

EVIDENCE OF CHEMICAL COMMUNICATION DURING THE GAMETOGENESIS OF HOLOTHUROIDS¹

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Abstract. This research provides evidence for chemical mediation in the initiation of gametogenesis and interindividual fine-tuning among populations of the holothurian *Cucumaria frondosa*. Initiated in the laboratory by increased day length, the gametogenesis of *C. frondosa* developed normally when individuals were transferred to an environment in which temperature and photoperiod were held constant and food was withheld. Gonad development and spawning of these sea cucumbers occurred simultaneously with animals that were fed. Individuals collected from the deep aphotic zone showed gonadal indices and histological development of gametes synchronous with populations found in the shallower photic zone. These data strongly suggest that day length and temperature were not the sole factors controlling the onset and development of gametogenesis, but rather that they act synergistically with other mechanisms. Laboratory experiments showed that gametogenic synchrony was less for individuals separately maintained under natural environmental conditions than it was for similarly treated individuals kept in groups. Finally, gametogenesis was initiated by exposure to more developed individuals, even without the photoperiod cue. This induction, effective only between animals of the same sex, became more evident with increasing maturity of the more developed individuals.

Key words: *Cucumaria*; chemical communication; echinoderms; gametogenesis; pheromones; reproductive cycle; sea cucumbers.

INTRODUCTION

Chemical communication is a widely studied topic of ecological importance in the animal kingdom. In recent years, a great deal of knowledge has been gathered from studies in insects and fish on the synthesis, physical structure, and functional properties of pheromones, as well as on how they are perceived and exert their action (Shorey 1976, Leroy 1987, Hardie 1991, Radl and Linsenmair 1991, Cork et al. 1992). Pheromones are also known to play various roles in the maturation, hormonal cycles, and mating events of mammals (Leroy 1987, Agosta 1992).

The number of unresolved questions in the field of chemical communication among marine invertebrates probably justifies the important surge of interest in this subject. A large amount of work in this field deals with predator-prey interactions (Coll and Sammarco 1988, Lawrence 1991, Legault and Himmelman 1993). Nevertheless, pheromones in invertebrates are presumed to serve in congener recognition, search for suitable colonizing area, and communication of potential threats. To date, most of the work has brought significant clues in favor of the existence of chemical mediators during many events related to reproduction in marine invertebrates. Examples include the studies of Boily-Marer

(1974), Boily-Marer and L'Homme (1986) and Zeeck et al. (1988) who described the induction of the nuptial dance in polychaetes by pheromones. Pheromones were also proposed to be the major inducers of courtship, moulting, and mating in crustaceans (Atema and Engstrom 1971, Atema et al. 1979, Eisner 1980, Gleeson 1980, 1982, Conner et al. 1981, Atema and Cowan 1986, Cowan 1991).

Reports of chemical communication among echinoderms are very scarce and some remain speculative. Run et al. (1988) indicated that a sex-specific contact chemoreception could partially explain sex recognition in the sea star *Archaster typicus*. Ormond et al. (1973) showed that an active component released by the gonad of the sea star *Acanthaster planci* induced reproductive behavior and spawning in nearby mature adults. Furthermore, studies on deep-sea echinoderms imply that chemical cues play a role in gametogenic seasonality (Tyler et al. 1982, Tyler and Gage 1984) and spawning synchronization (Tyler et al. 1982, Young et al. 1992). However, the proximate mechanisms by which deep-sea animals synchronize spawning or gametogenesis to ensure successful fertilization remain unknown (Young et al. 1992). Hamel and Mercier (1995a) found that chemical communication during an aggregative behavior in the sea star *Leptasterias polaris* seemed to play a role in gametogenic synchronization, mostly during the late stages of gamete maturation before spawning. The paired mating of the sea star *Neosmilaster geor-*

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