FERTILIZATION AND SEX DETERMINATION IN THE RHIZOCEPHALA (CIRRIPEDIA, CRUSTACEA)

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Introduction

In the summer of 1985, I visited Dr. Alberto Monroy at the Stazione Zoologica di Napoli after attending an international meeting (on mammalian reproduction) held on the island of Capri. A few days after I arrived in Napoli, I called Dr. Monroy from a friend's laboratory at the Universita di Napoli. He, despite my unexpected call and his busy schedule, kindly invited me to come to his laboratory that day. After discussing topics of fertilization for an hour or so, I told him that the Stazione Zoologica di Napoli was a "Mecca" for the study of Rhizocephala. The Rhizocephala are parasitic cirripeds which are not so familiar to most modern biologists. Some readers may recall the parasitic castration of female crabs by a rhizocephalan, Sacculina. Dr. Monroy knew this species very well, but he did not know that the study of Rhizocephala began in Napoli in 1787 by F. Cavolini. Geoffrey Smith of the University of Oxford spent three years in the Stazione Zoologica and published a landmark monograph on the biology of Rhizocephala (Smith, 1906). Before I began studying mammalian fertilization, I spent several years studying the life-cycle and sexual organization of the Rhizocephala. As a graduate student at Hokkaido University, Japan in Japan, I dreamed of spending a few months or years in Napoli to study the same species of Rhizocephala Geoffrey Smith used for his study. When I briefly talked to Dr. Monroy about what I found in the Rhizocephala, he was very much interested and wanted to hear more. As I had no pictures or diagrams with me, I asked Dr. Monroy if he could find volume 29 of the "Fauna und Flora des Golfes von Neapel." This book, written by Smith, has many illustrations of the Rhizocephala. Dr. Monroy went to the Library, but could not find the book. Since I knew that I would be coming back to Italy the following year, I promised to give a seminar during my next visit to the Satatione Zoologica. In return, Dr Monroy promised to find the book by that time. Unfortunately, these promises were never kept due to Dr. Monroy's sudden death in 1986. The following is what I wanted to present at the seminar.
Rhizocephalans Reproduce By Cross-Fertilization, Not By Self-Fertilization

Rhizocephalans are a group of parasitic cirripeds found on other crustaceans like crabs, hermit-crabs or shrimps (Fig. 1A and 1B). Well known examples of non-parasitic cirripeds are barnacles which are commonly found on rocks in the intertidal zone (Fig. 1C) and stalked (gooseneck) barnacles which are found on the surface of driftwood (Fig. 1D). These non-parasitic cirripeds are hermaphroditic. A mature animal has both a functional ovary and testes. Although self-fertilization may occur in these animals, cross-fertilization is generally the rule. They live gregariously and wherever adjacent individuals are available, they copulate using a long tubular penis (Barnes, 1980).

Fig. 1. Cirripeds in various forms. (A), Sacculina carcini parasitic to a crab. (B), Peltogasterella gracilis (= P. socialis) parasitic to a hermit-crab. (C), barnacles on rock in the intertidal zone. (D), gooseneck barnacle on a driftwood.

Before I began to study the Rhizocephala, people thought that all members of this subclass, with a few exceptions, were hermaphrodites which reproduced by self-fertilization. In fact, an adult rhizocephalan possesses both functional ovary and "testis." A mature individual can produce several broods of larvae even if it is separated from other members of the species. Professor Atsuhiko Ichikawa, the major Professor of my graduate study, wanted me to investigate the parasitic castration of male crabs by Rhizocephala. I can now confess that I was not much interested in the project. I was more interested in the Rhizocephala itself. By reading several