論文の内容の要旨

論文題目

Morphological, ecological, and molecular studies on the larval settlement of thoracican barnacles

（完胸超目蔓脚類の幼生着生過程に関する研究）

氏　　名　賴末　武史

Barnacles inhabit almost all marine environments. They are fascinating models for studying evolutionary ecology of marine invertebrates. For barnacles, larval settlement process is important for survival and successful reproduction during adult stage as adults cannot move from the settlement sites. Barnacles are also important from environmental and economic contexts. Some barnacle species settle on artificial objects such as ships' hulls, aquaculture net cages, and pipes in coastal plants, which results in huge economic losses and an increase in the emission of environmentally harmful gases. Understanding the settlement mechanisms of barnacles is important for improving non-biocidal anti-fouling technologies. I studied the settlement mechanisms of barnacles from various habitats to understand how they reach to the possible habitats, explore the substrata, and select sites for final cementation. In Chapter 2, I report the larval development of *Ashinkailepas seepiophila*, which inhabiting peripheral zones of deep-sea hydrothermal vent sites and active cold seep areas. I examined

whether they show a similar response to temperature as a vent endemic species *Neoverruca* sp. A larval developmental period of *Neoverruca* sp. is drastically affected by the thermal stimulation. In contrast to *Neoverruca* sp., *A. seepiophila* did not drastically shorten the developmental period from nauplius VI to cyprid when exposed to temperature of 10 °C. I conclude that late naupliar larvae of *A. seepiophila* need not to develop into cyprids as quickly as *Neoverruca* larvae at elevated temperatures because this species does not inhabit around active vents. In Chapter 3, I report the structure of the antennular attachment and sensory organs in cyprids of *A. seepiophila* and *Neoverruca* sp. and compared with other pedunculated and balanomorphan barnacles. The most significant difference was found in the shape of the antennular third segment (the attachment organ) and in particular the outline and angle of the attachment disc. Cyprids of *Megabalanus rosa* inhabiting the rocky intertidal zone have a radially symmetrical, bell-shaped attachment organ, whereas the third segment of *A. seepiophila*, *Neoverruca* sp., and the other species used for comparison had a shoe-shaped attachment organ with a ventrally angled disc surface. I suggest that the differences in shape and angle of the attachment organs will influence the surface exploration behavior. In Chapter 4, I present the molecular mechanisms of barnacle settlement. Gregarious settlement is essential for survival and reproduction of many barnacles. A glycoprotein, settlement inducing protein complex (SIPC), has been recognized as a signal for settlement and it is expressed in both conspecific adults and larvae. Although the settlement-inducing activities of SIPC are species-specific, the mechanism by which larvae distinguish conspecific SIPC from other species' is still unknown.

The complete primary structure of SIPC of *M. coccopoma*, as well as the partial structures of SIPCs of *Balanus improvisus*, *M. rosa*, and *Elminius modestus* were determined. All SIPCs contain highly variable regions that possibly modulate the affinity to the receptors, resulting in the species specificity of SIPC. Furthermore, I observed settled larvae of a lepadid barnacle *Lepas pectinata* which inhabits floating objects. I discuss the ecological significance of the larval colonization pattern of this species in Chapter 5. They showed the face-to-face settlement pattern with high density. This pattern may enable them to share the cement protein among neighbors and to capture foods effectively during the adult stage. My thesis provides insights into how barnacle larvae reach and settle to suitable habitats. Artifice adaptation within the settlement process must have enabled barnacles to inhabit almost all marine environments. This study will also contribute to the development of environmentally friendly antifouling technologies.