The Effect of Starvation on the Lipid and Carbohydrate Levels of the Gut of the Tropical Sea Urchin *Echinometra mathaei* (de Blainville)[1]

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THE UTILIZATION during starvation of the nutrient reserves in the gut of a temperate water sea urchin, *Strongylocentrotus purpuratus,* was measured by Lawrence et al. (1966). There have been no investigations of the utilization of reserves in the gut of tropical urchins, although the level of reserves in the gut of several tropical species has been reported (Giese et al., 1964; Lawrence, 1967). The results presented in this paper concern the levels of total lipid, neutral lipid, and carbohydrate, and the changes that occur with starvation in the gut of the tropical sea urchin *Echinometra mathaei* (de Blainville).

MATERIAL AND METHODS

Specimens of *Echinometra mathaei* were collected intertidally in the channel separating Eniwetok Island from Sand Island, Eniwetok Atoll, Marshall Islands (11°21′ N, 162°21′ E). Urchins were collected on August 2 and August 24, 1968, for analysis. Twenty individuals were starved in the laboratory over that period of time (24 days). The urchins were maintained in the laboratory with running unfiltered seawater (30°C).

The size of the gut, gonad, test, and lantern relative to the size of the body is expressed as the appropriate index, as recommended by Giese (1966) to provide more complete information about the urchins.

The gut, exclusive of the pharynx, was removed and washed free of its contents. The tissue was dried in a vacuum desiccator over sulfuric acid and homogenized with a mortar and pestle for analysis. The tissue from each group of animals was pooled for analysis as was done by Pearse (1965).

Total carbohydrate was measured by the sulfuric acid-phenol method of Dubois et al. (1956). Oyster glycogen was used for the standard curve. Total lipid was extracted from the dried tissue by the method of Freeman et al. (1957). The extracted lipid was fractionated into its neutral lipid fraction on silicic acid columns following Freeman et al. (1957) as modified by Towle (1961).

RESULTS

The values obtained from the three groups of animals are given in Table 1.

Although the gut index was lowest in the starved animals, the variations in all three groups overlapped. The low gonad index of the starved animals resulted from their spawning soon after being brought into the laboratory.

The level of total lipid was highest in the gut of the field animals collected at the end of the experiment. There was no change with starvation in the level of total lipid in the group which was collected at the beginning of the experiment. The level of neutral lipid in the gut was the same in both groups sampled immediately upon collection, but was lower in the gut of the starved animals. The level of carbohydrate also was lowest in the gut of the starved animals.

DISCUSSION AND CONCLUSIONS

The levels of total lipid in the gut of *Echinometra mathaei* found here are in the lower range of values which have been reported for other species of sea urchins (Giese, 1961; Lawrence et al., 1966; Lawrence, 1967; Pearse and Giese, 1966). The total lipid of the gut of a Caribbean member of the same genus, *E. lucunter,* was 18 percent of the dry weight. How-

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TABLE 1

THE GUT AND GONAD INDICES, AND THE LEVELS OF TOTAL LIPID, NEUTRAL LIPID, AND CARBOHYDRATE IN THE GUT OF *Echinometra mathaei* COLLECTED FROM THE FIELD AND STARVED IN THE LABORATORY

	DATE COLLECTED/DATE KILLED		
	AUGUST 2/ AUGUST 2	AUGUST 24/ AUGUST 24	AUGUST 2/ AUGUST 26 (STARVED)
Gut index[a]	1.0 + 0.3	1.3 + 0.45	0.82 + 0.12
Gonad index	3.6 + 2.4	2.5 + 1.0	1.9 + 1.3
Total lipid[b]	10	15	11
Neutral lipid[c]	58	58	45
Carbohydrate[d]	3.8	3.4	3.1

[a] The values for indices represent the mean ± 1 standard deviation.
[b] In percent of dry weight.
[c] In percent of total lipid.
[d] In percent of dry weight.

ever, the gut of *E. mathaei* from the field had a level of neutral lipid in the gut similar to that reported for three Caribbean species of sea urchins, including *E. lucunter* (Lawrence, 1967), and higher than that reported for a temperate water species (Lawrence et al., 1966).

The decline in the level of neutral lipid in the gut of *E. mathaei* with starvation supports the suggestion (Lawrence et al., 1966; Lawrence, 1967) that the level of neutral lipid in the gut of the sea urchin is indicative of the nutritional condition of the animal. Lawrence et al. (1966) found that starvation for 41 days resulted in a decrease in the level of neutral lipid in the gut of *Strongylocentrotus purpuratus,* a temperate water urchin, from 50 percent to 30 percent of the total lipid. In the present study, 24 days' starvation resulted in a fall of the level of neutral lipid in the gut of *Echinometra mathaei* from 58 percent to 45 percent of the total lipid. A direct comparison of the rates of change in the two species living at different temperatures is difficult because of the different proportions of the body components (see Giese, 1966, for a discussion of body components). For example, *Strongylocentrotus purpuratus* had an average weight of 50 grams, and the sum of the lantern and test indices was 62. The specimens of *Echinometra mathaei* used in this study had an average weight of 35 grams, and the sum of the lantern and test indices was 78.

The low levels of carbohydrate found in the gut of *E. mathaei* are comparable to levels found in other species of sea urchins (Giese, 1966; Lawrence et al., 1966; Pearse and Giese, 1966). The decline in the carbohydrate level of the gut of *E. mathaei* with starvation is similar to that found by Lawrence et al. (1966) for *Strongylocentrotus purpuratus.*

The level of neutral lipid in the gut of sea urchins appears to be a valid indicator of the nutritional condition. As the level of neutral lipid is more sensitive to nutritional changes, it appears to be a better criterion of nutritional condition than the relative size of the gut, the level of total lipid, or the level of carbohydrate.

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