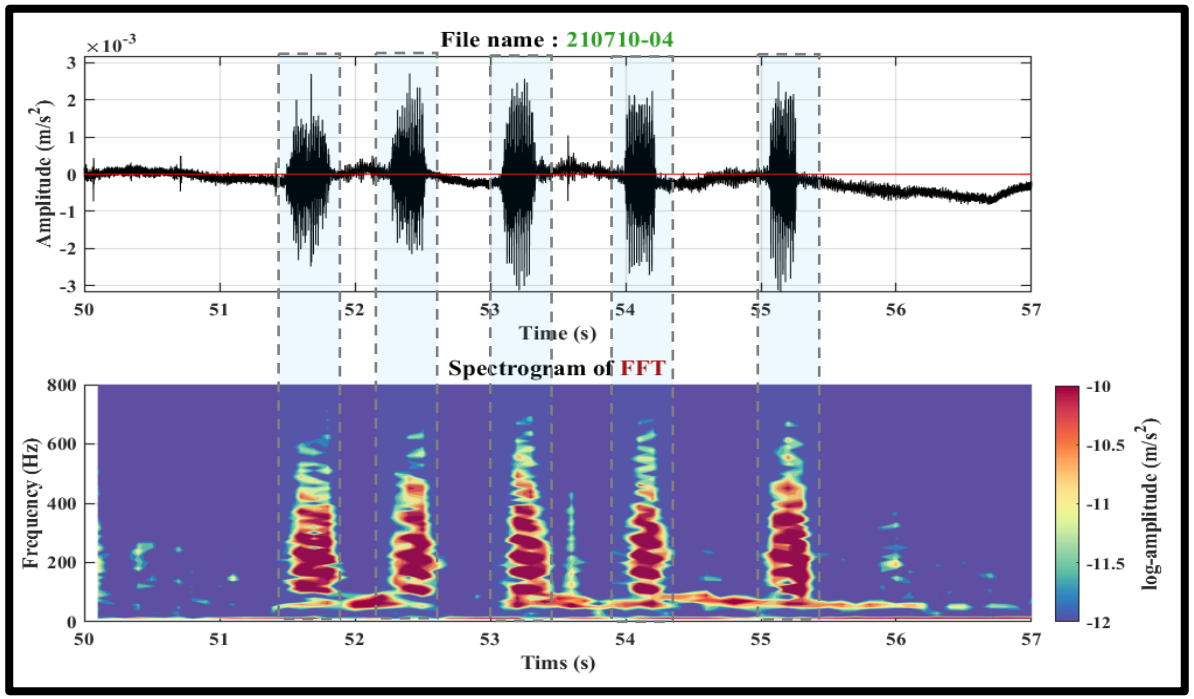
- Pulse rate (pulses/s)
- Peak amplitude (m/s^2)
- Pulse length (s)
- Dominant frequency (Hz)

< Statistics analysis >

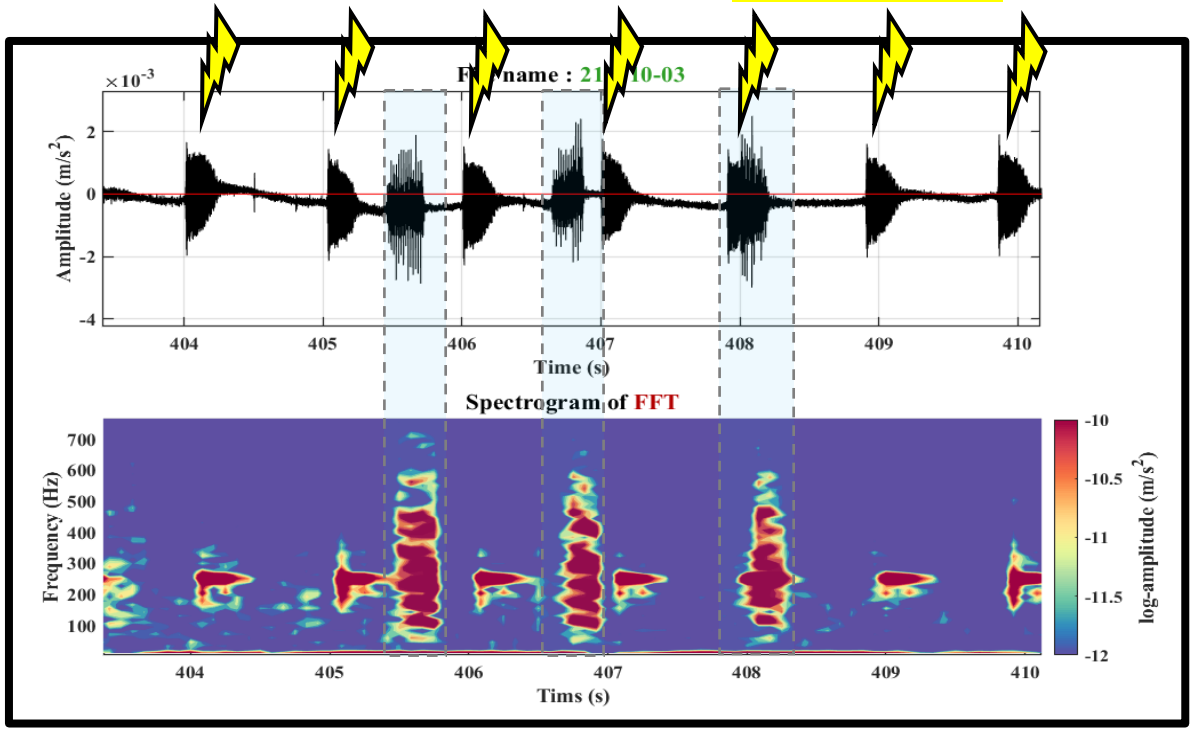
- ✓ Generalized Estimating Equations (GEE)
- ✓ (Two groups (control, treatment) × Three phases (pre-, mid-, post-stimulus)

Results & Discussion

“Pulses”



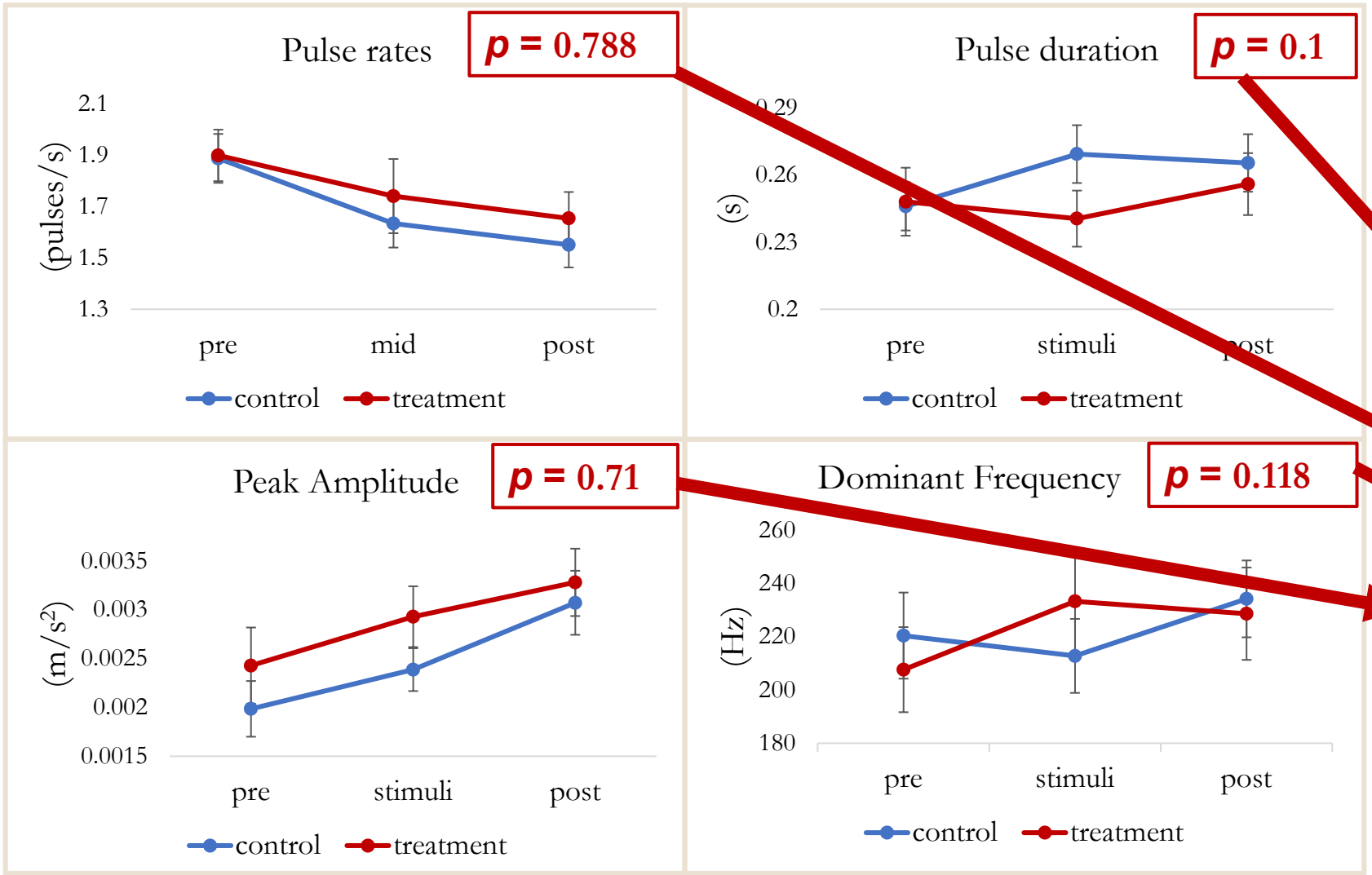
“Pulses with Stimulus”



<Control>

<Treatment>

Results & Discussion



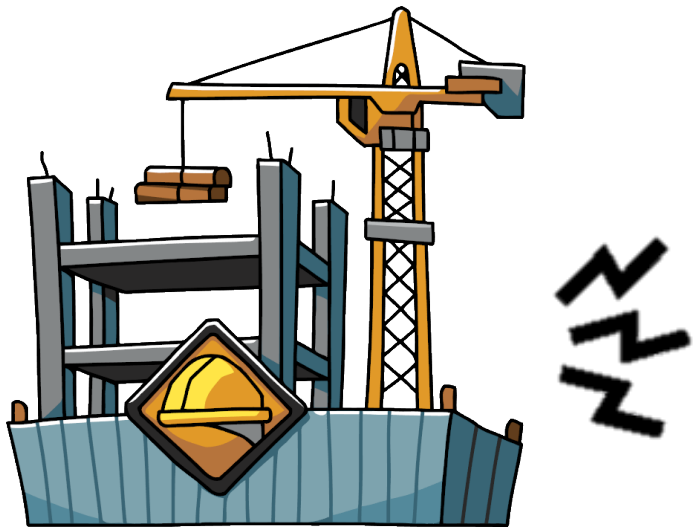
<GEE analysis>

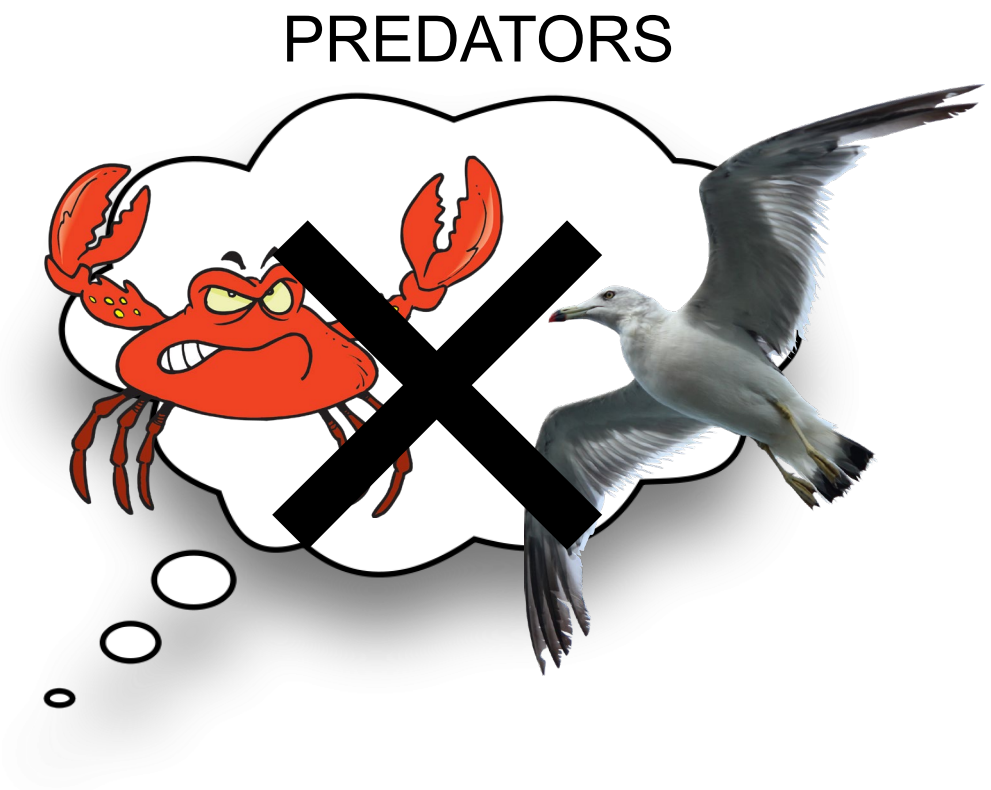
Group × Time (*p*)

Pile-driving disturbance didn't affect the drumming !

Results & Discussion

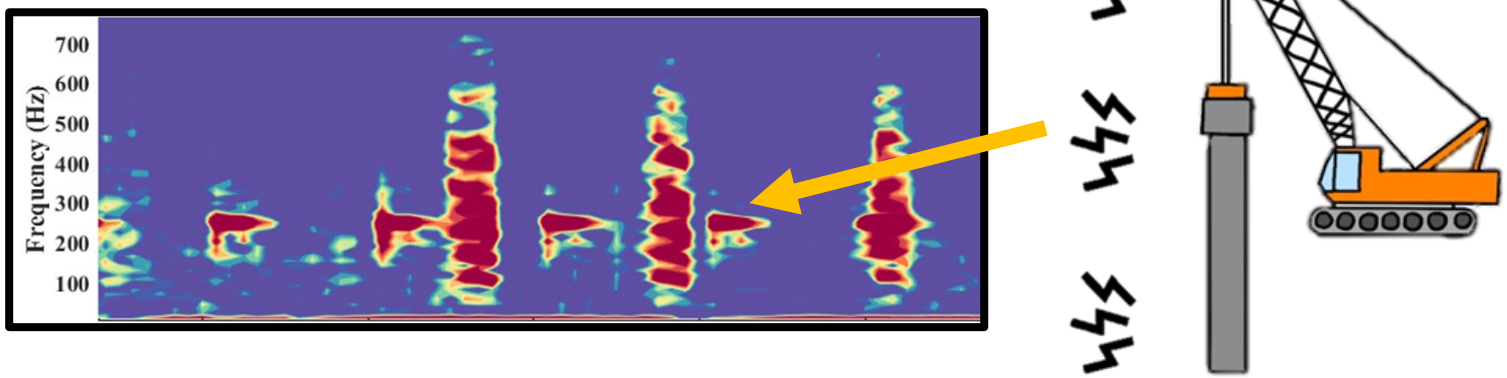
There are possibilities that,



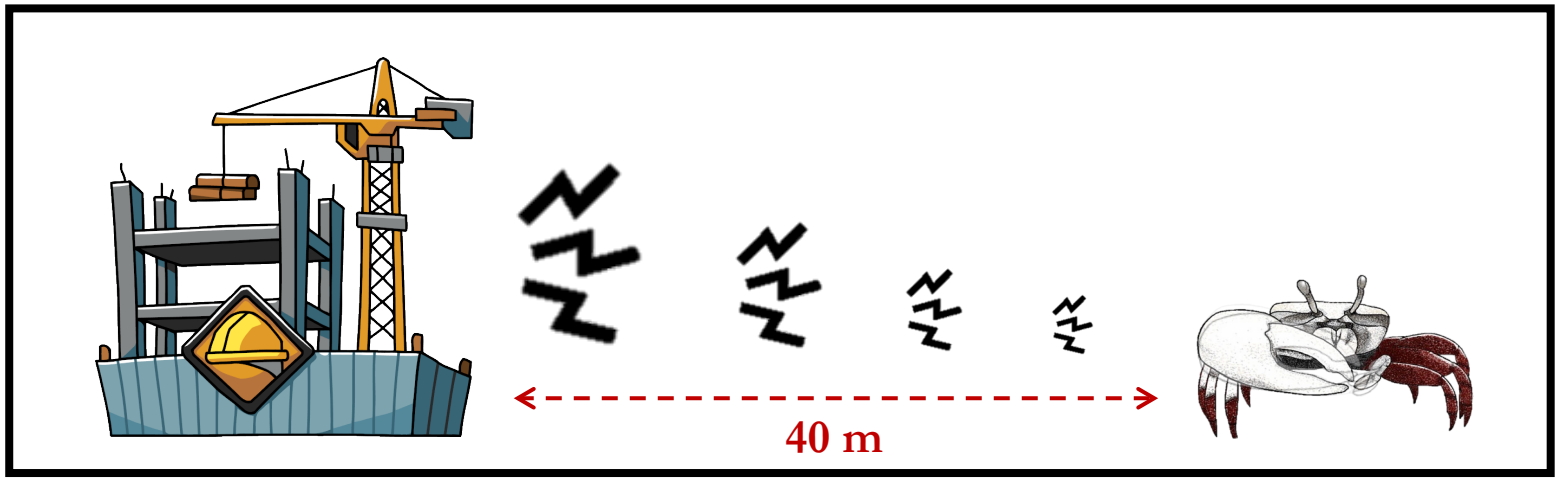


Results & Discussion

①Stimulus frequencies
(250Hz)



②Stimulus intensity
(50dB)



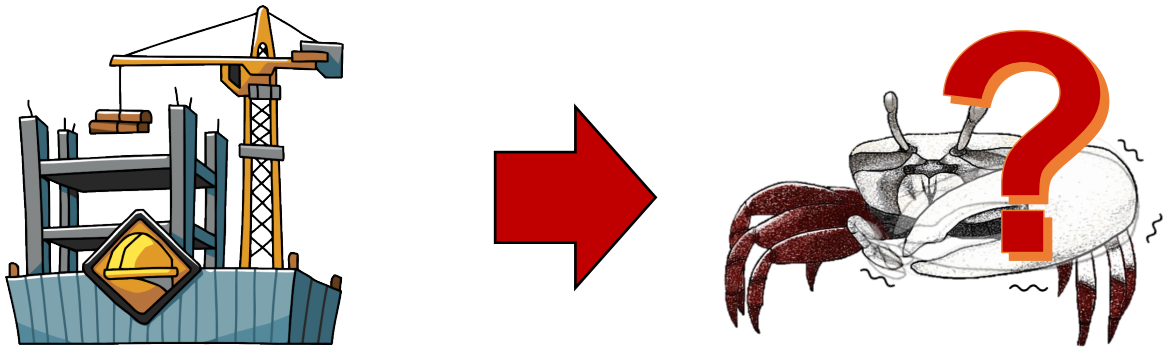
Conclusion

Frequency (250Hz) → more wide range of frequencies

Intensity (50dB) → more loud intensity

We can determine whether

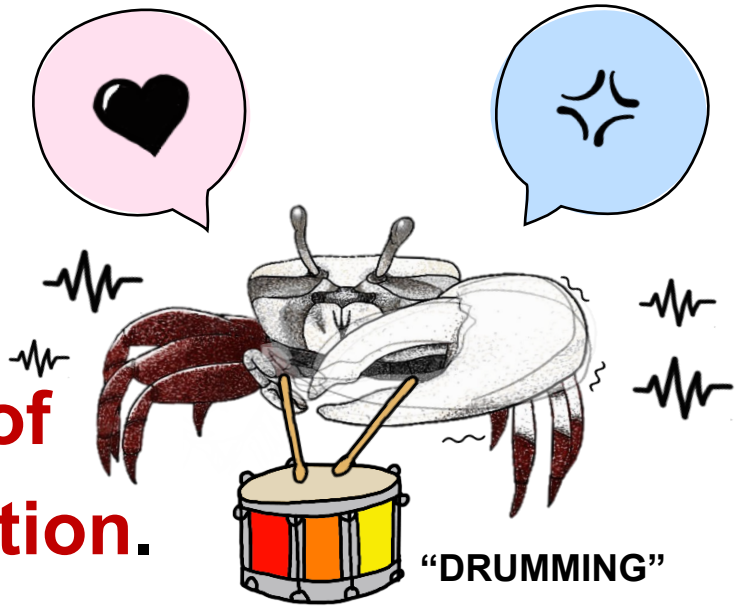
A. lactea are affected by construction vibrations or not.



Take-home message

1. **Crabs also have sophisticated vibrational communication systems.**

2. **We have to study & reduce the impact of human disturbance on their communication.**



Acknowledgement

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- The Korean Society of Oceanography for participation in PICES-2022

Thank you!