CONCENTRATION AND PRELIMINARY CHARACTERIZATION OF A CHEMICAL ATTRACTANT OF THE OYSTER DRILL, *Urosalpinx cinerea*

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Abstract—Predatory muricid gastropods, *Urosalpinx cinerea*, respond to specific chemical stimuli by creeping upcurrent. Attractant substances originate from living barnacles. Newly hatched snails have no prior predatory experience but respond strongly to attractants. We report here methods for rapidly extracting and desalting attractants from seawater. Attractants from living barnacles are relatively large, at least partially proteinaceous, heat-stable molecules (>1000 but <10000 daltons) that adsorb onto Amberlite XAD-7, a polycrylate water purification resin, at neutral pH. Attractants remain adsorbed to the resin during a wash with deionized water and can be eluted in a small volume with 100% methanol. Attractant substances are effective in the bioassay in μg/liter concentrations (octa- to nanomolar range). Potency is destroyed by nonspecific proteases (carboxypeptidase and pronase) but not by trypsin. Attractant is not sequestered within barnacles.

Key Words—Attraction, muricid gastropods, barnacles, chemical sensing, *Semibalanus balanoides*, *Balanus eburneus*, *Urosalpinx cinerea*, oyster drill, snail, predator-prey relationships.

INTRODUCTION

The majority of studies performed on the chemical nature of attractants for aquatic organisms have been on feeding attractants. These studies have been...
of two types: (1) tests and analyses of extracts or homogenates of prey (Shelton and Mackie, 1971; Atema et al., 1980; Carr, 1967; Townsend, 1973; Castilla, 1972; Gurin and Carr, 1974; Collins, 1975); and (2) characterization of molecular constituents of washings (Shelton and Mackie, 1977; Atema et al., 1980; Carr, 1967b; Hanscomb et al., 1976) or extracts of living animals and molecular analysis of individual compounds in synthetic mixtures (for review see Bardach, 1975; Atema, 1980). Both approaches indicate the presence, and some of the types of, molecules composing prey that are attractive to predators or scavengers (mainly amino acids and proteins). However, behavioral and biochemical identification of highly specific attractants such as those indicating specific prey are obscured by either approach. Homogenization and extraction generate complex organic mixtures from which trace organic molecules are not easily retrieved. Reconstitution of active mixtures is limited to those molecules readily detected, characterized, and commercially obtainable. Neither approach answers questions on the nature of a native attractant released from intact prey.

To paraphrase William Herrnkind (personal communication), in nature predators do not usually encounter extracted or homogenized prey, nor do they locate mixtures of readily available shelf chemicals. Furthermore, a specific behavioral response to molecular stimuli suggests that specific information must have been conveyed. Specific information requires a unique molecular structure to code that information. It might be expected that specific attractants would be similar in size and complexity to other information-conveying molecules, for example, hormones. Therefore, a basic premise in the investigation reported here is that specific attractants can be purified and characterized from the seawater bathing living intact prey.

Oyster drills, *Urosalpinx cinerea* (Say), have a well-documented ability to locate intact prey from a distance by creeping upcurrent in response to chemical cues (for a thorough review of the early literature see Carriker, 1955; Blake, 1962; Wood, 1968; Pratt, 1974, 1976; Ordzie and Garafalo, 1980). Newly hatched *Urosalpinx cinerea* from the Delaware Bay region have a specific propensity for a molecule(s) from barnacles (Rittschof et al., 1983). This propensity is maintained in adults even after they have fed exclusively upon oysters for over a year (Rittschof and Gruber, unpublished data). Indeed, if barnacles were a commercially important shellfish, oyster drills would probably be commonly called barnacle drills.

As part of an ongoing project with the objective of assessing the potential of chemical biocontrol measures for oyster drills, we reported (Rittschof et al., 1983) the development of a bioassay useful in monitoring attractants from prey. The assay uses newly hatched drills and their response to attractants in seawater. The assay was developed specifically for use in the determination of the chemical nature of attractant molecules. Here we report on the concentration, purification, and initial characterization of the attractant originating