sperm preparations of normal maize or of the waxy, sugary, or amylose-extender mutants transfers the glucose moiety from ADPG and uridine diphosphate glucose at ratios of 30 : 1, 3 : 1, and 2 : 1 with phytoglycogen, amylopectin, and amylose as acceptors, respectively (*9*). Identification of ADPG in *Chlorella* (*10*), and its isolation from sweet corn (*11*) and from rice (*12*), indicate that ADPG could be a natural substrate for starch synthesis.

On the basis of experiments with rice Murata *et al.* (*13*) proposed that ADPG could be formed by way of a reversal of sucrose synthetase activity (sucrose + ADP → ADPG + fructose). Sucrose synthetase in maize has much less affinity for ADP than for uridine diphosphate, and the reaction is strongly inhibited by all the uridine-containing nucleotides (*14*). This does not seem to be an important pathway in maize for the formation of ADPG, but (Table 3), when sucrose-C^{14} and either ADP or uridine diphosphate are used as substrates, sh_2 and normal preparations do permit about 1.5-percent incorporation by starch granules. The relatively small amount of starch synthesis in sh_2 mutants may in part reflect a small amount of ADPG formation by way of sucrose synthetase; in part, the transfer of glucose from uridine diphosphate glucose by the soluble and starch granule–bound glucosyl transferases.

In the sh_2 mutant, which completely lacks ADPG-pyrophosphorylase activity, starch synthesis is substantially blocked; this indicates that starch synthesis in the normal maize endosperm proceeds largely by way of ADPG as a substrate, and that ADPG is chiefly synthesized through the action of ADPG pyrophosphorylase. It also indicates that only limited amounts of starch are formed with uridine diphosphate glucose as a substrate, and rules out the possibility that any substantial portion of starch synthesis proceeds by way of glucose-1-phosphate and starch phosphorylase.

Note added in proof: We have found that *brittle-2*, another mutant that accumulates sucrose, also lacks ADPG pyrophosphorylase activity. We have not yet succeeded in obtaining enzymic activity in mixtures of mutant extracts.

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Sponge: Effect on the Form of Reef Corals

Abstract. *The sponge,* Mycale laevis, *when encrusting the lower surfaces of flattened reef corals, induces marked peripheral folding of the host colonies. This relationship, though facultative, has advantages for both associates. The sponge has a continually enlarging substrate that is free from competitive sessile forms. The coral may benefit from an increased feeding efficiency as a result of water currents produced by the sponge and it is protected from invasion by boring forms, notably clionid sponges.*

The common West Indian sponge, *Mycale laevis* (Carter), grows frequently in close association with living corals in the fore-reef slope environment (*1*) of Jamaica. The sponge encrusts the lower surfaces of certain reef corals that have assumed a flattened colony form as a result of growing in dimly illuminated reef habitats. *Montastrea annularis* (E. and S.) is the most common coral involved in the association, but the sponge has also been found living with *Montastrea cavernosa* (Linn.), *Mycetophyllia lamarckana* (E. and H.), *Porites astreoides* (Lamarck), and *Agaricia agaricites* (Linn.).

Corals associated with *Mycale* assume a characteristic shape: the edges of the colonies become indented at intervals by more or less prominent peripheral folds, the oscules of the sponge opening outward at the apex of the arches. The appearance of such an association is shown in Fig. 1. It seems likely that the upturned folds along the edge of the coral are formed in response to the strong currents of exhalant water flowing out through the oscules of the sponge.

The arches tend to be relatively uniformly spaced along the edge of the coral, a distance of 9 to 12 cm being a common interval as measured along a line following the coral's undulating edge (Table 1). Since each arch in the coral's edge bears an oscule of the sponge, the relative uniformity of spacing of the arches suggests that there is an optimum volume of sponge tissue which can be drained through any one exhalant canal system. Arches and oscules tend to be smaller when closer together and larger when more widely spaced.

The association appears to have advantages for both animals. The underside of the coral offers the sponge a substrate that progressively increases in surface area, the more so because of the folding of the coral's growing edge induced by the sponge. If *Mycale laevis* becomes established on a young, clean coral, by keeping up with the growth of the coral the sponge is provided with a continually enlarging substrate that is free from competitive sessile organisms. The coral may benefit in two ways. The outwardly directed, exhalant water currents issuing from the oscules of the sponge probably increase water circulation over the adjacent coral surface and thus lead to a localized increase of the coral host's feeding efficiency and growth rate. This effect may facilitate

Table 1. Arch intervals (in centimeters) along the edges of coral colonies (*Montastrea annularis*) overgrown by the sponge *Mycale laevis*. Diameters of colonies: specimen 1, 23.0 and 16.5 cm; specimen 2, 16.5 and 11.5 cm; specimen 3, 12.0 and 10.5 cm.

Specimen 1	Specimen 2	Specimen 3
9.5	9.5	11.5
8.0	9.0	8.0
11.0	11.0	8.0
11.0	11.5	4.0
12.0	9.0	5.5
20.0	3.0	5.0
12.0	2.5	2.5
14.0	4.0	6.0
11.5		7.0
11.0		5.0

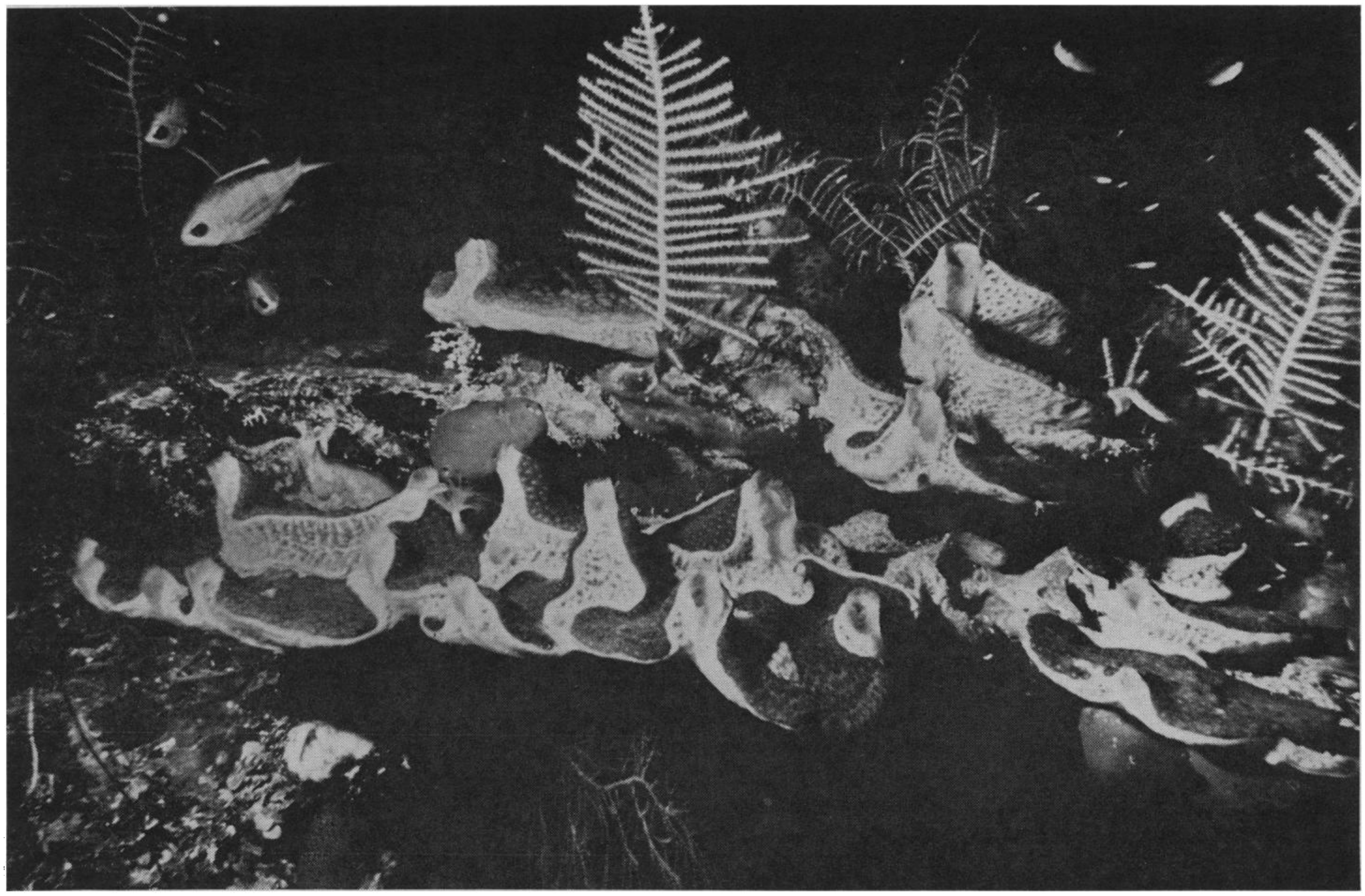

Fig. 1. The reef coral *Montastrea annularis* associated with the sponge *Mycale laevis*. Discovery Bay, Jamaica; depth, 40 meters. The peripheral folds of the coral grow around the oscules of the sponge. Fouling and boring organisms are absent from those parts of the coral overgrown by the sponge. The greatest lateral extent of the coral is 0.7 meter. [T. F. Goreau]

the formation of folds over the oscules. Also important to the coral is the fact that *Mycale* prevents the reverse side of flattened colonies from becoming heavily encrusted with a host of sessile organisms, such as tubicolous polychaetes, bryozoans, algae, colonial foraminiferans, antipatharians, gorgonians, and other sponges (see cover picture and legend). The most significant consequence of the association to the coral is the protection provided against invasion by boring organisms, especially clionid sponges. Living clionids are always absent from coral surfaces covered by *Mycale*, although flattened corals not so protected are invariably invaded. Excavation by boring sponges weakens the coral skeleton, especially at the basal point of attachment, where the coral may break away from its substrate (*1*). In the presence of *Mycale* the under surface of corals is clean and shows only a slight smoothing out of the finest epithecal folds.

The association of *Mycale* with its coral host is apparently stable over a period of many years. An estimate of its duration may be made by counting the epithecal folds on the reverse side of the colony, assuming with Ma (*2*) and Wells (*3*) that these represent diurnal accretions of skeleton by the coral. The lower surfaces of several small, dried colonies of *Montastrea annularis* overgrown with *Mycale laevis* were examined by removing a strip of sponge 2 cm wide to expose the underlying epitheca from the outer growing edge of the coral to its base. After inspection to ascertain freedom from encrusting and boring organisms, the presence of which would show that this part of the colony had at one time not been associated with *Mycale*, the epithecal folds were counted over set distances at several different places. The average count for three colonies of similar size was 36 folds per millimeter, and the average radius of the flattened fronds was about 10 cm. Thus these small colonies had apparently been growing with *Mycale* for approximately 10 years, but in larger colonies the association is undoubtedly of much longer duration.

Mycale laevis is widely distributed on Jamaican reefs from shallow water (1 meter) down to depths of at least 80 meters; it also occurs as a fouling organism on wharf piles at Port Royal, Jamaica (*4*). Free-living, encrusting to massive individuals are found over its entire vertical range, but at depths greater than 25 meters the sponge occurs commonly in the association described here.

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