ON THE FEEDING OF SOME SCLERACTINIAN CORALS WITH BACTERIA AND DISSOLVED ORGANIC MATTER

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ABSTRACT

Feeding experiments were carried out with 6 species of common scleractinian reef-building corals from reefs of the Bismarck Archipelago. Their ability to utilize planktonic bacteria and dissolved organic matter (protein hydrolyzate) as food was demonstrated by using radiocarbon. The amount of organic carbon assimilated per day by animals given labeled food at concentrations approaching those found in situ was equivalent to 10–20% of the carbon content of the polyp's body. The rate of consumption and assimilation of some planktonic algae by corals was much lower. Corals could consume organic phosphorus bound in the cells of planktonic bacteria more actively than inorganic phosphate at the same concentration (several μg liter^{-1}). The rate of consumption of phosphorus was 3 μg g^{-1} day^{-1}.

According to the experimental data of Yonge and Nicholls (1931) zooplankton provides a principal food source for polyps of scleractinian corals. However, recent field observations have shown that zooplankton is usually very scarce in tropical oceanic waters passing over coral reefs (Johannes et al. 1970). Coral polyps certainly utilize organic matter produced by symbiotic zooxanthellae (Muscatine 1967; Franzisket 1969) but active photosynthesis by zooxanthellae requires an extensive inflow of nutrients which are very scarce in tropical waters. Polyps are believed to have additional sources of food, both particulate and dissolved. Stephens (1962) showed that polyps can consume glucose from solution at concentrations ranging from 2–20 mg liter^{-1}. The polyps of corals usually have well-developed cilia which can separate planktonic organisms such as algae and bacteria (Abe 1937; Roushdy and Hansen 1960). The ability of corals to consume and digest planktonic bacteria has been shown by Di Salvo (1969) and Sorokin (1971*a*).

Quantitative studies of possible feeding mechanisms of the polyps of reef-building corals are required for calculation of the energy budget of coral reef ecosystems, which are among the richest in the ocean (Odum and Odum 1955). During cruise 50 of RV *Vitjaz* in the western tropical Pacific I had an opportunity to measure the assimilation of dissolved organic matter and phosphorus by coral polyps.

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MATERIAL AND METHODS

Specimens of some of the common species of reef-building corals, including species of *Montipora*, *Pocillopora*, *Porites*, *Pavona*, and *Acropora* were used in experiments carried out at field laboratories set up on islands in the St. Andrew reefs and at Ninigo atoll (Bismarck Archipelago). Branches of corals were cut off under water with scissors and the cut was sealed with soft plastic to prevent the secretion of mucus. The branches so prepared were maintained in an aquarium submerged near shore. Experiments were carried out at night to exclude the possible assimilation of labeled CO_2 by symbiotic zooxanthellae. It is possible that evolution of small amounts of CO_2 can take place during metabolism of food organisms.

The intensity of feeding by corals was studied by the radiocarbon method (Sorokin 1968, 1971*a*,*b*). Natural bacterioplank-

ton, planktonic algae maintained in culture, and dissolved organic matter (DOM) were labeled and used as food.

Bacterioplankton was labeled with ^{14}C by the addition of a portion (0.2–0.5 mg C liter^{-1}) of labeled hydrolyzate of algal protein (Sorokin 1971*b*) to the surface seawater sample taken in the open ocean and prefiltered through a fine plankton net. After 25–40 hr of exposure in the dark at 30°C the labeled hydrolyzate was almost completely (95–97%) consumed by the bacteria. The water was then acidified with HCl and the labeled CO_2 formed during microbial metabolism was removed by bubbling air through the water. The water, containing the labeled bacterioplankton, was then brought to pH 8.0 by adding an alkaline solution. The practically complete absence in this water of small nannoplanktonic forms was shown by direct microscopy of the membrane filters.

The planktonic algae were labeled in growing cultures by introducing labeled ^{14}C-CO_3^{2-} during photosynthesis. Cultures of *Amphidinium klebsii* and of a mixture of several species of green flagellates (isolated and maintained by L. Lanskaya) were used. The labeled phytoplankton and bacterioplankton were used at the optimal concentration for filter feeding by most marine filterers (0.5–0.7 mg of the wet biomass per liter).

Labeled acid hydrolyzate of algal protein was used as the labeled DOM (Sorokin 1971*b*). The neutralized solution of the hydrolyzate was preserved in sterilized ampoules. Before use it was dissolved in seawater in the proportion 1:10 and filtered under sterile conditions through a membrane filter (pore size, 0.3μ). The concentration of hydrolyzate in the expermental vessels was 0.3 mg C liter^{-1}. To prevent microbial growth in the vessels, and consequently the formation of particulate labeled organic matter in the vessels during experiments with DOM as food, streptomycin was added at a concentration of 50 mg liter^{-1}. Control experiments showed that at this concentration the streptomycin almost completely stopped microbial assimilation of labeled organic matter by the microflora of seawater for up to 10 hr. At the same time the presence of streptomycin enhanced the survival of corals and other benthic animals, as well as of planktonic animals.

As a criterion of the intensity and efficiency of feeding of corals the index of assimilation values C_a/C was used. This index is the per cent ratio of carbon in assimilated labeled food (calculated per 24 hr) to the carbon content in the body of the consumer (Sorokin 1968). To measure it, 8–12 g of coral branches, prepared as described above, were placed in aquaria filled with 1–2 liters of prefiltered seawater. A portion of labeled food was added to each aquarium. After 6–7 hr exposure, the corals were washed clean of adhering labeled food material by actively rinsing them for 1 min in seawater. The washed corals were placed in beakers with 200 ml of seawater previously boiled with HCl and then adjusted to pH 8.2 to remove HCO_3^- ions. At the end of the experiment radioactivity was measured in the tissues of coral (R) and in CO_2 evolved by the coral during the second stage of the experiment (r_o).

The value of R was measured in preparations of the alkaline hydrolyzate of coral tissues. These were prepared by boiling the corals in a small portion (3–5 ml) of 0.1 N KOH solution. After the tissues were dissolved the residual material was washed from the skeleton by a jet of water. The hydrolyzate was neutralized with HCl, its volume adjusted to 20 ml, and 0.5-ml aliquots were poured into planchets and dried. Self-absorption in the preparations was measured by estimating the decrease of count of the standard portions of labeled algae introduced into similar preparations of the coral's nonlabeled tissues. The value of r_o was estimated after distillation of CO_2 from the water and precipitation as $BaCO_3$.

Simultaneously, control experiments were performed with corals previously fixed with