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Ingestion and Incorporation of Coral-Mucus Detritus by Reef Zooplankton

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Abstract

The copepod *Acartia tonsa* and the reef mysid *Mysidium integrum* ingest stained coral mucus. Ingestion rates determined with radioisotope-labeled mucus ranged from 4 to 81% body carbon · 24 h^{-1} for the copepods and 1 to 70% body carbon · 24 h^{-1} for the mysids. Incorporation was measured by comparing the organic composition of fecal material and by the incorporation of isotope-labeled mucus. *A. tonsa* incorporated 47% of ingested ash-free material, 68% of carbon and 36% of nitrogen. *M. integrum* incorporated 44% of ingested ash-free matter, 57% of carbon and 55% of nitrogen. Incorporation estimates using ^{14}C-labeled mucus were 65% and 39% for incorporation by *A. tonsa* and *M. integrum* respectively. *A. tonsa* and *M. integrum* incorporated both the mucus substrate and the epiphytic bacteria of the mucus-detritus.

Introduction

One potential energy source for reef zooplankton are mucus aggregates which dominate the particulate matter in reef water columns (Johannes, 1967; Marshall, 1968; Ducklow and Mitchell, 1979a), which can be readily assimilated by reef zooplankton. Ingestion studies using natural particle assemblages have shown that detritus is the major food source for some reef and lagoon zooplankton (Gerber and Marshall, 1974; Gerber and Gerber, 1979). Coral-mucus detritus may provide a significant pathway for the conversion of coral primary productivity to higher trophic levels. Thus the utilization of coral-mucus aggregates by reef zooplankton may be an important component of reef energetics.

Coral mucus differs as a food source from most other types of detritus. Aging and colonization by bacteria are required to increase the nutritional value of many kinds of detritus (Baker and Bradnam, 1976; Yingst, 1976). A cellulose-based detrital particle may be difficult for many types of detritivores to utilize directly (Oláh, 1972; Tenore, 1977). In contrast, the mucopolysaccharide matrix of coral mucus contains fatty acids, triglycerides, wax esters, and other high energy compounds (Coles and Strathmann, 1973; Benson and Muscatine, 1974; Ducklow and Mitchell, 1979a).

Corals derive their energy from zooxanthellae primary production and the ingestion of zooplankton and detritus particles (Johannes, 1974; Lasker, 1976; Lewis, 1976, 1977). Most of the primary production on a reef is linked to the corals via their zooxanthellae (Scott and Jitts, 1977). The products of zooxanthellae primary production are incorporated into mucus synthesized by the host organism (Crossland *et al.*, 1980a). Fatty acids synthesized by the zooxanthellae can be transferred to the host coral (Patton *et al.*, 1977). Crossland *et al.* (1980b) found 50 to 60% of the photosynthetically fixed carbon to be lost from *Acropora acuminata* within 40 h as mucus and dissolved organic carbon. Lipids of photosynthetic origin were lost as mucolipids.

Corals form the base of the reef food web. However, except for some fish, which eat the coral animal (Hiatt and Strasburg, 1960; Hobson, 1974), the energy in corals is not directly available to higher trophic levels. Coral mucus could be a major pathway for the transfer of coral energy into the reef food web. Several species of crabs, commensal with corals, excite their host colonies to produce mucus, which the crabs then ingest (Knudsen, 1967). Reef fish and shrimp can also ingest coral mucus (Johannes, 1967; Daumas and Thomassin, 1977).

Reef particulate matter, consisting to a large degree of detrital aggregations of coral mucus (Qasim and Sankaranarayanan, 1970), is a potential food source for reef zooplankton. Pure mucus produced by stressed corals can be ingested and assimilated by reef zooplankton (Richman *et al.*, 1975). However, coral-mucus detrital aggregates

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found in the water column may differ significantly in their chemical and nutritional value from mucus produced by stressed coral colonies (Coles and Strathmann, 1973), which is much higher in lipids and lower in percent ash than natural mucus detritus (Daumas and Thomassin, 1977). In addition, bacterial colonization of coral-mucus particles produced in the laboratory may not be the same as that in field samples (Ducklow and Mitchell, 1979 b).

The objective of this study was to determine the availability of coral-mucus detritus aggregates to reef zooplankton by examining the ingestion and utilization of mucus aggregates by *Acartia tonsa* and *Mysidium integrum*.

Material and Methods

Zooplankton Collection

Acartia tonsa were collected by 333 μm-mesh plankton net tow from the laboratory dock. Copepods were isolated by pipette from ethyl-m-amino benzoate methane sulfonic acid (MS-222) sedated plankton. This technique has no long term effect on the behavior of the copepods (Landry, 1978). Small hand nets were used to collect *Mysidium integrum* from swarms on reefs at Fowey Reef, (Florida), Churchill Beach, (Grand Bahama Island) and Mama Rhoda Reef, Chub Key (Bahamas). Mysids were kept for several days on shipboard in either an aerated 4-l jar or a 60-l tank. Mysids were not fed on shipboard. Mysids were maintained in the laboratory in a 60-l tank and fed mucus prior to their use in experiments.

Mucus Production

Mucus was collected in the field with syringes, forceps and small vials, from coral and zoanthid colonies. *Porites divaricata* colonies, collected from a reef flat near Soldier Key, Florida, were maintained in the laboratory in 50-μm filtered seawater in a shallow flow-through 30-l tank. A 12 h L:12 h D cycle was maintained using a bank of 6 (60 cm) fluorescent bulbs. Mucus aggregates were collected by pipette from colony surfaces and kept in sea water prior to use. Mucus particles were stored for less than 2 wk. Mucus particles were concentrated by sedimentation.

The mucus was ground in a tissue grinder and fractionated, with 10-, 50-, and 200-μm nylon mesh sieves, into particles of 10 to 50 μm and 50 to 200 μm, to facilitate feeding by two different sized zooplankton species. Grinding and size fractionation was done to provide as homogeneous a food source as possible. A survey of particles, in a reef water sample, stained by Alcian blue, a mucopolysaccharide specific stain (Steedman, 1950), found mucus particles ranging from $< 2\,\mu$m to $> 200\,\mu$m. Particle counts were not conducted as quantitative sampling of aggregates with standard techniques is impossible (Trent *et al.*, 1978). On the reef large flocs may break up as result of wave action, and small particles may also aggregate into large flocs.

Chemical Analyses

Mucus, zooplankton and reef particulate matter were collected on combusted GFC filters rinsed with ammonium formate solution, (0.6 M), to remove salts and dried to constant weight at 59 °C for dry weight determinations. Samples were combusted at 500 °C for 12 h for ash determinations. Chlorophyll *a* was determined by fluorescence (Yentsch and Menzel, 1963). Carbon and nitrogen were determined with a Perkin-Elmer Model 240 elemental analyzer. Carbonates were eliminated prior to analysis by a 10-min exposure to concentrated HCl fumes. The number of bacteria on mucus was determined by the acridine orange direct count (AODC) method (Hobbie *et al.*, 1977; Rublee *et al.*, 1980). Saponifiable lipids were determined as fatty acid methylesters after saponification and methylation in BF_3/methanol on a gas chromatograph (Brown *et al.*, in preparation). A C_{19} tracer was added as an internal control and fatty acid retention times compared to standards. This procedure does not include the determination of wax esters or cholesterol.

Ingestion Experiments

Initial ingestion experiments used neutral red, a vital stain, to label the mucus. Mucus was labeled overnight in 0.01% neutral red (w/v) in an acidified sea water solution (pH 6.5). Neutral red is more soluble in acid solution (Fleming and Coughlan, 1978). Free dye was rinsed from particles retained on 3-μm Nuclepore filters with 2 rinses of acidified filtered sea water and 3 rinses of filtered sea water. Neutral red also stains zooplankton, thus live controls were used to test for adsorption of free stain. Controls were separated from the stained mucus by a 10-μm mesh screen. Neutral red-labeled mucus was used to determine gut retention times at a concentration of 650 $\mu g\,C \cdot l^{-1}$. Ingestion was followed as colored pellets formed in the digestive tracts. The production of magenta fecal pellets was followed over time, after the introduction of the stained mucus. Stained mucus was also used to test rinsing procedures for experiments using isotope-labeled mucus.

Feeding experiments were also conducted using mucus labeled with [methyl-^{3}H]-thymidine, in a modification of the technique used by Hollibaugh *et al.* (1980). In using this technique to label particles we filtered free bacteria ($< 3\,\mu$m) from the particle suspension. After grinding and fractionation, mucus particles were labeled for 12 to 24 h in 0.2 $\mu Ci \cdot ml^{-1}$ ^{3}H-thymidine. Particles were rinsed on 3-μm Nuclepore filters, and resuspended for 1 to 2 h in non-radioactive thymidine. After rinsing 10 times with filtered sea water on 3-μm filters the particles were re-

suspended in filtered sea water for the ingestion experiments. The concentrations used encompass the carbon concentrations found on most reefs (Johannes, 1967; Marshall *et al.,* 1975; Westrum and Meyers, 1978; Ducklow and Mitchell, 1979a; Simmons, 1979), as well as those measured in this study. Specific activities ranged from 10^3 to 10^5 dpm · mg dry weight mucus^{-1}.

Copepods and mysids were maintained in filtered sea water for 24 h prior to the experiments. All experiments were conducted at 20°–22 °C. Approximately 25 copepods or 3 mysids were added to 3 to 6, 0.5-l jars of seawater. Jars were rotated (end over end) on a plankton wheel at 1 rpm to keep mucus particles in suspension. Replicate control jars for non-specific adsorption of label contained equal numbers of MS-222 killed specimens. Particles 10 to 50 μm were fed to *Acartia tonsa,* and 50- to 200-μm particles were fed to *Mysidium integrum.* After ingestion experiments, individuals were collected on 200- or 333-μm sieves, rinsed free of adsorbed radioactive particles with filtered sea water, and were weighed (dry weight) on 8-μm Nuclepore filters prior to isotope assays. Ingestion rates, expressed per unit zooplankton carbon (μg mucus C · μg zooplankton C^{-1} · 24 h^{-1}) were computed from weight specific ingestion rates, using carbon conversion factors of 40% for *A. tonsa* (Beers, 1966; Roman, 1977) and 32.9% (SE = 1.9 n = 4) for *M. integrum.* Ingestion experiments were incubated for 45 min for copepods and 45 to 60 min for mysids. These feeding times were less than the gut retention times of the individuals, as determined in the dye experiments.

Incorporation Experiments

Incorporation was estimated by the organic ratio method (Conover, 1966). While the accuracy of this technique has been questioned (Lasenby and Langford, 1973; Cosper and Reeve, 1975; Yingst, 1976), it nevertheless provides a low estimate of incorporation efficiency. Fecal pellets were isolated for either ash-free dry weight or carbon and nitrogen analysis from 1-l jars containing copepods or mysids and various concentrations of mucus. Isolations were done within 3 h from the introduction of food, and only intact fecal pellets were used.

Incorporation was also determined using radioactive mucus. Several colonies of *Porites divaricata* were kept in 1 l of aerated, filtered sea water containing 0.25 μCi · ml^{-1} of D-[^{14}C(U)]-glucose for 2 wk under constant illumination. Mucus particles were collected by pipette and incubated in sea water. Mucus particles were ground, fractioned, and rinsed 5 times with filtered sea water. Specific activities were approximately 10^4 dpm · mg^{-1} with less than 0.1% of the label passing through a 3-μm filter. Labeled mucus was fed to mysids and copepods for 2 to 4 h. After removal from the radioactively-labeled food, individuals were allowed to feed for an additional 2 h on unlabeled mucus. Individuals were also removed after 45 min in labeled mucus for estimates of ingestion rates. Incorporation efficiencies were calculated by extrapolating ingestion rates from 45 min to the total feeding period (2 or 4 h). Controls (MS-222 killed or '0' time = 2-min incubation) were run to correct for isotope adsorption.

Results

Mucus Composition

The two sizes of mucus particles used in feeding experiments showed no statistical difference in percent ash-free weight (% AFDW), chlorophyll a · g AFDW^{-1}, bacteria counts · g AFDW^{-1}, C : N ratios (by weight), or percent carbon of dry weight (95% confidence level; Student's t-test). Pooled data for the two size fractions are presented in Table 1. Field-collected mucus flocs from several species of anthozoans yielded similar % AFDW's (Table 2). At one station, where a sufficient mucus sample was collected for carbon and nitrogen analysis, values were similar to those of laboratory collected mucus of *Porites divaricata.*

Replicate 0.5-l samples of sea water were collected on 12 occasions from 1 m below the surface on several Miami area reefs and patch reefs on both rough days and in calm weather. Variability in the particulate matter present was great both between days, sites, and replicates (Table 3). The % AFDW showed no significant variation between

Table 1. *Porites divaricata.* Composition of mucus detritus

$\bar{x}$	SE	n	
27.38	1.52	16	Ash-free dry weight (% of total dry weight)
0.77	0.06	4	μg Chl a · mg ash free dry weight^{-1}
7.56×10^7	1.30×10^7	4	Bacterial cells · mg ash-free dry weight^{-1}
9.3	0.7	6	Carbon : Nitrogen
6.5	0.5	7	Carbon (% of dry weight)
8.4	1.3	3	μg saponifiable lipid · mg ash-free dry weight^{-1}

Table 2. Composition of anthozoan mucus collected in the field

Source		Ash-free dry weight (% of total dry weight)		
		$\bar{x}$	SE	n
Porites divaricata		33.3	2.8	3
		38.4	4.1	10
Siderastrea sp.		25.7	3.1	3
Eunicea sp.		16.5	2.1	3
Pseudopterogorgia sp.		32.3	3.6	3
Briarium asbestinum		31.1	2.8	3
Palythoa sp.		28.0	5.1	4
Palythoa sp.	C : N	11.1	4.3	2
Palythoa sp.	% C	6.8	0.5	2

Table 3. Particulate matter from Florida reefs

Location	Dry weight $mg \cdot l^{-1}$	SE	Ash-free dry weight $mg \cdot l^{-1}$	SE	n	Conditions
Soldier Key	10.55	0.74	[a]		4	strong current
Triumph Reef	2.33	0.62	0.75	0.07	2	calm
Fowey Reef	0.69	0.09	0.23	0.02	5	calm
Fowey Reef	5.29		[a]		1	rough
Fowey Reef	11.01	0.79	[a]		5	rough
Bache Shoals	13.54	2.01	2.96	0.24	4	strong surge
Bache Shoals	14.75	1.91	4.20	0.20	4	strong surge
Bache Shoals	10.58	0.30	[a]		2	strong surge
Bache Shoals	2.45	0.22	1.10	0.04	2	calm [b]
Bache Shoals	2.01	0.38	0.70	0.04	2	calm [b]
Bache Shoals	1.62	0.46	0.66	0.01	2	calm [b]
Bache Shoals	1.85	0.14	1.02	0.13	2	calm [b]

[a] Not determined
[b] From Russel (1981)

days or sites. The overall mean % AFDW was 36.0 (SE = 2.0, $n = 23$).

Ingestion of Mucus

Acartia tonsa and *Mysidium integrum* both ingested neutral red-labeled mucus particles at 650 $\mu g\ C \cdot l^{-1}$. Gut retention times were 60 to 75 min for *A. tonsa,* and 90 to 120 min for *M. integrum,* at 22 °C. The daily ration of *A. tonsa* ranged from 4 to 81% (Fig. 1). Mysid daily ration ranged from 1 to 70% (Fig. 2).

Incorporation of Mucus

The incorporation efficiency of mucus by *Acartia tonsa* did not significantly vary with food concentration ($0.1 < P < 0.25$; $F_{1,18} = 2.16$). In incorporation experiments at 10 concentrations of mucus, ranging from 125 to 1 578 $\mu g\ C \cdot l^{-1}$, the copepods incorporated 47.1% (SE = 3.0%, $n = 20$) of the AFDW portion of the mucus detritus. Incorporation efficiencies, calculated using the percent carbon and nitrogen of dry weight of feces and food in 4 experiments, were 68.3% (SE = 3.9%, $n = 4$) and 36.3% (SE = 9.0%, $n = 4$) respectively. Incorporation efficiencies estimated with ^{14}C-labeled mucus were not statistically different from those found using Conover's (1966) ratio method on the carbon values of isolated feces from *A. tonsa* (95% confidence level; Student's *t*-test). The incorporation efficiency of *A. tonsa* of mucus AFDW was statistically lower than carbon incorporation efficiencies ($0.02 < P < 0.05$).

Incorporation of AFDW by mysids at mucus concentrations ranging from 140 to 1 968 $\mu g\ C \cdot l^{-1}$ showed no significant correlation with mucus concentration ($0.25 < P$; $F_{1,10} = 1.2$). Average incorporation efficiency was 44.2%

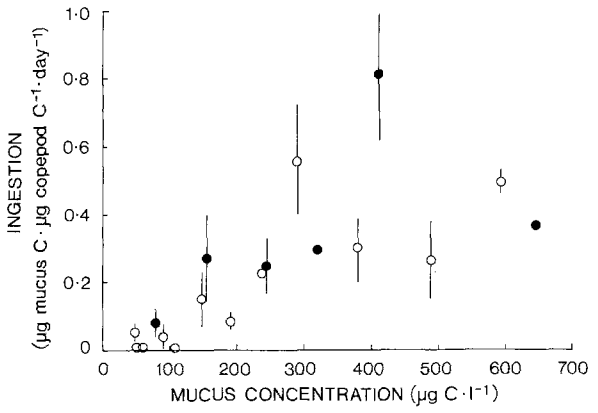

Fig. 1. *Acartia tonsa.* Ingestion rates (μg mucus $C \cdot \mu g$ copepod $C^{-1} \cdot d^{-1}$) as a function of mucus concentration (μg mucus $C \cdot l^{-1}$). Data from both ^3H (○) and ^{14}C (●) determinations are included. Ingestion rates ar 240, 322 and 644 $\mu g\ C \cdot l^{-1}$ represent single determinations; all other rates were determined as means of from 2 to 6 replicates. Means are plotted; vertical bars represent standard errors

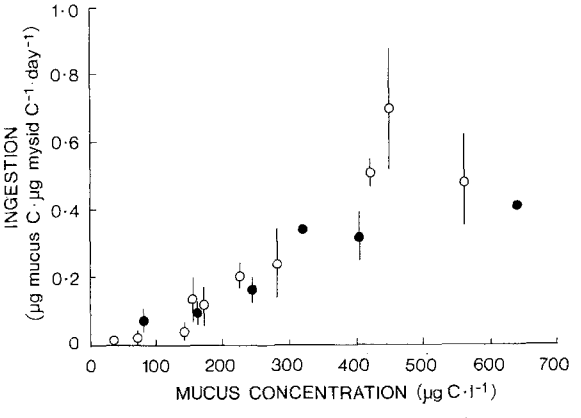

Fig. 2. *Mysidium integrum.* Ingestion rates (μg mucus $C \cdot \mu g$ mysid $C^{-1} \cdot d^{-1}$) as a function of mucus concentration (μg mucus $C \cdot l^{-1}$). Data from both ^3H (○) and ^{14}C (●) determinations are included. Ingestion rates at 322 and 644 $\mu g\ C \cdot l^{-1}$ represent single determinations; all other rates were determined as means of from 4 to 12 replicates. Means are plotted; vertical bars represent standard errors

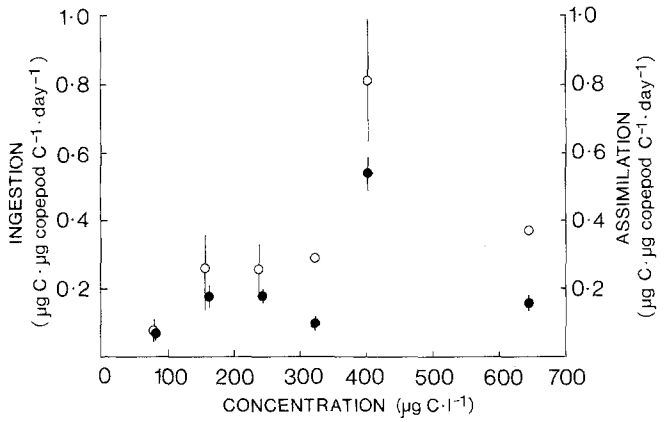

Fig. 3. *Acartia tonsa.* Ingestion (○) and incorporation (●) rates (μg mucus C · μg copepod $C^{-1} \cdot d^{-1}$) of *A. tonsa*, determined using ^{14}C. Means are plotted; vertical bars represent standard errors

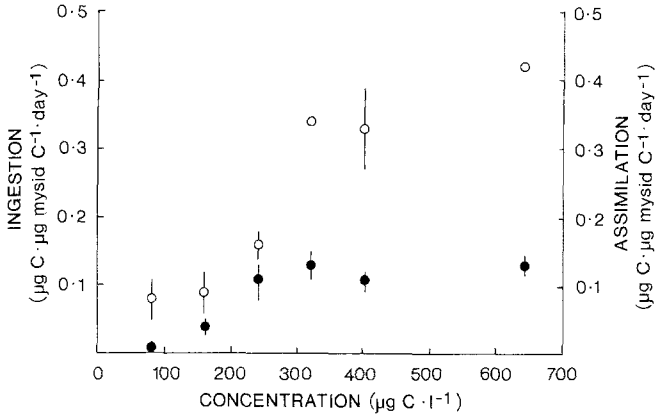

Fig. 4. *Mysidium integrum.* Ingestion (○) and incorporation (●) rates (μg mucus C · μg copepod $C^{-1} \cdot d^{-1}$) of *M. integrum*, determined using ^{14}C. Means are plotted; vertical bars represent standard errors

(SE = 1.7%, $n = 12$). No significant differences were found between the incorporation efficiencies of AFDW, C or ^{14}C for *Mysidium integrum* (95% confidence level; Student's *t*-test). No correlation with mucus concentration was found for carbon and nitrogen incorporation efficiencies. Approximately 57.7% (SE = 3.4%, $n = 8$) of carbon and 55.0% (SE = 9.6%, $n = 7$) of the nitrogen ingested was incorporated by *M. integrum*.

Incorporation efficiencies were also determined by using ^{14}C-labeled mucus at 6 food concentrations. The mean incorporation efficiency for *Acartia tonsa* fed ^{14}C-labeled mucus was 65.5% (SE = 4.3%, $n = 32$) (Fig. 3), whereas the incorporation efficiency of *Mysidium integrum* averaged 38.7% (SE = 4.3%, $n = 32$) (Fig. 4).

Discussion

Whether reef zooplankton communities can survive on reef phytoplankton production, or require supplemental carbon in the form of detritus is not known. Although detritus may not have sufficient nutritional value to support copepod growth, it can provide a significant carbon source (Roman, 1977). In this study, *Mysidium integrum* was maintained on coral mucus detritus for up to 2 months. It seems unlikely that tropical zooplankton would have storage reserves to survive for that period of time (Lee *et al.*, 1971).

The nitrogen available in mucus may be a significant portion of the particulate nitrogen pool on the reef. Particulate nitrogen values on reefs are generally below 15 $\mu g \cdot l^{-1}$, usually 4 to 8 $\mu g \cdot l^{-1}$ (Hickel, 1974; Caperon *et al.*, 1976). Using the proportion of nitrogen in mucus determined in this study, 1 mg dry weight of mucus contains approximately 8 $\mu g\ N \cdot l^{-1}$. In areas where mucus is abundant, this would provide a lot of available nitrogen. Like other macroscopic aggregates, coral-mucus particles would supply carbon, phosphate and trace elements (Silver *et al.*, 1978; Trent *et al.*, 1978; Alldredge, 1979; Shanks and Trent, 1979). Macroscopic aggregates may also be the site of significant primary production. High chlorophyll and phaeopigment levels are associated with macroscopic aggregates (Trent *et al.*, 1978), and may be due to both epiphytic diatoms and adsorbed sinking phytoplankton. Chlorophyll levels in coral-mucus aggregates may be due to zooxanthellae released from the coral (Marshall, 1972).

The composition of coral mucus has usually been studied with mucus collected by stressing the coral. The mucus produced in this way is clear, free of salts, zooxanthellae and sediment (Coles and Strathmann, 1973). Pure mucus is approximately 76 to 82% AFDW (Coles and Strathmann, 1973; Ducklow and Mitchell, 1979a), while mucus from field collections, or unstressed corals, has a higher ash content and shows a greater variability in AFDW (9 to 60% AFDW Richman *et al.*, 1975; Daumas and Thomassin, 1977). Rublee *et al.* (1980) found that mucus rinsed from *Briarium asbestinum* was 48% AFDW. In the present study, natural particles collected in the laboratory were approximately 27% AFDW and particles collected in the field ranged from 16 to 38% AFDW. Mucus produced by stressed corals is lower in ash than natural assemblages. Daumas and Thomassin (1977) noted that mucus from stressed corals was much higher in lipids than that collected in the field. This agrees with the low levels of saponifiable lipid found in the present. Mucus collected in the field has a caloric value, much closer to the caloric value of carbohydrates than that of lipids (Coles and Strathmann, 1973; Benson and Muscatine, 1974; Richman *et al.*, 1975).

Species of *Acartia* are important components of reef zooplankton communities (Emery, 1968; Glynn, 1973; Richman *et al.*, 1975; Youngbluth, 1980). Calanoid copepods were the dominant zooplankton emerging at night into traps from the reef face, and mysids were also common (17 to 20 · m^2) (Alldredge and King, 1977).

The variability in ingestion rates of mucus by *Acartia tonsa* and *Mysidium integrum* in this work is similar to that found in studies on natural particulate matter (Adams and

Steele, 1966; Roman, 1977; Foulds and Mann, 1978; Conover and Huntley, 1980; Dagg and Grill, 1980). Not all copepods ingest particles, even after 24-h starvation. Only 60% of *A. tonsa* had ingested mucus after 30 min.

There are several sources of error associated with the use of isotopic tracers in feeding studies (Conover and Francis, 1973; Foulds and Mann, 1978). The use of [methyl-^{3}H]-thymidine, as a metabolically conservative tracer, attempts to minimize these problems (Hollibaugh *et al.*, 1980). It is not known which pools of ^{14}C-labeled mucus are labeled, or the portion of the label in the bacteria, the mucus matrix, or the carbonate ash. Any ^{14}C-incorporation rates must also be interpreted considering potential metabolic losses (Lampert, 1975, 1977). Thus any ingestion and incorporation rates determined with ^{14}C-labeled mucus will be conservative estimates.

Acartia tonsa ingested from 4 to 81% body carbon · 24 h^{-1} of coral mucus. This compares with the 6 to 81% body carbon · 24 h^{-1} ingested by *A. tonsa* using macrophyte (*Fucus vesiculosus*) detritus (Roman, 1977). This is higher than the 10 to 40% body carbon · 24 h^{-1} ingested by *A. tonsa* fed the diatom *Nitzschia closterium* (Roman, 1977). Ingestion rates are higher and more variable on detritus than on phytoplankton (Chervin, 1978; Gerber and Gerber, 1979; Dagg and Grill, 1980).

The ingestion rates measured with ^{3}H and with ^{14}C are similar, although the two tracers do not label the same pools. At low food concentrations, ^{14}C-determined ingestion rates measured with ^{14}C-labeled mucus were higher than those with ^{3}H-labeled mucus. Labeling the surface bacteria (^{3}H) may not be as sensitive as labeling the mucus substrate.

The agreement of the ^{14}C and organic ratio (Conover, 1966) carbon incorporation efficiencies supports the use of ^{14}C label in these experiments. No previous incorporation experiments have been conducted using *Mysidium integrum*. However, Clutter and Theilacker, (1969) using *Metamysidopsis elongata*, a free swimming mysid from the Pacific, calculated assimilation efficiencies of 19 to 29% of dry weight, 36.8% C, 11.5% N and 12.5% ash. Assimilation of ash is not measured by the Conover (1966) ratio method and may bias assimilation efficiency estimates (Lasenby and Langford, 1973). *Mysis stenolepis* fed cellulose and hay detritus particles, had 20 to 50% assimilation of ^{14}C (Foulds and Mann, 1978). Roman (1977) found that the copepod *Acartia tonsa* incorporated 5 to 10% of dry weight of *Fucus vesiculosis* detritus. *A. tonsa* incorporated 12.9% of dry weight on coral-mucus detritus. In contrast, Gerber and Gerber (1979) found that reef zooplankton assimilate 86 to 91% of the organic matter ingested.

Zooplankton may utilize the detritus matrix and/or the attached bacteria. Foulds and Mann (1978) estimated that 1 to 5% of the hay and cellulose detritus fed the mysid *Mysis stenolepis* was assimilated whereas 50% of the bacterial biomass was assimilated. Coral-mucus particles may be more digestible than cellulose-based detritus. While we did not separate incorporation efficiency into bacterial and mucus components, the contribution of bacterial carbon and nitrogen to the mucus aggregates can be estimated from the bacterial biomass on mucus. Using conversion factors of 2×10^{-14} g C · bacteria^{-1} and 5.7×10^{-15} g N · bacteria (Ferguson and Rublee, 1976; Rublee, 1978), we estimate that 2.3% of the organic C and 6.0% of the organic N of coral mucus are bacterial biomass. These estimates agree with those of Rublee *et al.* (1980) for *Briarium asbestinum* coral mucus. The measured incorporation of carbon and nitrogen by *Acartia tonsa* and *Mysidium integrum* is greater than that available in the attached bacteria, suggesting that the coral-mucus matrix was incorporated by these common reef zooplankton species.

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