

# Dissimilar behavioral and spatial avoidance responses by shrimps from tropical and temperate environments exposed to copper

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Organisms of the species *P. vannamei* and *P. varians* were able to recognize and avoid a copper gradient. However, in terms of locomotion, they showed an opposite reaction.



# Introduction

- Coastal transition areas present stressful environmental conditions.
- Scenarios for ecological risk assessment might differ between tropical and temperate regions.
- Decapods are representative fauna and play an integral ecological role in coastal ecosystems.



Fig 1. *P. vannamei*. Figure obtained from: <https://colombia.inaturalist.org/taxa/1071972-Penaeus-vannamei>



Fig 2. *P. varians*. Figure obtained from : <https://www.tiendadecaballitos.es/Camaron>

# Introduction

- Behavioral changes associated with exposure to pollutants represent the earliest response and the first line of defense for organisms confronted by perceivable chemical signals.
- Such alterations in behavior can lead to ecological consequences at the population, community and ecosystem level.
- Non-forced vs forced exposure scenarios.



Fig 3. Forced Scenario.

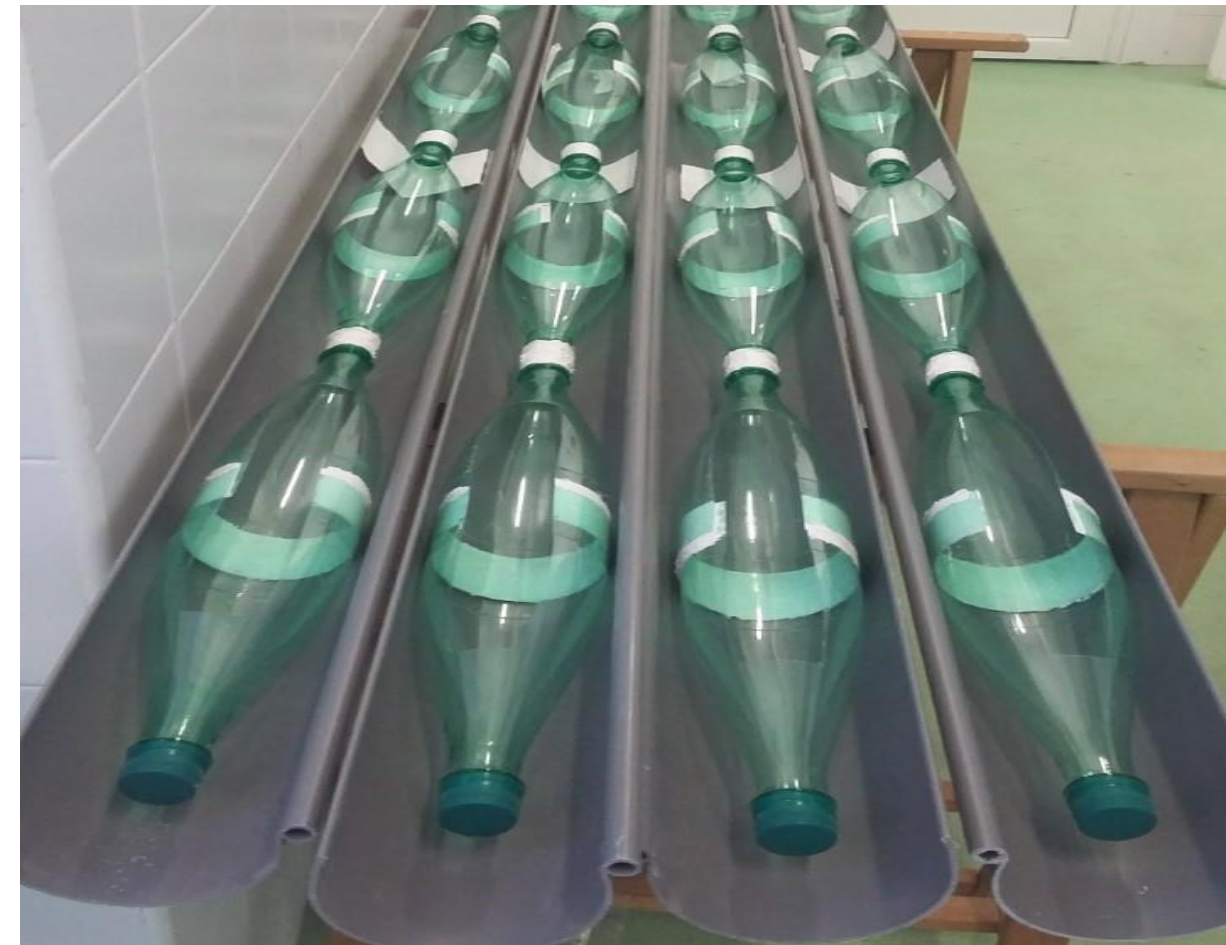


Fig 4. Non-Forced Scenario.



# Objective

Evaluate the behavioral responses associated with two different scenarios of exposure to contaminants (non-forced vs forced exposure scenarios) in two shrimp species (*P. vannamei* and *P. varians*), representative of different latitudes.



Fig 5. Estuary in Puntarenas. Figure obtained from: <https://gr.pinterest.com/pin/411516484673954789/>



Fig 6. Salt Marshes. Figure obtained from: <http://www.todoactividades.com/es/actividades/paseo-en-barco-por-las-marismas-parque-natural-bahia-de-cadiz-5442/>

# Methodology

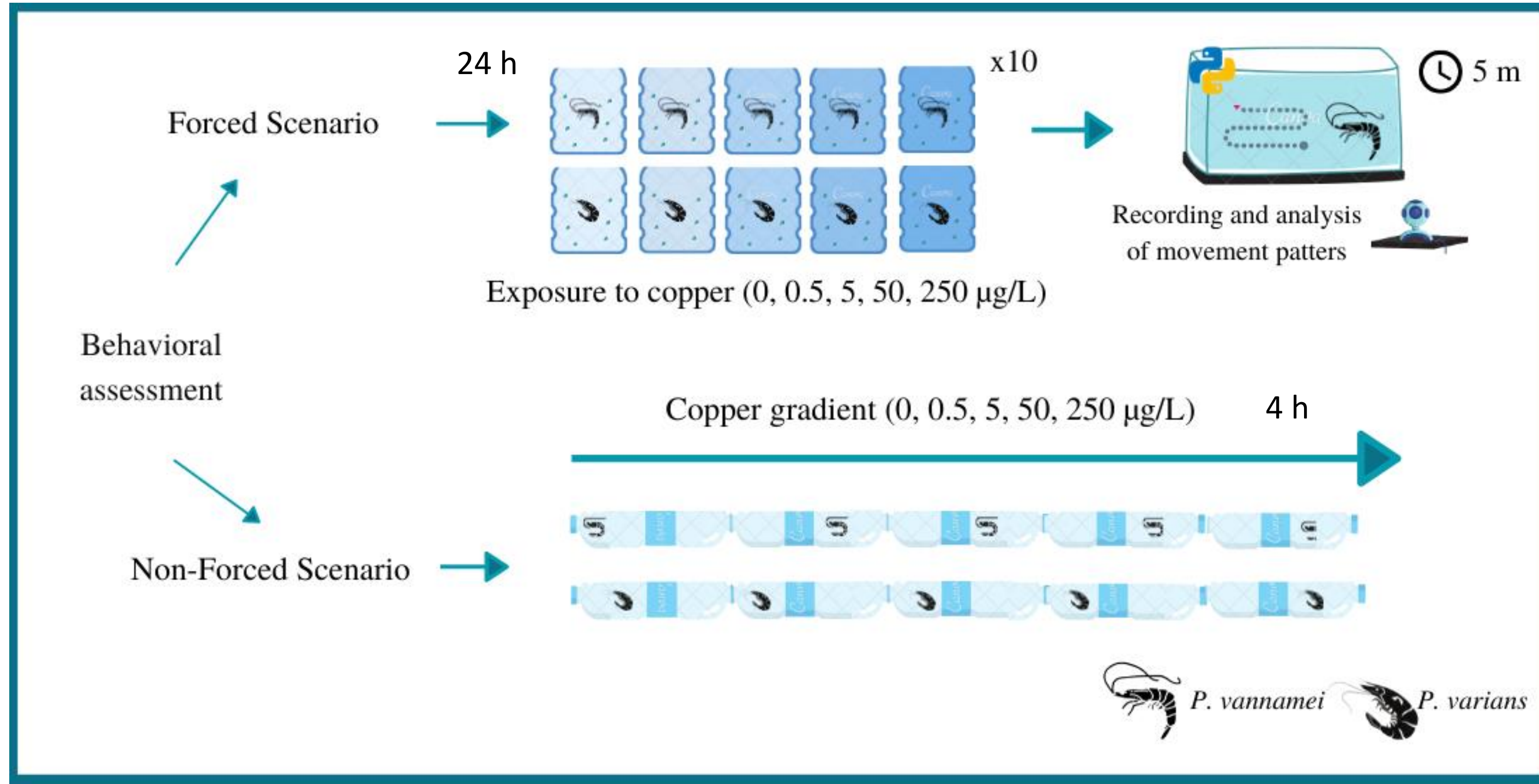


Fig 7. Experimental Design

# Results and Discussion

- Opposite trend in the pattern of locomotion was recorded between the species.

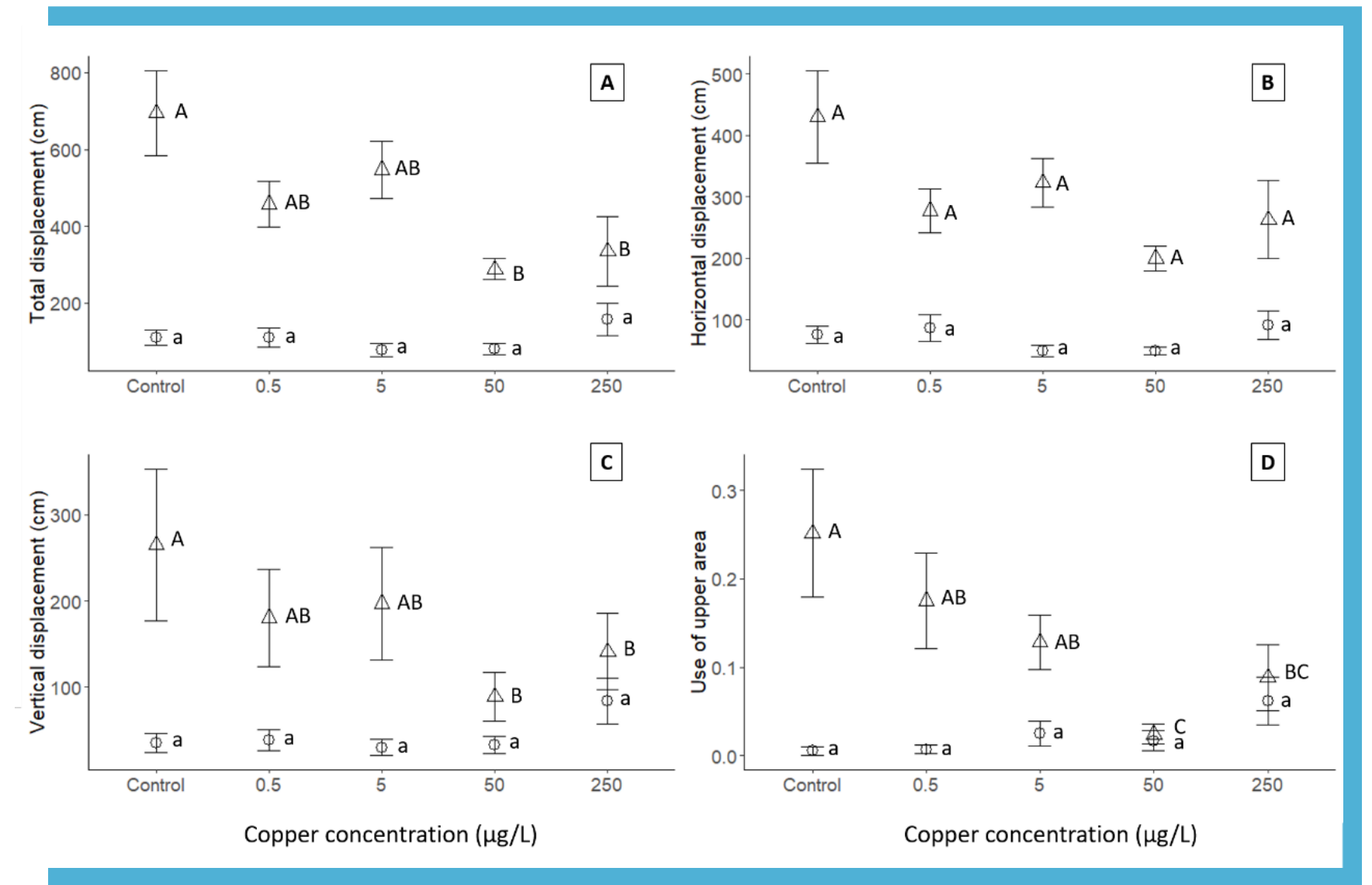
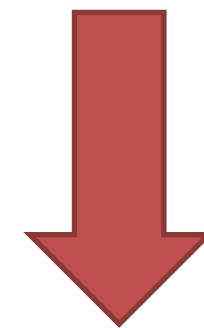
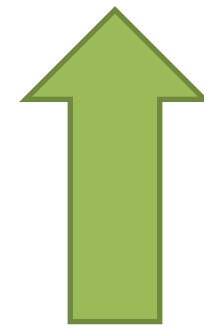
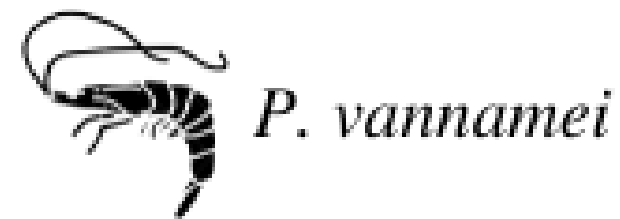


Fig 8. Changes in the locomotion of *P. varians* (triangles) and *P. vannamei* (circles) after a forced 24-h exposure to a range of concentrations of copper. Different letters indicate significant differences among the treatments for each species, uppercase for *P. varians* and lowercase for *P. vannamei*.



# Results and Discussion

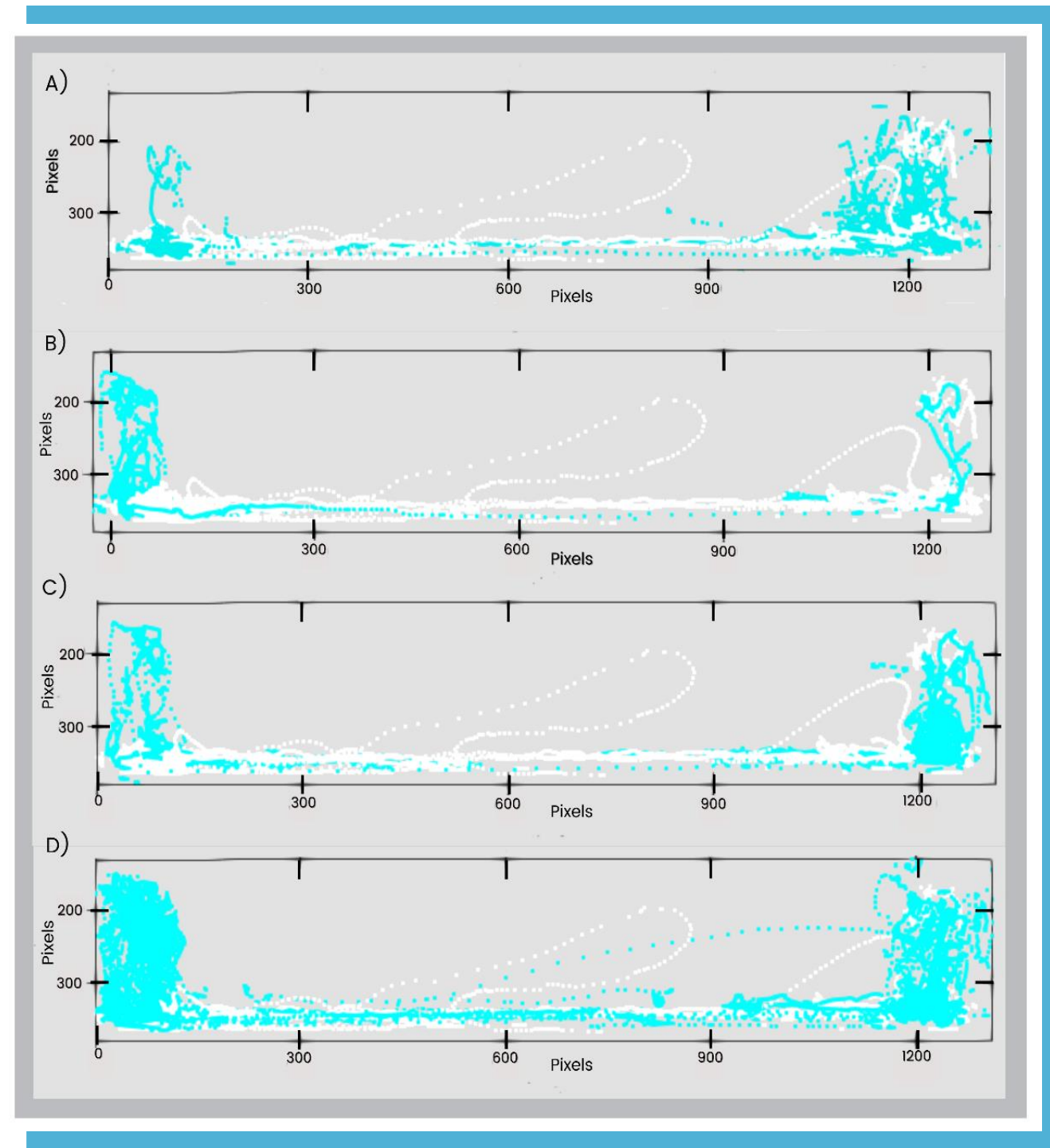


Fig 9. Representation of the displacement routes by individuals of *P. vannamei*. White lines correspond to the control group and light blue to the organisms after exposure to the copper concentrations of 0.5 µg/L (A), 5 µg/L (B), 50 µg/L (C) and 250 µg/L (D).

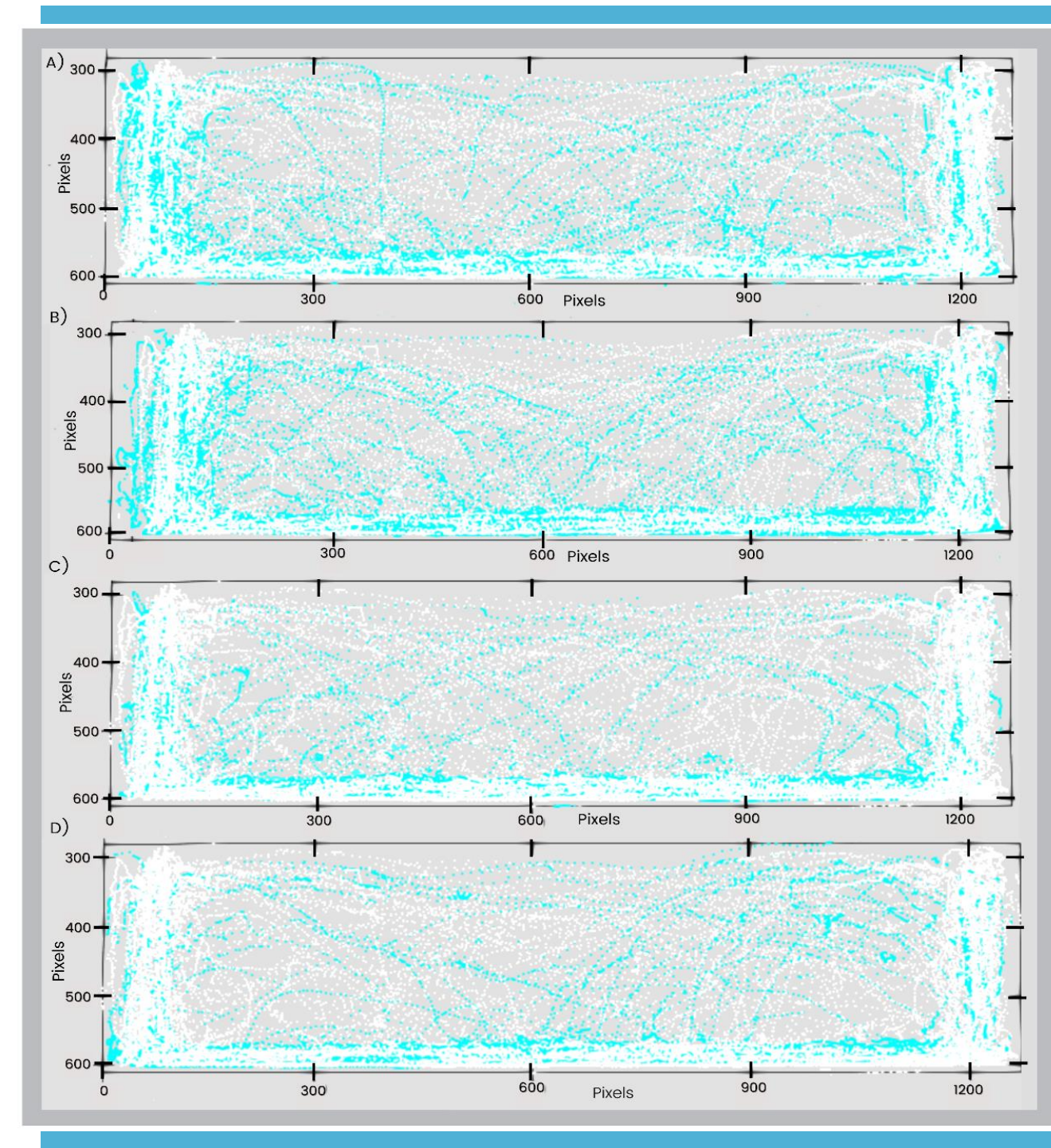
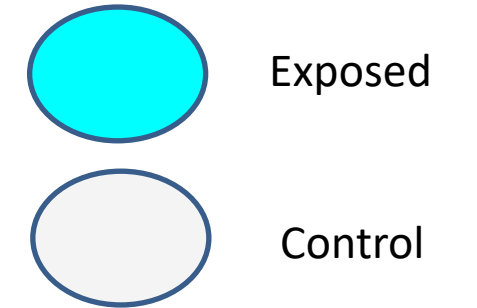


Fig 10. Representation of the displacement routes by individuals of *P. varians*. White lines correspond to the group and light blue to the organisms after exposure to the copper concentrations of 0.5 µg/L (A), 5 µg/L (B), 50 µg/L (C) and 250 µg/L (D).





# Results and Discussion

- Clear induction of lethargy was observed in *P. varians*.
- Trace metals influence neurological processes.
- Opposite reaction was observed in *P. vannamei*.
- Model proposed by Untersteiner (2005).
- This kind of opposite behavioral reaction has been reported previously.



Figure 11. *Simocephalus vetulus*



Figure 12. *Macrobrachium lamarrei*

## Monitoring Behavioral Responses to the Heavy Metal Cadmium in the Marine Shrimp *Hippolyte inermis* Leach (Crustacea: Decapoda) with Video Imaging

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## Microcrustaceans escape behavior as an early bioindicator of copper, chromium and endosulfan toxicity

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# Results

Table 1. Concentrations (in µg/L) of copper (with their respective 95% confidence intervals) that triggered avoidance in 25, 50 and 75 percent (AC<sub>25</sub>, AC<sub>50</sub> and AC<sub>75</sub>, respectively) of the shrimp populations (*Penaeus vannamei* and *Palaemon varians*) after 4 h exposure in a non-forced system.

Species	AC <sub>25</sub>	AC <sub>50</sub>	AC <sub>75</sub>
<i>P. vannamei</i>	0.75 (0.10 - 2.29)	11.30 (4.07 - 30.50)	170.0 (56.8 - 1200)
<i>P. varians</i>	4.70 (0.14 - 18.9)	42.7 (9.78 - 512)	389 (76.8 - 124000)

- Both species significantly avoided the highest concentrations of copper.
- The avoidance response was clearer in *P. vannamei*, while *P. varians* showed some tolerance to lower concentrations of (or inability to recognize the risk of) copper.

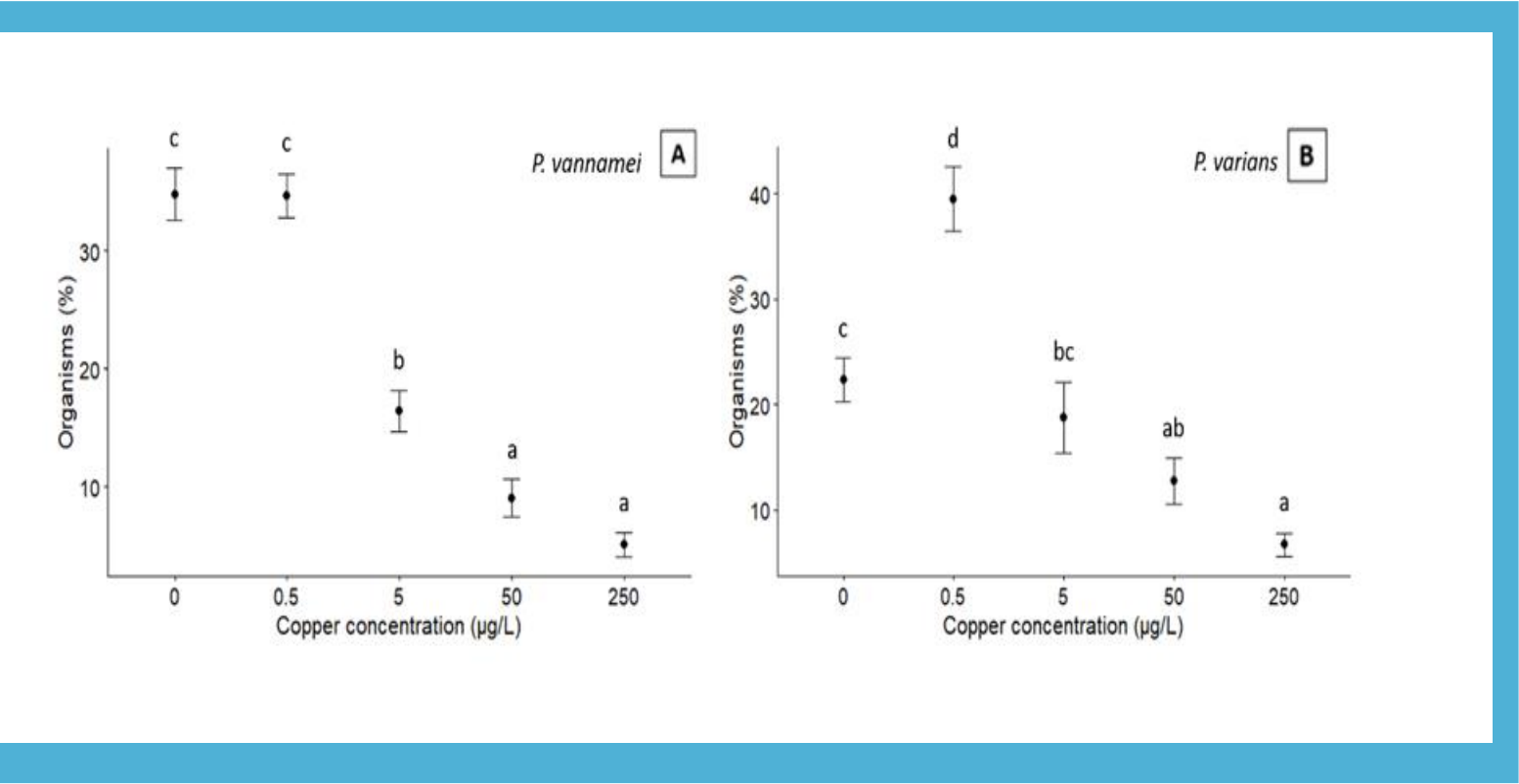
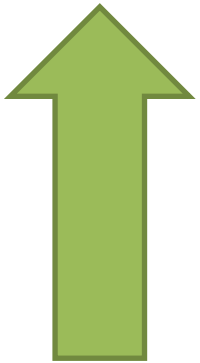
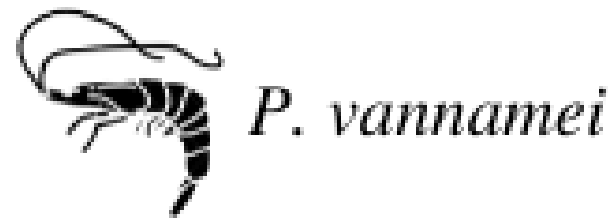


Figure 13. Distribution of the individuals of *P. vannamei* (A) and *P. varians* (B) exposed to a gradient of copper in a multi-compartment system. Different letters indicate statistically ( $p < 0.05$ ) significant differences among treatments.



# Results and Discussion

Differences between species could be attributed to two main factors: how repulsive the stimulus caused by the pollutant is and the organism's ability to identify the substance and recognize the risks of exposure .



*P. vannamei*



Greater ability to detect and recognize the risk of copper contamination.



*P. varians*



Lack of ability to interpret the risk correctly at such a low concentration.











# Discussion



The ability of both species to avoid copper may produce changes in the spatial distribution of the species such as:

- High rate of organisms evading  • Reduced local abundance in their original area. 
- Migration of the organisms  • Increase competitive interactions between species. 
- Lower ability to escape from the contamination  • Higher susceptibility to suffering the toxic effects 





# Conclusions

- Considering the outcome of our experiment, *P. vannamei* could be better suited to deal with this specific stressor than *P. varians*, due to its ability to escape from contamination.
- Even though behavior and avoidance stand as important endpoints in the evaluation of contaminants present in an ecosystem, there is a need for more information regarding species-specific sensitivity to sublethal concentrations of contaminants.