INHIBITION AND INDUCTION OF BARNACLE SETTLEMENT BY NATURAL PRODUCTS PRESENT IN OCTOCORALS

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Abstract—Barnacle settlement inhibitors and inducers are present in the gorgonian Leptogorgia virgulata and the pennatulacean Renilla reniformis. The inhibitors are low-molecular-weight compounds (<20,000 daltons) that were detected in soft tissue homogenates and dialysates of homogenate and in ambient “gorgonian water.” Settlement was almost completely inhibited at a dialysate concentration of 1.0 g wet weight equivalents/liter. The inhibitors probably function in chemical defense against predation and fouling, and could prove useful in ship fouling control. The settlement inducers are high-molecular-weight substances (>20,000 daltons) that adsorb to surfaces.

Key Words—Inhibition, induction, chemical defense, larval settlement, fouling, barnacle, Balanus amphitrite amphitrite, octocorals, Leptogorgia virgulata, Renilla reniformis.

INTRODUCTION

Chemical interactions between organisms are relatively well known in terrestrial communities (Sondheimer and Simeone, 1970; Whittaker and Feeny, 1971). It is now clear that marine communities are also organized around a variety of chemical messages affecting the behavior and distribution of organisms (Kittredge et al., 1974). Particularly important to community development, and to the fouling of surfaces, is the chemical information involved in larval settlement (Crisp, 1974, 1976).

Larval settlement can be affected by two major kinds of allelochemics:
inducers and inhibitors. Inducers are substances that encourage settlement and metamorphosis. Barnacle cyprids, for example, settle gregariously near barnacle spat and adults (Knight-Jones and Stephenson, 1950; Knight-Jones, 1953), and this response is probably due to cyprid contact with adsorbed proteins (Crisp and Meadows, 1962, 1963; Larman and Gabbott, 1975). Inducers are also implicated when the larvae of predators or symbionts settle specifically on their prey or host organisms (Scheltema, 1974; Lewis, 1978). Only a few studies have succeeded in identifying settlement inducers (Kato et al., 1975; Morse et al., 1979).

Allelochemics that discourage settlement and metamorphosis—settlement inhibitors—have received less study. Barnacle settlement may be suppressed by specific microbes or microbial films (D'Agostino and Sheridan, 1969) and by the tannins present in certain brown algae (Sieburth and Conover, 1965), but no data are given in these reports. In fact, settlement inhibition by natural products is poorly understood in any animal, and convincing evidence has yet to be reported in barnacles, probably because it is difficult to show a settlement difference between an inhibition treatment that approaches zero and a chemically neutral control that may not be much higher.

We report here that settlement of the barnacle *Balanus amphitrite* *Darwin, 1854* is inhibited by substances present in the gorgonian *Leptogorgia virgulata* (Lamarck, 1815) and the pennatulacean *Renilla reniformis* (Pallas, 1766). Curiously, these same octocorals have inducers that promote barnacle settlement.

**METHODS AND MATERIALS**

**Octocoral Preparation.** Colonies of *Leptogorgia virgulata* were collected by free-diving on the jetty at Radio Island, near Beaufort, North Carolina. *Renilla reniformis* were obtained by trawling in the adjacent Newport River estuary. The animals were maintained in the laboratory in running seawater for no more than two days before being used. Most of the work was accomplished in the summer and fall.

Soft tissues of the octocorals were weighed and homogenized in full strength (34°/oo) seawater with a tissue grinder, followed by centrifugation (12,000 g) and fiber filtration (Whatman No. 1). The resulting “homogenate” was diluted with seawater to concentrations of 1.0 or 2.0 g soft tissue wet weight equivalents/liter and used as test water. In most of the experiments, however, the homogenate was dialyzed for 24 hr at 4°C in 100 times its volume of stirred seawater. This treatment separated the homogenate into dialysate and retentate fractions, both of which were used in tests after further dilution. In two experiments most of the bacteria were removed from undialyzed