Can a crab alter color to adapt to its environment?

A behavioral and chemical study of the coloration of the harlequin crab *Lissocarcinus orbicularis*

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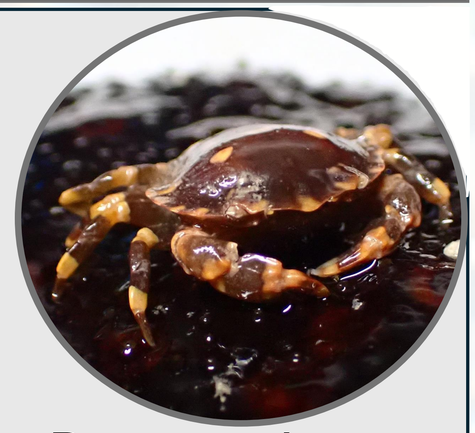
I am the harlequin crab ***Lissocarcinus orbicularis***. I am a symbiotic crab that lives on different types of sea cucumbers, also known as holothurians. In particular, I live on the leopard sea cucumber ***Bohadschia argus*** in Mo'orea in French Polynesia. My main characteristic is that I mimic my host in order to remain camouflaged. My coloration is due to colored molecules called "**carotenoids**." These are stored in cells called "chromatophores" and are acquired through diet in animals. It is known (Caulier et al, 2013) that I feed partly on the integument of my host, which would explain my mimicry.



Since I can adapt to the color of my host and my host *B. argus* has two morphotypes (*i.e.*, brown and gray) :

- **what happens if I switch to a morphotype with different colors?**
- **And if I am separated from the latter, do I lose my color?**
- **And what happens to my carotenoid levels?**

Colorimetric analysis

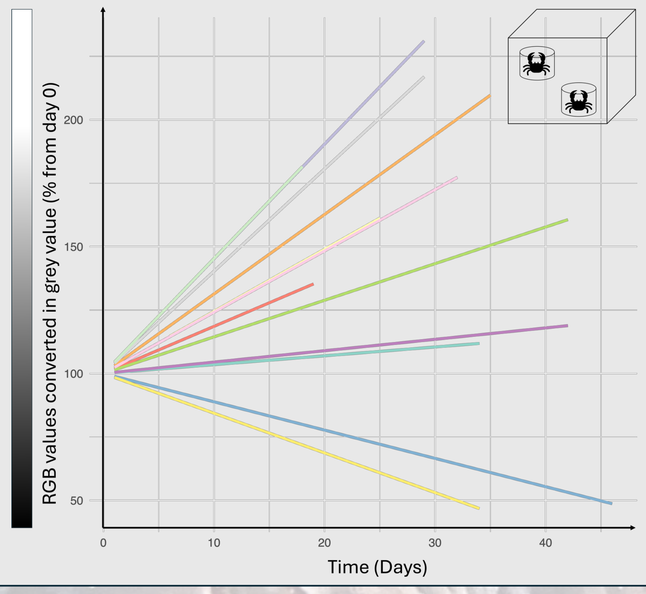


Fig. 1. Variation in RGB values converted to grayscale levels according to the formula: Luminance = 0.2126 × Red + 0.7152 × Green + 0.0722 × Blue (Gonzalez et al. 2016; Lourtie & Mussoi et al. 2024) **when isolating the harlequin crab from its host.** The luminance obtained was then expressed as a relative percentage compared to the value measured at time T0 (*i.e.*, initial coloration immediately after collection) (Y axis). The X axis represents the duration of the experiment in days. Each curve corresponds to an individual: an increase in the relative value indicates progressive discoloration, while a decrease reflects an intensification of coloration.

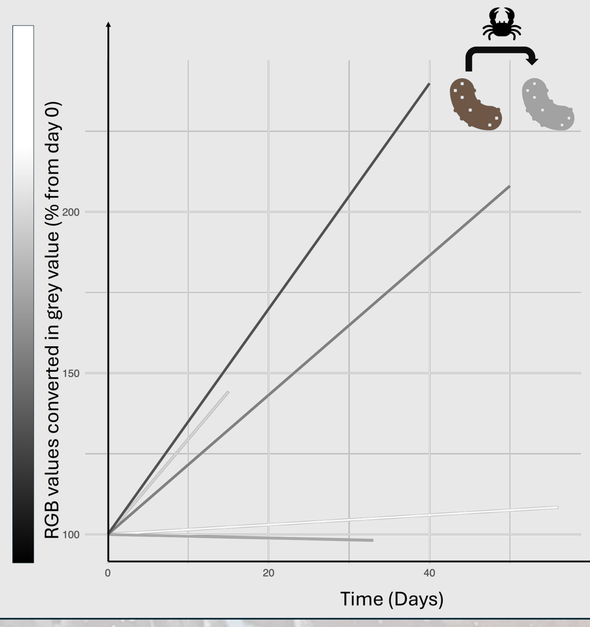
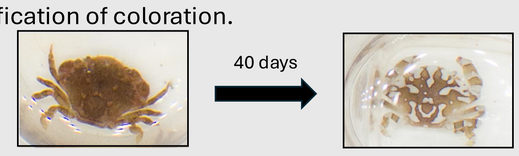


Fig. 2. Variation in RGB values converted to grayscale levels according to the formula: Luminance = 0.2126 × Red + 0.7152 × Green + 0.0722 × Blue (Gonzalez et al. 2016; Lourtie & Mussoi et al. 2024) **when the crab moves from a brown host to a gray host.** The luminance obtained was then expressed as a relative percentage compared to the value measured at time T0 (i.e., initial coloration immediately after collection) (Y-axis). The X-axis represents the duration of the experiment in days. Each curve corresponds to an individual: an increase in the relative value indicates gradual discoloration, while a decrease reflects an intensification of coloration.



Chemical analysis

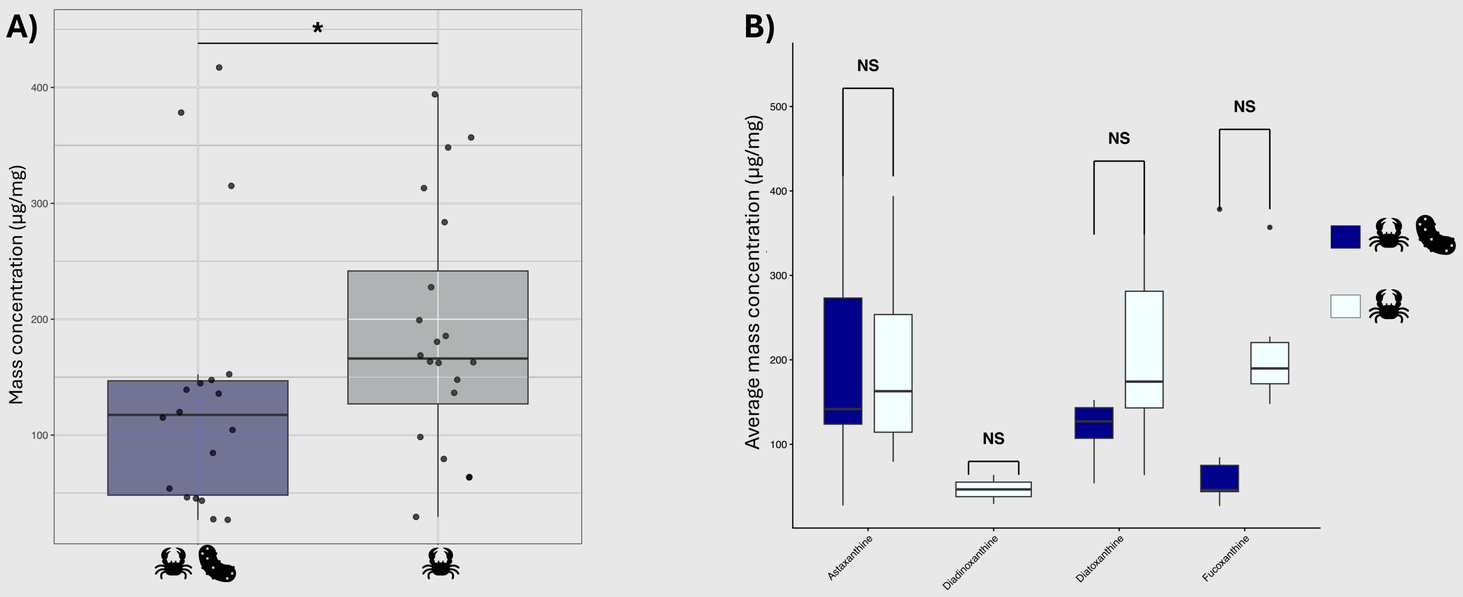


Fig. 3. Results of qualitative and quantitative analyses of carotenoids obtained by HPLC-MS (High Pressure Liquid Chromatography – Mass Spectrometry). **A) Total amount of carotenoids** measured in individuals attached directly to their host and in individuals isolated until death (*i.e.* between 40 and 60 days). **B) Amount of each carotenoid identified** in harlequin crabs under the two conditions described above. Values are expressed in µg of carotenoids per mg of sample, with each point representing an individual. A Wilcoxon test was performed for each comparison; the asterisk indicates a significant difference and NS indicates no significant difference. **C)** Qualitative analysis of diatoxanthin detected in the **harlequin crab**, its host ***B. argus***, and in the **suspended particles present** in the experimental aquarium, illustrating its retention time and molecular structure.

Take home message

Colorimetric analyses initially showed a general tendency toward discoloration when I am separated from my host, although this phenomenon is not systematic. This observation is corroborated by quantitative carotenoid analyses: my total pigment content is significantly higher when I am isolated. The carotenoids I contain are mainly astaxanthin, diadinoxanthin, diatoxanthin, and fucoxanthin, the latter being clearly dominant in isolated individuals. Fucoxanthin is present both in my host's integument and in the suspended particles I feed on. As described by Caulier et al. (2013), my diet is partly based on the ingestion of host tissue and organic particles from the environment. I therefore obtain my carotenoids from these food sources, which could explain my ability to adjust my color to that of my host and thus maintain my mimicry!

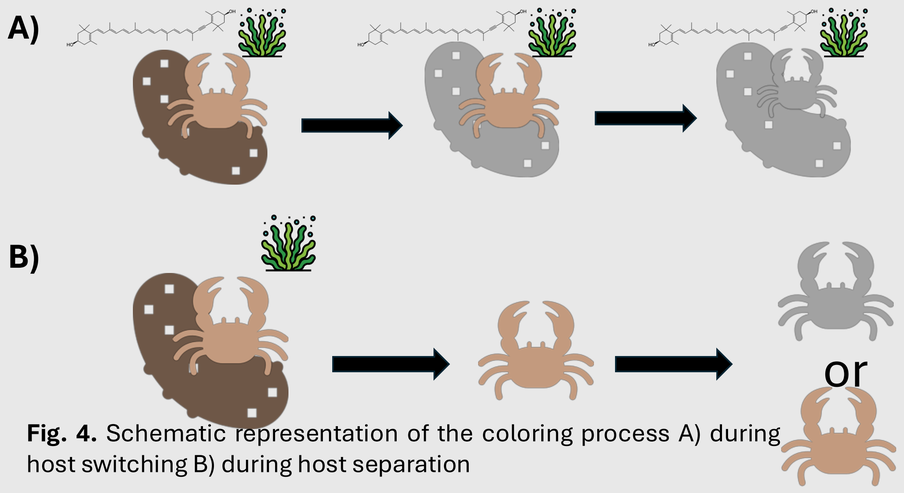


Fig. 4. Schematic representation of the coloring process A) during host switching B) during host separation