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SQUAT LOBSTERS (GALATHEIDAE: *MUNIDOPSIS*) ASSOCIATED WITH MESH-ENCLOSED WOOD PANELS SUBMERGED IN THE DEEP SEA

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ABSTRACT

Four species of galatheids, *Munidopsis crassa, M. curvirostra, M. nitida,* and *M. subsquamosa* were recovered from mesh-enclosed wood panels placed near experimental "wood islands" in the deep sea and retrieved with the aid of the deep submersible research vessel *Alvin.* Samples of the first and third of these species were large enough to allow regression analysis of carapace width and short carapace length. Five individuals of *M. crassa* which grew beyond 10-mm carapace width and thus were trapped within the bags are speculated to have increased this width by 1.86 mm ± 2.17 (SD) per month during a 9.6 ± 3.71 (SD)-month period. However, real growth of both this species and the smaller *M. nitida* remains untested. Notes on geographic distribution of the species and stomach contents are given.

Published information on deep-sea squat lobsters of the genus *Munidopsis* consists mainly of the original descriptions, a few systematic reviews of selected groups, and distributional data for a few species gleaned from sporadic sampling. Only recently has sampling in the deep sea begun to produce collections that can be analyzed for attributes such as morphometric variation or growth.

Organisms attracted to wood enclosed in mesh bags, submerged at deep ocean stations and retrieved with the aid of the DSRV *Alvin,* were discussed by Turner (1977). The first of these experimental substrates retrieved was submerged for 15 months. Among individuals of several phyla found on the wood were squat lobsters, decapod crustaceans of the galatheid genus *Munidopsis.* Turner estimated that a month or two would have elapsed after submergence before there would have been significant settlement of encrusting or boring organisms on the wood and that another month might pass before predators such as worms and galatheids might be attracted. The smallest galatheid that she found measured 8 mm in total length and the remainder were between 24 and 45 mm in body length. On the basis of these data, she postulated that the squat lobsters, given sufficient food, could grow at a rate of 5 mm in total length per month. It is the purpose of this paper to reexamine these galatheid samples, identify the species present, determine the length-width relationships of the carapace of individuals, comment on growth rates indicated by the data, and give notes on distribution and food habits.

MATERIALS AND METHODS

Mesh openings of the nylon bags in which the wood panels were enclosed were diamond-shaped. The mesh was rather stiff, and, when tightly stitched in place in a single layer, its open spaces of 5 × 10 mm on the short and long axes allowed access by invading organisms to the wood within (Turner, 1977).

Squat lobsters retrieved from mesh-enclosed wood panels (Table 1) were identified to species, sexed, and catalogued in the crustacean collection of the National Museum of Natural History (USNM).

Measurements by dial calipers or ocular micrometer of the carapace length (CL) (tip of rostrum to posterior margin), short carapace length (SCL) (postorbital margin to posterior margin), and maximum carapace width (CW), for all megalopae to adults were recorded to the nearest tenth of a millimeter. (Megalopae are distinguished by relatively much longer pleopods than those of succeeding developmental stages.) Regression of short carapace length on width was calculated for the two species represented by samples large enough to analyze in this way. Short carapace length was chosen over total length because broken rostral tips prevent reliable total length measurements. For simplicity, Model I regression (Sokal and Rohlf, 1981) was applied here; although Model II regression is appropriate when the independent variable is subject to error, differences between the two models are inconsequential in this case. Speculation on growth rate was attempted for a few individuals of one species which grew large enough to become trapped within the mesh.

Results and Discussion

Observers in *Alvin* have noted that there are often many *Munidopsis* on experimental wood panels submerged in the deep sea, but that most of the animals actively swim off when panels are retrieved by *Alvin.* Although there is some uncertainty as to the maximum size of an individual *Munidopsis* that could pass through the 5 × 10-mm diamond-shaped nylon mesh enclosing the experimental panels, it seems reasonable that animals up to 10 mm in carapace breadth could do this. Length of time an experimental substrate is submerged gives only indirect information concerning the time at which an individual *Munidopsis* might settle on the wood. *Munidopsis* smaller than the mesh size of the enclosing bags might enter this meshwork early in the period of colonization and never again leave, but physical trapping can be assumed only for individuals larger than the mesh.

No *Munidopsis* have been retrieved from wood panels submerged for periods of 1–11 months, but they have been retrieved from panels submerged longer than that. If it is assumed that entrapment occurs at sizes greater than 10-mm CW, growth rate for such individuals can be estimated for the period extending from roughly 1 year after panel submergence to time of retrieval. This is admittedly a statistical exercise because food supply in the bagged panels may differ from that on the open deep-sea floor. Moreover, the premise could be negated by the presence of some galatheids which might become permanent residents after attraction to materials within the meshwork when <10-mm CW. Nevertheless, it seems worthwhile to analyze the information at hand, since there are no published estimates of growth rates for these animals other than the first estimates of Turner (1977).

Samples of four species of *Munidopsis* were recovered from the mesh bags (Table 1). These are discussed below as the data allow.

Munidopsis crassa Smith, 1885, ranges in the western North Atlantic from SE of Georges Bank, SE of Martha's Vineyard, off Cape Hatteras, N of St. Croix, to N of Islas Los Roques and Islas de Aves, Venezuela, in depths of 3,000–5,012 m (USNM); and in the eastern Atlantic has been reported from the Bay of Biscay, between the Azores and Portugal, and N of the Canary Islands, in depths of 4,255–4,700 m (Miyake and Baba, 1970). Gore (1983) gleaned other details from both published and unpublished sources concerning distribution of the species within this geographic range, including a bathymetric span of 2,514–5,275 m, and noted the need for clarification of the distinction between this species and a set of closely related species, *M. subsquamosa* Henderson, 1885, *M. aculeata* Henderson, 1888 (as *M. subsquamosa aculeata*), and *M. barnardi* Kensley, 1968.

A scattergram of SCL versus CW for the samples of *M. crassa* is shown in Fig. 1 and regression of the data points is given in Table 2.

Only 6 *M. crassa* (Fig. 1), grew too large to escape the mesh, and hence became confined within it. The smallest confined *M. crassa* (13.6-mm CW) was taken from wood panels submerged for 23 months (Table 1), but paradoxically, one of the largest of these trapped animals (26.6-mm CW) was also taken from bagged panels submerged for 23 months.

Five of the *M. crassa* >10-mm CW, for which both submergence and retrieval dates are complete, could have been confined within bagged panels for an estimated 3–12 ($\bar{x} = 9.6 \pm 3.71$ SD) months. Growth of CW among these is calculated

Table 1. Samples of *Munidopsis* recovered from mesh-enclosed "wood islands" submerged and later recovered from stations in the northwestern Atlantic with aid of DSRV *Alvin*. Only measured specimens are included in tabulation.

Station	Submergence		Removal		Months down	Species	Number of specimens
	Dive	Date	Dive	Date			
Deep Ocean Station 1,	597 and	30 Aug 1975	773	29 Jul 1977	23	*M. curvirostra*	1
110 miles (177 km) S	685	17 Aug 1976	773	29 Jul 1977	11	(merged samples)	
Woods Hole, Mass.							
39°46'N, 70°41'W,							
1,830 m							
Deep Ocean Station 2,	1026	27 Jul 1980	1311	17 Jul 1983	36	*M. crassa*	1
190 miles (306 km) SE	1026	27 Jul 1980	1312	18 Jul 1983	36	*M. crassa*	1
Woods Hole, Mass.	1026	27 Jul 1980	1312	18 Jul 1983	36	*M. crassa*	3
38°18.4'N, 69°35.6'W,	777	3 Aug 1977	1028	29 Jul 1980	35+	*M. crassa*	2
3,506 m	790	23 Sep 1977	1031	3 Aug 1980	35+	*M. crassa*	4
	817	29 Jun 1978	1026	27 Jul 1980	25	*M. crassa*	7
	601	5 Sep 1975	777	3 Aug 1977	23	*M. crassa*	2
	601 and	5 Sep 1975	790	23 Sep 1977	24	*M. crassa*	
	602	6 Sep 1975	792	26 Sep 1977		(merged samples)	10
	681 and	13 Aug 1976	817	29 Jun 1978	9–22	*M. crassa*	
	790	23 Sep 1977	819	29 Jun 1978		(merged samples)	1
	657 and	10 Jun 1976	790	23 Sep 1977	13–15	*M. crassa*	
	681	13 Aug 1976	790	23 Sep 1977		(merged samples)	1
Tongue of the Ocean, Ba-	564	8 May 1975	1070	11 Nov 1980	66	*M. nitida*	1 +
hamas, 24°53.2'N,							fragment
77°40.2'W, 2,066 m	492	20 Jan 1974	754	11 May 1977	46	*M. nitida*	2
	563	6 May 1975	850	10 Nov 1978	42	*M. nitida*	2
	564 and	8 May 1975	849	9 Nov 1978	42	*M. nitida*	
	752	9 May 1977	1069	10 Nov 1980	18	(merged samples)	3
	564	8 May 1975	850	10 Nov 1978	42	*M. nitida*	17
	752	9 May 1977	1069	10 Nov 1980	42	*M. nitida*	1
	492	20 Jan 1974	751	8 May 1977	40	*M. nitida*	24
	552	19 Apr 1975	753	10 May 1977	25	*M. nitida*	17
	563	6 May 1975	754	11 May 1977	24	*M. nitida*	31
	564	8 May 1975	752	9 May 1977	24	*M. nitida*	14
	564	8 May 1975	754	11 May 1977	24	*M. nitida*	12
	564	8 May 1975	755	12 May 1977	24	*M. nitida*	12

Table 1. Continued.

Station	Submergence Dive	Submergence Date	Removal Dive	Removal Date	Months down	Species	Number of specimens
	849	9 Nov 1978	1068	9 Nov 1980	24	*M. nitida*	9
	752	9 May 1977	849	9 Nov 1978	18	*M. nitida*	3
	752 and	9 May 1977	852	12 Nov 1978	18	*M. nitida*	
	755	12 May 1977	851	11 Nov 1978	18	(merged samples)	13
	755	12 May 1977	852	12 Nov 1978	18	*M. nitida*	7
	493	21 Jan 1974	563	6 May 1975	15	*M. nitida*	3
	492	20 Jan 1974	563	19 Apr 1975	14	*M. nitida*	11
	Destroyed board		751	8 May 1977	?	*M. nitida*	8
St. Croix, off N Coast.	873	17 Dec 1978	1079	6 Dec 1980	24	*M. crassa*	6
17°56.63'N, 64°48.6'W,	873	17 Dec 1978	1080	7 Dec 1980	24	*M. crassa*	8
4,000 m	873	17 Dec 1978	1082	13 Dec 1980	24	*M. crassa*	8
	875	19 Dec 1978	1078	5 Dec 1980	24	*M. crassa*	3
	1078						
	1079	5–6–7 Dec	1287	16 Nov 1982	23	*M. crassa*	
	1080	1980				(merged samples)	1
	875	19 Dec 1978	?	— — —	24	(indeterminate species)	2?
	873		1078	5–6–13 Dec			
	874	17–18–19	1079	1980		*M. subsquamosa*	
	875	Dec 1978	1082				
			1288	17 Nov 1982		(merged samples)	6

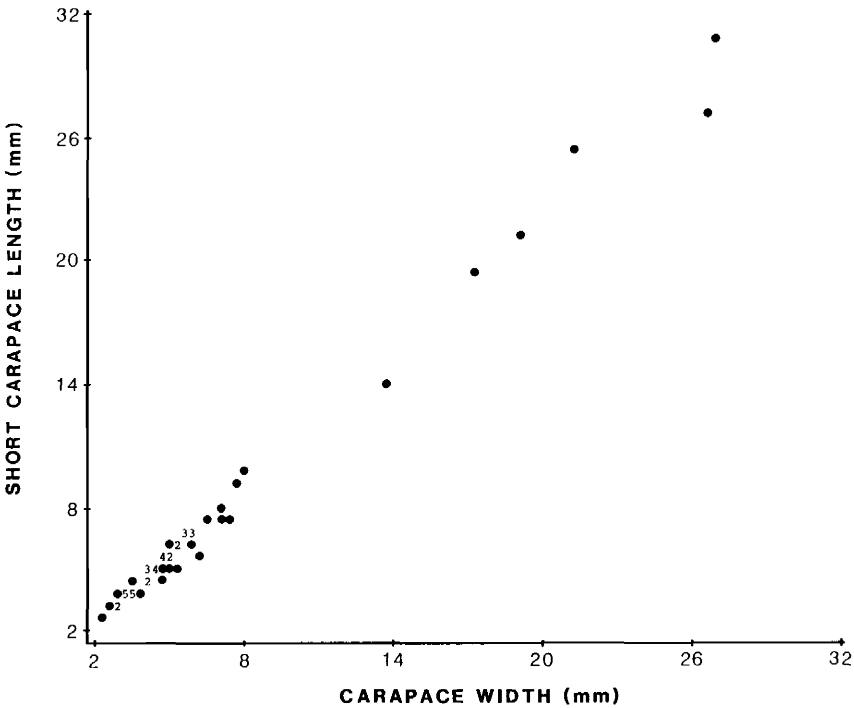

Fig. 1. Scattergram of short carapace length against carapace width for sample of *Munidopsis crassa* recovered from "wood islands" submerged in the deep sea. Each digit represents multiple points. Statistics given in Table 2. Equation of best fit line: $Y = 0.07021 + 1.10711\ X$.

as a mean of 10.78 mm ± 5.28 SD after confinement in the bags, or 1.86 mm ± 2.17 SD per month (Table 3). The short estimated period of entrapment for the second individual from Deep Ocean Station 2 (Table 3) may account for its large SD in monthly rate. That individual may actually have gained residence at a size smaller than the mesh size and benefited thereafter from enhanced food supply.

Munidopsis curvirostra Whiteaves, 1874, ranges in the North Atlantic from Davis Strait and Iceland, in depths of 650–1,800 m, into the western Atlantic where it is known from the St. Lawrence estuary and Nova Scotian shelf, southward to off Cape Fear, North Carolina, in depths of 137–2,359 m (Brunel, 1970; Squires, 1965), and in the eastern Atlantic from Ireland and Bay of Biscay to off Cape Ghir, Morocco, at 1,490–2,212 m (Miyake and Baba, 1970, in part). Only 1 broken specimen was taken.

Munidopsis nitida (A. Milne Edwards, 1880) ranges in the western North Atlantic from the Gulf of Mexico, N Campeche Bank, 28°47′N, 87°50′W and 27°48′N, 88°45′W, through the West Indies to Dominica, in depths of 1,407–3,968 m (A. Milne Edwards and Bouvier, 1897, and USNM). Milne Edwards and Bouvier also reported this species in the Pacific Ocean from the Aru Islands SW of New Guinea and between Papua and the Amirante Islands, in depths between 1,463 and 1,957 m.

A scattergram of SCL against CW for the sample of *M. nitida* measured is shown in Fig. 2 and regression of the data points is given in Table 2.

The shortest well-documented submergence time for experimental wood panels that contained *M. nitida* was 14 months (Table 1). Since only two of the animals

Table 2. Linear regression analysis for width (*X*) and short carapace length (*Y*) in mm for samples of two species of *Munidopsis* recovered from wood panels submerged in the northwestern Atlantic Ocean. Station data are given in Table 1.

Species	Data pairs	Mean X	Mean Y	Minimum	Maximum	SD	Slope	Intercept	r^2
M. crassa	59	6.29		2.20	27.00	5.318			
			7.04	2.50	30.90	5.913			
							1.10711	0.07021	0.9915
M. nitida	182	3.70		2.00	11.00	1.763			
			4.24	2.20	14.20	2.228			
							1.2522	−0.39709	0.9824

in these samples exceed 10 mm in CW, growth rate of captives based on them cannot be refined beyond the estimate for increase in total length made by Turner (1977) that is cited in introductory remarks above, for we have now identified the species she discussed as *M. nitida.*

It is difficult to compare this first estimate with ours for *M. crassa,* since these species are markedly different in size at maturity. Among the samples of *M. crassa,* only one animal approximates 10 mm in CW, i.e., 8 mm, 20.2 mm total length. Growth of total length beyond that size among the 5 *M. crassa* could have been a calculated mean of 40.92 mm ± 16.53 SD after entry into the bags, or 6.56 mm ± 7.56 SD per month (Table 3). The speculative growth rates at least harmonize with the specific size differences.

Munidopsis subsquamosa Henderson, 1885, ranges around the world at scattered localities off Japan, the Bay of Bengal, in the eastern Pacific from Cascade Basin off Coos Bay, Oregon (Ambler, 1980), to vicinity of the Galapagos Rift zone, 00°48′N, 86°07′W, and in the western Atlantic SE of New England (USNM), Gulf of Mexico off Campeche Banks, 23°30′N, 95°32′W, through the Colombian Basin S of Jamaica (Pequegnat and Pequegnat, 1970, 1971), to the Venezuelan

Table 3. Growth data in mm for five specimens of *Munidopsis crassa* trapped with mesh-enclosed wood panels, retrieved after submergence in the deep sea (see Table 1 for locality data).

Locality	Months down	Carapace width − 10 mm =	Growth inside mesh	Months inside mesh	Growth/month inside mesh
Deep Ocean Station 2	24	19.0	9.0	12	0.75
	15	27.0	17.0	3	5.67
	23	21.2	11.2	11	1.01
	23	26.6	16.6	11	1.51
St. Croix	23	13.6	3.6	11	0.33
			$\bar{x}$ = 10.78 ±5.28 (SD)		$\bar{x}$ = 1.86 ±2.17 (SD)
		Total length − 20.2 mm =			
Deep Ocean Station 2	24	55.7	35.5	12	2.96
	15	80.0	59.8	3	19.93
	23	66.2	46.0	11	4.18
	23	67.8	47.6	11	4.33
St. Croix	23	35.9	15.7	11	1.42
			$\bar{x}$ = 40.92 ±16.53 (SD)		$\bar{x}$ = 6.56 ±7.56 (SD)

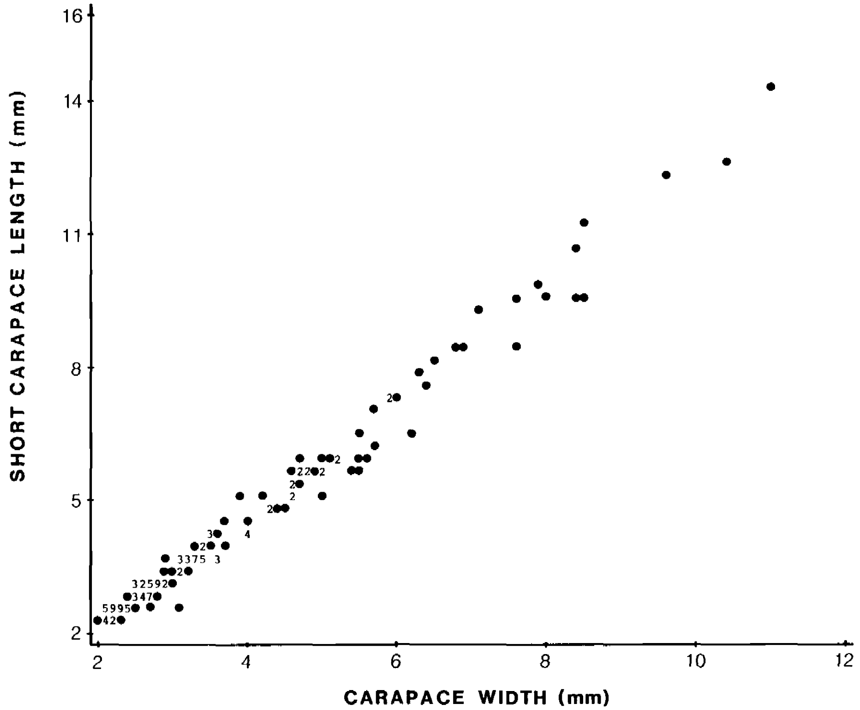

Fig. 2. Scattergram of short carapace length against carapace width for sample of *Munidopsis nitida* recovered from "wood islands" submerged in the deep sea. Each digit represents multiple points. Statistics given in Table 2. Equation of best fit line: $Y = -0.39709 + 1.2522\ X$.

Basin (Gore, 1983, USNM) and N of St. Croix (USNM), and in the eastern Atlantic in the Gulf of Gascogne (de Saint-Laurent, 1985), in depths of 1,829–4,151 m. Interpretations of the taxonomic status of *M. subsquamosa* (Ambler, 1980; Gore, 1983; de Saint Laurent, 1985) remain to be clarified by studies now in progress by the first and last of these authors. One small male, 16.1 mm SCL, and five juveniles, 4.8–7.1 mm SCL, were taken at the St. Croix station.

Turner (1977) reported stomach contents of galatheids from the "wood islands" to include setae of polychaetes, a nematode, sponge spicules, and minute quantities of wood. To that can be added species of Foraminifera (planktonic *Globigerina* and benthic *Cibioides robertsianus* (Brady)), minute shell fragments of mollusk, a species of harpacticoid copepod, an asellote isopod, and a considerable quantity of wood fragments. Sacrifice of other specimens might show sponge spicules or detrital material (Gore, 1983) or representatives of other invertebrates from at least the 10 phyla that have been reported as associated with experimental "wood islands" (Turner, 1977). In this regard, galatheids (mainly *M. subsquamosa*) found in the vicinity of hydrothermal vents in the eastern Pacific were not attracted to traps baited with cut fish, whereas the brachyuran crab, *Bythograea thermydron* Williams, readily entered such traps (Williams, 1980).

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