

SHELL COVER AS AN ESTIMATE OF FITNESS IN HERMIT CRABS

WILLIAM C. GRANT, JR. AND PAUL PONTIER. WILLIAMS COLLEGE, WILLIAMSTOWN, MASSACHUSETTS

Differential fitness of phenotypes is central to the concept of natural selection. Recently Schoener (Science 185:27-39) and Vance (Ecology 53: 1052-1074) have indicated that there is actually little overt evidence for fitness among individuals of natural populations. The *Anomura* provide an extremely valuable tool for evaluating the relative status of individuals in their environment because the mollusc shell occupied by any hermit crab is an environment of constant and measurable proportions. The present studies have been aimed at estimating the fitness of crabs inhabiting gastropod shells of different size categories under conditions of predation and by applying environmental stress in the form of DDT. Two species of hermit crab, *Pagurus acadianus* and *P. arcuatus* were used in these studies.

TABLE 1

PREDATION OF HERMIT CRABS IN SHELLS OF VARIOUS SIZE
RELATIVE TO CRAB WEIGHT

Shell Type	<i>P. acadianus</i>			<i>P. arcuatus</i>		
	No. Crabs Introduced	Total Eaten	Percent Predation	No. Crabs Introduced	Total Eaten	Percent Predation
Small SAI>1	35	32	91.4	37	33	89.1
Normal SAI=1	21	8	38.0	23	11	47.8

The appropriate size shell for any hermit crab was estimated by the use of a shell adequacy index, SAI (Grant, MDIBL Bulletin, 13:50-53). Crabs of both species occupying small shells and crabs in normal sized shells were selected according to the SAI. In each experiment one crab occupying an inappropriately small shell and one in a normal-sized shell were placed in a 45 x 55 cm. container with a rock crab (*Cancer irroratus*) for a period of a week. Crabs eaten during the course of the experiment were replaced every two days. The total number of crabs of each type and the rates of predation were recorded for each of fifteen separate experiments. The results are given in Table 1 complement the results of earlier studies which showed that crabs in broken shells were preyed upon more frequently than crabs in whole shells. Thus hermit crabs in shells of the appropriate size category and those inhabiting whole rather than damaged shells have a higher level of individual fitness to predation by rock crabs.

In analyzing the effects of DDT as a stressor agent hermit crabs were placed in glass beakers containing aerated sea water at 11-12°C with ¹⁴C ring-labelled DDT (N. E. Nuclear) at a concentration of 0.1 ppm. Volume was adjusted to 40 mg of crab tissue/1 ml of sea water. Aliquots (0.1 ml) of solution and whole crabs were removed at the end of six hours and placed in 2 ml Protosol (N. E. Nuclear) and 13 ml Aquafluor scintillation solution (N. E. Nuclear) to be counted by liquid scintillation spectrometry. Other crabs were placed in non-labelled, 0.1 ppm DDT solutions under the same conditions and their survivorship recorded over a 24-hour period. In both cases crabs were tested without shell and with shells with an SAI index of approximately 1.0, >1.0 and <1.0. The results of those studies are shown in Table 2.

TABLE 2
 SURVIVORSHIP PLUS UPTAKE OF DDT BY HERMIT CRABS AT 0.1 ppm DDT WITHOUT SHELLS
 AND WITH SHELLS OF DIFFERENT SAI VALUE

Species	SAI Index	Number Crabs	Percent Surviving Hours; DDT dose 0.1 ppm			6 hr. post ¹⁴ C DDT dose 0.1 ppm		
			6	12	24	Number Crabs	ppm DDT/crab	Percent Absorbed
<i>P. acadianus</i>	No shell	31	96.6	65.5	51.7	15	0.62±0.09	5.05
	approx. 1.0	9	100.0	100.0	100.0*	6	0.47±0.12	4.21
	0.73 (small shells)	9	77.8	55.6	44.4	6	0.65±0.21	5.25
	1.28 (large shells)	3	100.0	-	100.0	3	0.51±2.36	4.68
<i>P. arcuatus</i>	No shell	16	100.0	68.7	41.8	11	0.61±0.18	5.37
	approx. 1.0	6	100.0	83.4	83.4	4	0.52±1.80	4.54
	0.81 (small shells)	6	50.0	50.0	50.0**	4	0.59±2.37	5.18

*one crab out of shell
 **two crabs out of shell

It is clear from survivorship values that hermit crabs of both species have higher fitness in appropriately sized shells than they do out of shells or in shells that are too small when DDT is used as a stressing agent. *P. acadianus* in large shells also have high survival values. The degree of protection afforded by larger shells and those of the appropriate size is consistent with the fact that crabs so protected absorb about 20 percent less DDT than do exposed crabs or those in small shells. That individuals of the latter group with SAI >1.0 show somewhat higher initial mortalities may be explained on the basis of previous studies which have shown that crabs occupying small sized shells became hypersensitive and highly aggressive.

The results of this study indicate that Gastropod shells afford hermit crabs significant protection from both predators and short term pulses of DDT induced environmental stress at concentrations of 0.1 ppm or above. The size of the shells occupied by crabs according to a shell adequacy index may be used as a reliable indicator of relative fitness in individual crabs.

(Supported by NSF Grant GB-31548.)

1974 #12

A SELECTIVE EFFECT OF CHROMATE ON RENAL UREA REABSORPTION IN *Squalus acanthias*

HENRY O. HEINEMANN, NICHOLAS FRANKI, HENRY BERLINER, AND RICHARD M HAYS.
DEPARTMENT OF MEDICINE, DIVISION OF NEPHROLOGY, ALBERT EINSTEIN COLLEGE OF
MEDICINE; AND CORNELL UNIVERSITY MEDICAL COLLEGE, NEW YORK, NEW YORK

Urea crosses the cell membrane of the erythrocyte and the toad bladder by a pathway which is distinct from that of water, and by a process that has the properties of facilitated diffusion. Urea movement across these tissues can be selectively and reversibly blocked by phloretin. Urea reabsorption