The curious incident of the hermit crab and the gastropod

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Abstract

Living space is a fundamental resource for the growth and survival of plants, marine, and terrestrial animals and even human beings. Of the variety of life that covert space, hermit crabs are unique in their motivation to find, defend and maintain gastropod shells as portable homes. The limited supply of empty shells in the environment, as well as a constant need to upgrade these resources as they grow, means that these charismatic crabs are always on the lookout for bigger, better and newer homes. We present the curious case of an intertidal hermit crab (*Isocheles sawayai*) that was found dead, tucked away behind the body of an injured gastropod (*Olivancillaria vesica*) whose shell it was presumably trying to occupy. This unusual observation highlights the extremes to which some crabs may go to beat potential rivals and be the first to access limiting resources.

Introduction

Living space can take the form of competitor-free substrate (e.g., barnacles [1]), physical refuge (e.g., urchins and reef fish [2] [3]), territory or home ranges (e.g., wolves [4]) or even physical extensions to body-form (e.g., shelled organisms like mussels [5]). Of all the animals that covert living space, hermit crabs (Paguroidea) are unique in their use of empty gastropod shells as a secure living space to protect their soft abdominal exoskeleton [6].

Having a good-quality shell is not only essential for continued growth [7], but is vital to protect individuals against predation [8], desiccation, thermal [9] and osmotic stress [10]. Because of this, hermit crabs have evolved the ability to rapidly assess the quality of a potential shell (i.e., its subjective value; [11]), which in turn dictates many aspects of their behaviour including: competitive interactions with other individuals (shell fights; [12]) and the unusual phenomenon of aggregating at shell exchange markets [13] [14]. The vital need to upgrade shells throughout their lives means that hermit crabs are constantly on the lookout for bigger, better, and more spacious homes.

To increase the chances of encountering a suitable empty shell, hermit crabs use a range of tactics including: random locomotion, attendance at shell-supplying sites (where shells may be sourced or traded) and aggressive interactions with conspecifics [13]. Often the challenge is made more difficult because of the critically limited supply of these resources [15]. This has been previously acknowledged along the southern Atlantic coast of Brazil and is thought to be the reason crabs utilize gastropod shells of a wide range of shapes and sizes (i.e., up to 17 different species [16]). More recently, such limitation has been reflected in observations of hermit crabs utilizing a range of unusual shelters (e.g., barnacles and bivalves [17]) and even plastic debris derived from a certain brand of chocolate egg [18]. Such clear scarcity in limiting resources can drive crabs and other organisms to attempt exploitation of resources that can have adverse effects on fitness and survival.

Objective

In this short article, we present a curious case of resource exploitation that highlights the extremes to which hermit crabs may go to be the first to access limiting shell resources. During recent biodiversity surveys at Palmeiras Beach in Caraguatatuba Bay (Brazil), a hermit crab (*Isocheles sawayai*) was observed dead, tucked away behind the body of a still living but injured gastropod (*Olivancillaria vesica*). Here we report on this curious

incident and consider the possible causes and implications for hermit crab populations in shell limiting environments.

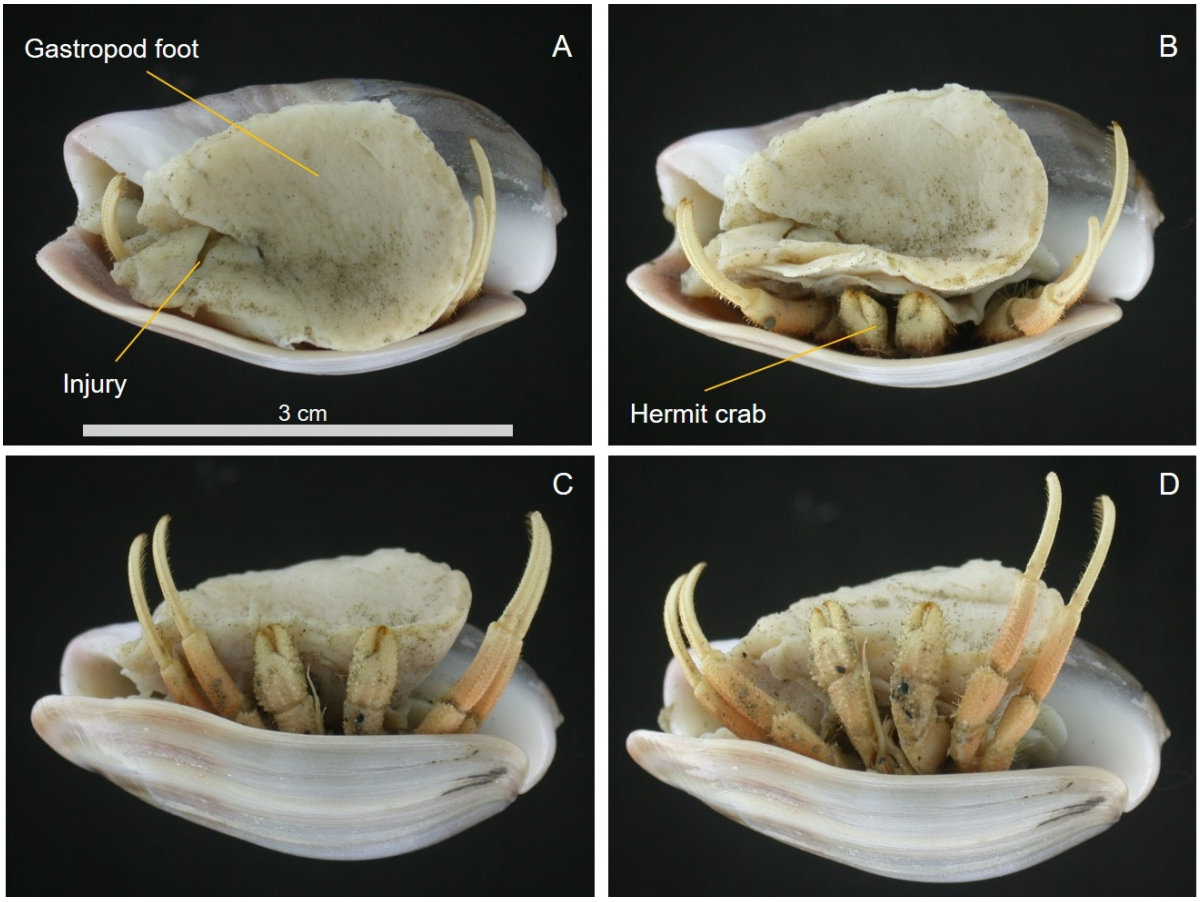

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Figure Legend

Figure 1. Extraction of the dead hermit crab (*Isocheles sawayai*) from behind the foot of a gastropod (*Olivancillaria vesica*) still in its shell.

(A) *In situ* condition as discovered in the field.

(B–D) The gradual removal of crab from the lower basal margin of the gastropod foot.

Note: The anterior of the shell points toward the right-hand side of the frame.

Results & Discussion

Upon collection, the body of the deceased hermit crab was almost completely obscured by the foot of the still living gastropod (Fig. 1A). Upon closer *in situ* inspection, the dactylus and the propodus of the second and third pereopods of the crab were found to be sticking out between the shell aperture and the gastropod foot (this species of gastropod does not have an operculum). Although still alive, the foot of the gastropod showed signs of a failed predation attempt, most likely from a species of large swimming crab known to use a tactic called 'peeling' that can lead to non-lethal injuries [19]. Figure 1(B-C) presents the extraction sequence for the hermit crab in the laboratory. The shield length (a most common measure of size) of the hermit crab was 5.8 mm, while the shell internal volume was 10 mL, making it a large and particularly desirable home if not occupied by the body of the gastropod.

Isocheles sawayai is a filter-feeding hermit crab that lives partially buried in sandy substrates within shallow coastal waters [20]. Although has been shown to inhabit the empty shells of *Olivancillaria vesica* it is not the preferred domicile shell species in sheltered environments (i.e., 5.6% of observations). In the surf zone, however, as was the case in the study area, these shells can act as a ballast for hermit crabs preventing burial and overturning by waves.

This is the first observation of a hermit crab is found dead inside the shell of a still-living gastropod that we could find in the published literature. This is surprising given that there have been decades of targeted work investigating the ecology of a range of common benthic intertidal species (including *Isocheles sawayai* [16]). While there is no way to know exactly how this curious incident came about, there are two plausible explanations. First, the crab searching for a replacement shell, encountered the live gastropod and preyed upon it in an attempt to secure its shell. Although our literature review revealed some species of hermit crabs have been shown to attack live gastropods in the laboratory [21], this has never been reported for this species or indeed any other group in nature. The second explanation is that like many other hermit crabs [22], this individual was attracted by the smell of the injured gastropod (almost certainly the result of a failed predation event) and climbed into the mantle cavity of the gastropod – as hermit crabs typically do when evaluating or exchanging shells. Subsequently, and while attempting to remove the remaining tissue, the individual became trapped by the contracting foot and was subsequently suffocated.

Although we will never know definitively how this curious incident occurred, it highlights the pitfalls of acquiring resources in limiting environments and is interesting from a perspective of marine ethology and evolutionary biology. Greater sampling within the study area may provide evidence on whether this is an isolated instance or whether it might be a more common phenomenon exhibited by this and perhaps other species of the hermit crab. It would also be interesting to evaluate if other hermit crabs (some of which live in extremely shell limiting environments) may engage in similar extreme behavior to be the first to access limited resources. Globally, it will become increasingly important to understand the responses of animals to decreasing resource availability within marine and coastal environments.

Conclusions

This curious incident involving a hermit crab and a gastropod highlights the pitfalls of acquiring resources in limiting environments and may have parallels for other organisms that covert space to survive and thrive.

Alternative Explanations

Conjectures

Greater sampling within the study area may provide evidence on whether this is an isolated instance or whether it might be a more common strategy exhibited by this species of the hermit crab. It would also be interesting to evaluate if other hermit crabs (some of which live in extremely shell limiting environments) may engage in this type of activity. Globally, it is going to become increasingly important to understand the potential responses to decreasing resource availability in intertidal environments.

Additional Information

Methods

The collection site was Palmeiras Beach, Caraguatatuba Bay (23°40'04.84S, 45°25'49.60W), located on the southeast coast of Brazil in the state of São Paulo.

As part of intertidal surveys done for a study into the population biology of the trigonal clam (*Tivela mactroides*) a range of specimens were sampled from intertidal quadrats along a wave-swept shore. The observation described in this short article involved a specimen of the hermit crab *Isocheles sawayai* [Forest & de Saint Laurent, 1968] and a typically non-preferred gastropod *Olivancillaria vesica* [Gmelin, 1791]. This hermit crab is a filter feeding infra-littoral species that lives partially buried in sandy substrates within shallow coastal waters along the western Atlantic coast, from Venezuela to Brazil (Santa Catarina) [20]. Upon discovery, the two organisms were photographed and preserved in ethanol (70% in seawater) for transportation to the benthic laboratory where the crab was extracted and properly identified. A subsequent literature analysis was undertaken to identify previous descriptions of this phenomena for this particular species and intertidal hermit crabs more generally.

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Ethics Statement

Not applicable.

Citations

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