Title: Are sandy beach scavengers calorie conscious? Food preferences of two sandy beach scavengers with different foraging strategies

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Background:
Understanding the rules that shape the foraging behaviour of animals has been a central theme in ecology for decades, with a focus on optimal foraging. Sandy beaches in particular, are interesting ecosystems to test foraging ecology as the resident fauna depend almost entirely on allochthonous resources, which are often unpredictable in their supply. According to the optimal foraging theory, it is predicted that animals will forage in such a way as to maximize their foraging efficiency i.e. net caloric intake per unit time to maximise fitness, by selecting food items with the highest energetic return. This can be achieved through different foraging strategies and/or food choices in their diet. Sandy beaches in particular, are interesting ecosystems to test optimal foraging ecology as the resident fauna consumers depend almost entirely on allochthonous resources, which are often unpredictable in their supply. One of the most common feeding guilds that have shown to be particularly dependant on such resources are beach scavengers. For this study, two globally abundant beach scavengers, namely ghost crabs (Ocypode spp.) and plough snails (Bullia spp.), were our species of interest.

Ghost crabs are highly mobile decapod crustaceans found on the shores of tropical and subtropical beaches. They are typically nocturnal and are often seen scampering on the beach surface in search for food. They have an acute sense of sight and smell, which enables them to respond rapidly to prey or beach deposits. Their diet is highly varied, and they often occupy several trophic levels: they have the ability to deposit feed, scavenge and are known to engage in cannibalism. Plough snails on the other hand, are gastropods most common on tropical, subtropical and temperate beaches. They are carnivorous, and locate their food primarily by olfactory sense as they have no eyes. In attempts to reach prey, they either crawl along the beach floor or surf the currents along the shore. Despite having very different foraging strategies, both scavengers have become well adapted to their environment and have sustained, in some cases, very large populations.

This study thus aims to determine whether these sandy beach scavengers show preferences for the food items they consume. The first objective was to test the food selections of ghost crabs (Ocypode ryderi) and plough snails (mostly Bullia rhodostomasp) when presented with a choice among food items. Furthermore, for plough snails we tested whether their response to food items were was consistent across all snail size classes, and if their response was a function of the food (trimethylamine) concentration. It was hypothesized that sandy
beach scavengers seek to maximize their foraging efficiency, in the sense of the optimal foraging theory, and thus it was predicted that, when presented with a choice (as in the case of ghost crabs), they will select the food item with the highest calorific content. It was also hypothesized that, because beaches have an erratic food supply, resident scavengers will be less discriminative selective of food items they choose when a feeding opportunity arises. It was therefore predicted that when food items are presented independently, as in the case of plough snails, individuals will respond equally in numbers towards a food item regardless of its calorific content. Furthermore, this response is predicted to be consistent across all snail size classes. Lastly, it was predicted that snail numbers would respond positively to the concentration of the food item’s cue.

**Methods:**

Predictions were tested in situ at two beach locations in KwaZulu-Natal (for ghost crabs) and Port Elizabeth (for plough snails), South Africa. Natural foraging conditions were simulated for ghost crabs and plough snails through simultaneous presentation and sequential presentation of food items respectively. For ghost crabs, food items were presented in the form of gelatine cubes which contained: liquidised pilchard (high calorific content), liquidised bluebottle (lower calorific content), blue-dye in the form of food colouring (colour control for bluebottle) and pure gelatine (control that was clear in colour). For each set of each of the four cubes, the food item first investigated and the first food item taken/consumed was recorded.

For plough snails, whole food items were given: pilchard (high calorific content) and jellyfish (low calorific content). These were presented one at a time after the other and selected at ordered at random. For each food item presented, photographs of the demarcated sampling area were taken for a set duration every Xs for the duration of 5 swashes, after which, and all plough snails within a 15-cm radius were collected and their shell length recorded. All photographs were later processed and plough snail abundances recorded.

Then, to test the response of plough snails to food concentration cues, five treatments were presented to the snails on the backwash of the swash in adjacent but separate plots in a random order. These treatments were a similar protocol was done as the above. A concentrated and diluted (with sea water) solution of liquidised fish and liquidised bluebottle were given, with a control of plain sea water. All snails present in the sampling area that emerged from the sand in response to each treatment were collected and their shell size measured.

**Results**

Ghost crabs preferred pilchard (highest calorific content) significantly more often than other food types with a rank order of pilchard, bluebottle, blue dye and pure gelatine cubes. Similarly, snail aggregations responding to fish were significantly larger than those responding to jellyfish (lower calorific content). This was consistent across all snail size classes, but was not affected by food-cue concentration.

**Conclusion:**

Results supported the first prediction in that both ghost crabs and plough snails showed preferences for calorie-rich foods, despite differences in their foraging strategies. For plough
snails, this result was consistent across all snail sizes, but was not affected by the strength of the food cue (within the concentrations tested). Due to preferences shown by both beach scavengers, the second prediction was not supported. It was therefore concluded that optimal foraging may hold true for both sandy beach scavengers through their individual foraging strategies and diet choices. They are therefore well adapted to their environment despite the unpredictability of their food supply.