crepancy could be due to either a) difference in excretion rates of TMAO under the two conditions (free swimming versus confinement in a 3L aquarium); b) in complete equilibration of TMAO in the internal compartment; c) both. Nevertheless, the lack of correlation between endogenous TMAO biosynthesis and the magnitude of the loss coefficient strongly suggests that the ability of some elasmobranchs (lemon and nurse sharks) but not others (spiny dogfish and little skate) to synthesize TMAO is not related to differences in excretion rates.

In a separate study we measured and compared ^{14}C-TMAO and total TMAO concentrations in plasma, liver, kidney, muscle, skin, and cartilage. Table 2 shows these concentrations and the relative specific activities of ^{14}C-TMAO in these organs. The steady-state specific activities were significantly higher than plasma in liver and cartilage and lower as indicated above in muscle.

TABLE 2

CONCENTRATIONS OF ^{14}C-TMAO AND TOTAL TMAO IN PLASMA AND ORGANS OF DOGFISH, *Squalus acanthias*

Organ	^{14}C-TMAO $\left(\frac{\text{dpm/g organ}}{\text{dpm/ml plasma}}\right)$ x100	TMAO (μmole/ml or g)	Relative Specific Activity (S.A. Organ/S.A. plasma x100)
Plasma	-	71 ± 5	-
Skin	54 ± 4	35 ± 3	110
Muscle	40 ± 8	138 ± 6	21
Cartilage	80 ± 11	21 ± 5	271
Liver	125 ± 14*	40 ± 7*	222
Kidney	82 ± 9	53 ± 10	110

Values are means (± S.E.) of five fish per group. *Value corrected for water content (30%).

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1973 #21

FITNESS IN THE HERMIT CRAB *Pagurus acadianus* WITH REFERENCE TO *Hydractinia echinata*

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Jensen, 1970 (Ophelia 8: 135-144) has shown that European hermit crabs *Pagurus bernhardus* have a preference for mollusc shells colonized by the hydroid *Hydractinia echinata* and Wright, 1973 (Nature 241: 139-140) has suggested that the possession of commensal hydroids may be an important factor in interspecific competition between hermit crabs. These studies have been confirmed by Grant and Ulmer 1974 (Biol. Bulletin: in press) for *Pagurus acadianus* individuals of which show strong preference for *Hydractinia*-colonized shells. Under some conditions preference may favor coexistence of *P. acadianus* with *P. pubescens*, a related, sympatric species which inhabits the same types of mollusc shells but avoids shells colonized by hydroids. The present study was undertaken to see in what other ways the possession of colonized shells might be advantageous to individuals of *P. acadianus* in increasing individual fitness.

1. *Dominance:* In each of 36 ten-minute trials dominance was recorded between members of a pair of *P. acadianus* crabs of the same size, one housed in a plain shell and the other in a colonized shell. In 73.8 percent of the trials crabs in *Hydractinia*-colonized shells showed dominance although no attacks involving physical contact were made on subordinate individuals. However in those few cases where crabs in plain shells were dominant attempts were made to evict subordinates for their colonized shells.

2. *Shell Adequacy:* The method of Vance 1973 (Ecology 53: 1062-1074) was adapted to measure size adequacy of shells occupied by hermit crabs. Fifty crabs of all sizes were allowed to select shells over a 72-hour period from a large pool (500 shells) containing a wide range of shell sizes. A linear regression equation was calculated for width of shell in mm/crab weight in grams in order to derive a shell adequacy index (SAI). An SAI value of 1.0 indicates that a shell occupied by a crab is of the preferred size according to the calculated index; if greater or less than 1.0 the shell is larger or smaller respectively. SAI values for individual crabs inhabiting plain or colonized shells were calculated from field collections made in the Salsbury Cove area of Frenchman Bay. These results are shown in Figure 1 where each point represents the mean SAI for crabs within the size range indicated. The

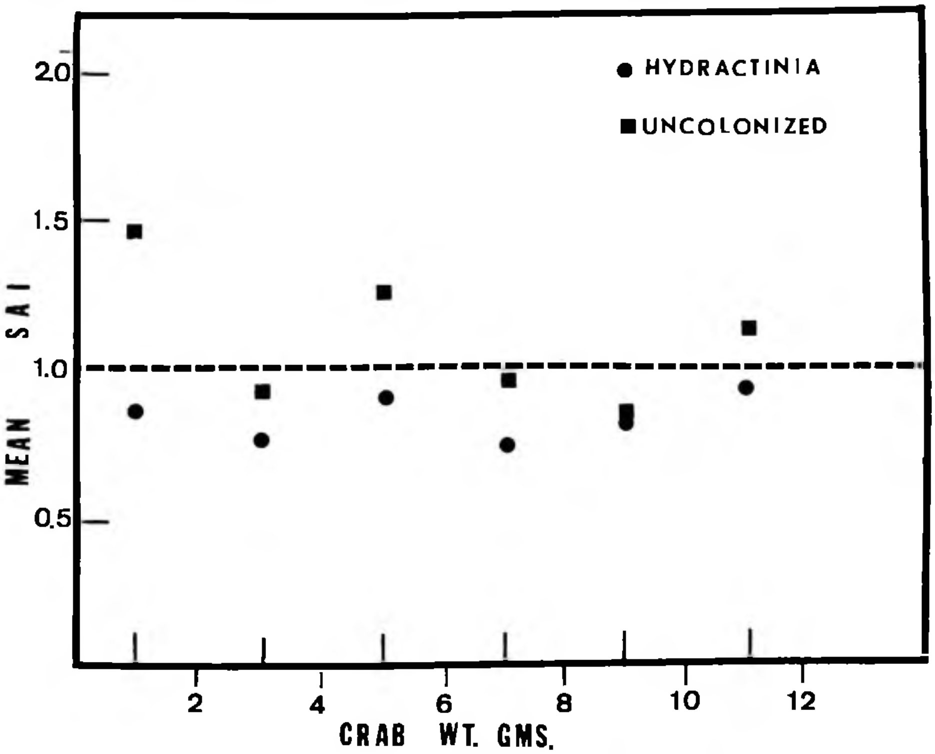

Fig.1 SHELL ADEQUACY INDICES

mean SAI for hermit crabs in plain shells approached 1.0 but was significantly less at 0.85 + 0.06 for those inhabiting shells with *Hydractinia* colonies.

3. *Predation:* Vance 1973 (Ecology 53: 1075-1083) suggests that occupancy of inadequately large shells affords hermit crabs more protection from predation by rock crabs than does possession of smaller shells. Inhabitation of *Hydractinia*-colonized shells as well as the physical condition of occupied shells could also act as significant deterrents to predation. To test this assumption each of a group of rock crabs *(Cancer irroratus)* was presented with three hermit crabs; one in a complete shell, one in a damaged shell, and one in a colonized shell for a period of one week during which any hermit crabs eaten were replaced by new specimens at 48-hour intervals. The overall predation was 53.8 percent of the total number of hermit crabs introduced. Within shell categories predation varied from 81.8 percent for crabs in damaged shells to 18.2 percent for those in whole shells. No crabs inhabiting shells with *Hydractinia* colonies were eaten.

In another series of tests crabs occupying mollusc shells of varying condition (Type 1 - whole shell, Type 2 - partially damaged shell, Type 3 - badly damaged shell) were allowed to select from a large pool of shells of appropriate size containing specimens in all three types of condition. The distribution of shell types occupied at the beginning and end of the test period and the percent shift between categories is shown in Table 1. During tests the number of crabs occupying whole shells (Type 1) rose by 76.6 percent.

TABLE 1

Selection of shells over a three-day period by individuals of *P. acadianus* according to the physical state of the shells: Type 1 = complete shell, type 2 = partially damaged, type 3 = damaged.

	SHELL TYPE		
	1	2	3
First Trial:			
Initial distribution of crabs by shell type	15	11	4
Final distribution at termination of trial	28	2	0
Second Trial:			
Initial distribution of crabs by shell type	15	11	4
Final distribution at termination of trial	25	2	3
Percent change of shell type in both trials	+76.6%	-81.8%	-62.5%

It is concluded that possession of *Hydractinia*-colonized shells by individuals of *P. acadianus* constitutes an effective defense against predation and serves to increase individual fitness. Preference shown by many hermit crabs for undamaged mollusc shells suggests a behavioral adaptation which also affords greater security against predators. The crabs in colonized shells occupied mollusc shells smaller than the preferred range suggests that there may be a selective advantage in maintaining possession of shells with *Hydractinia* colonies even if SAI values are low. The dominance characteristics displayed by hermit crabs in colonized shells supports the above view as such individuals although dominant appear to avoid direct combat. In these circumstances dominance plays essentially a defensive role by serving to reduce shell exchange between individuals inhabiting colonized and those occupying uncolonized shells.

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1973 #22

THE UPTAKE OF 2-DEOXY-D-GLUCOSE BY THE CHOROID PLEXUS OF THE DOGFISH *Squalus acanthias*

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The epithelial cells of the dog choroid plexus actively accumulate D-glucose and D-galactose (Csáky and Rigor, Life Sci. 3:931, 1964). As part of a comprehensive project on the sugar transport in the choroid plexus of the dogfish *(Squalus acanthias)*, the uptake of 2-deoxy-D-glucose by this tissue was investigated.

The choroid plexi of the third (including also the plexi of the lateral ventricles) and the fourth ventricle were rapidly removed from decapitated animals by cutting of the tissue close to its attachment. The tissues were separately placed into ice-cold dogfish Ringer solution for no longer than 15 minutes. The pooled plexi (of either the third or the fourth ventricles) of three animals were then placed into 2.5 ml dogfish saline containing usually 1 mM 2-deoxy-D-glucose-^{14}C of the required specific activity (usually 0.2 μCi/ml) without or with other sugars. Aerobic incubation (air as gaseous phase) was then carried out at 15°C with occasional shaking. At the end of the incubation each piece of tissue was blotted, weighed, and placed into a homogenizing tube containing 2 ml water at 100°C for 10 minutes. The subsequent analytical procedure for the determination of tissue sugars was that described previously (Kleinzeller and McAvoy, J. Gen. Physiol. 62:169, 1973). In short the tissue was homogenized, the tubes were centrifuged and a portion of the supernatant was taken for the determination of the total (free plus phosphorylated) sugar. Free sugar was then determined after precipitation of the phosphorylated components by the $ZnSO_4$-$Ba(OH)_2$ procedure. Scintillation spectrometry was employed for the determination of radioactivity. The data are expressed as the tissue/medium (T/M) ratio of total sugar. Such an approach is justified on the assumption that the transport of free sugar across the membrane is the rate-limiting step, phosphorylation taking place within the cells. A considerable spread of T/M values for tissues of different animals was observed.

The time curve for the uptake of 2-deoxy-D-glucose showed that the choroid plexi of both ventricles took up the sugar at a rapid rate; even after two-hour incubation no steady state was