Ruddy Turnstone	common	3-6	mollusks and crustacean	brown back, white belly, black and white face markings, orange legs	flocks in groups of 10-20, forages in mudflats, can be approached closely
Brown Pelican	common	6	fish	silvery brown above, dark neck, reddish bill	seen mostly in morning, solitary foragers often stand in the outer mudflats, flies in lines of ~15 low over water
herons	uncommon	3,4,6	fish and crustacean	tall shore birds, long bill; often Little Blue Herons, incl. juveniles	forage in intertidal for fish, crabs; usually solitary
raptors	rare	1	vertebrate	hooked bill, talons	perch on edge of forest, soar out over water; Osprey and Common Blackhawk seen
INSECTS					
dragonfly A	uncommon	2,3,4, 6	insects(?)	red, 7cm body; clear white wings	flying around mudflats. Little hovertime,
dragonfly B	uncommon	3,4,6	insects	brown, 5cm body, yellow wings with dark end spots	presumably feeding; often, the two types were seen together
yellow butterfly	common	1,2	?	yellow wings, about 5cm across	seen frequently throughout the day, alight only on plants of the forest edge
sandflies	common	1,2	?	small, flea that is found in the shade	active during low temperature times

+may actually include several spp. or subspecies with various colorations
*these fish were seen in flowing rivulets, not stagnant pools.

SHELL PREFERENCE IN HERMIT CRABS (*PAGURIDAE*)

Jennifer L. Burnaford, Kimberly A. Isaacs and Jack V. Ko

Abstract. We examined shell preference in hermit crabs on the Playa Sirena in Corcovado National Park, Costa Rica. We found that under natural conditions a significantly higher proportion of crabs occupied shells too small for them. We offered both conical and bubble shells to crabs in the lab; the proportion of crabs that chose conical shells was significantly greater than the proportion of crabs occupying conical shells in the field. Preference for conical shells was found to increase with increasing crab size. Shells were determined to be a limiting resource because the preferred sizes and types of shells appear to be unavailable in the field. Shell limitation appeared to be most severe for large crabs. (JLB)

INTRODUCTION (JVK)

Hermit crabs (*Paguridae*) are found in abundance along the world's coastlines. Because of their soft and vulnerable abdomens, the crabs utilize empty gastropod shells for protection. However, as the crabs get larger, they outgrow their shells and must search for new ones. We noticed that crabs along the Playa Sirena appear to be limited by shell availability, correct shell size, and possibly shell type. We observed two abundant shell types, conical or spiral shaped and bubble-like. While bubble shells appear to be more abundant, we wondered if conical shells might be preferred since the shell's internal structure could allow the crab to have a stronger grasp, therby making it more difficult for a predator to remove it.

We proposed three hypotheses to explain shell selection among hermit crabs of different sizes. Conical shells would be preferred over bubble shells because conical shells provide more protection. At the same time, the crabs would choose shells of adequate size to provide maximum protection but also ease of transportation. However, due to a limited availability of shells in the field, the types of shells used by crabs in the field would differ from the types of shells chosen by crabs in the laboratory.

METHODS (KAI)

This study was conducted along the Playa Sirena in Corcovado National Park, Costa Rica. We sampled hermit crabs from a 5m x 15m transect at the end of the Sendero Rio Sirena water line just after high tide. We collected all hermit crabs and empty shells from this area and measured shell length, shell type, and fit. The snail shells used by crabs of this area fell into two categories: conical

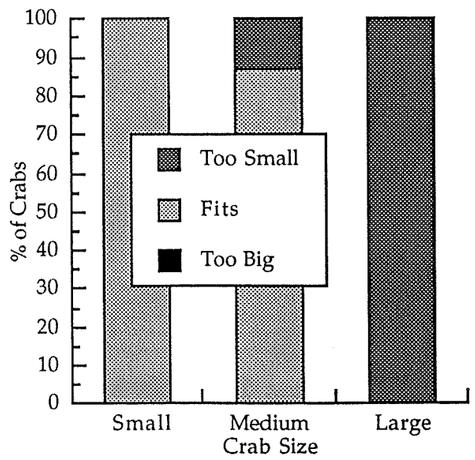

Figure 1. Hermit crab preference for shell size in the field.

(longer, more coiled shells) and bubble (shells resembling spheres cut in half). Three classifications of shell fit were used: small (body protruding from shell opening), fit (body flush to shell opening), and large (body capable of being withdrawn completely into shell). The ratio of shell length to width of shell aperture was then determined in the lab and shells were classified as small (aperture <7mm), medium (7.1-12.9mm), and large (>13mm). The width of the crab's cephalothorax was measured and classified as small (<5mm), medium (5.1-7.9mm), or large (>8mm). Crabs were removed from their shells by dipping the ends of the shells in hot water and pulling on the crabs.

Experiments were run on groups of five crabs: two small, two medium, and one large. Each group was provided with 18 shells: 3 shells of each type and size. The large shells used were collected outside the transect, because abundance of large shells was limited in our testing area. Trials were run for 30 min. After that time crabs were removed and size and type of shell chosen by each crab was recorded. Shells were reused for all trials. Sixteen manipulations were run on 80 crabs.

Results (KAI)

Significantly more hermit crabs in the field were found in shells that were too small for them when compared to crabs who were given a choice of shell sizes (χ^2=40.74, p<0.005; Table 1). While significantly more large crabs were found in small shells in the field (G=105.5, p<0.005; Table 2), the difference in shell fit was not significant across sizes in the lab (G=3.22, p>0.05; Table 3). When crabs were given a choice in the manipulations, 89% chose shells that fit.

Table 1. Shell fit as seen in the field and the laboratory in Corcovado, Costa Rica.

	Fit of shell		
	Too small	fit	Too large
Field	47	186	0
Lab	1	68	9

χ^2=40.74, p<0.005

Table 2. Fit of shell versus size of hermit crab found in the field in Corcovado, Costa Rica.

	Fit of shell		
Crab size	Too small	Fit	Too large
Small	0	130	0
Medium	8	56	0
Large	39	0	0

G=105.5, p<0.005

Table 3. Fit of shell versus size of hermit crab found in the laboratory manipulations in corcovado, costa rica.

	Fit of Shell		
Crab Size	Too Small	Fit	Too Large
Small	0	26	5
Medium	1	26	4
Large	0	16	0

G=3.22, p>0.05

Table 4. Shell type choice in hermit crabs, as observed in the field and as found in lab preference tests in Corcovado, Costa Rica.

	Shell type	
	Conical	Bubble
Field	78	156
Laboratory	42	36

χ^2=10.4, p<0.005

Table 5. Preference of shell type between large and small hermit crabs in Corcovado, Costa Rica.

	Shell type	
Crab size	Conical	Bubble
Small	13	18
Large	12	4

χ^2=4.62, p<0.05

Given a choice of shells, 21% more crabs were found in conical shells in the lab than those found in the field (Table 4). This preference for conical shells increases as crab size increased (χ^2=4.62, p<0.05; Table 5).

Discussion (JVK)

The fact that only one empty shell was found on the beach suggests that empty shells are not readily available under natural conditions. While preference for well fitting shells was shown in the lab, the high number of crabs found in the field with shells too small for them suggested that shells of correct size were also limiting, especially for larger crabs. The comparison of crab size and shell type preference in the lab and in the field suggests that the preferred conical shells were also limited in number, again with larger crabs being most affected. We concluded that shell limitation is a more important factor for large crabs than for medium or small crabs since larger crabs are less often found in shells of adequate size and preferred type.

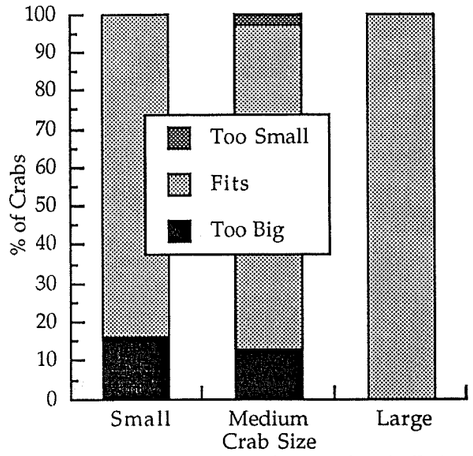

Figure 2. Hermit crab preference for shell size in the lab.