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学 位 論 文 要 旨

氏名: 神原　広平

題目: Ecological and molecular biological studies on feeding and water utilization abilities of rhinotermitid subterranean termites
（ミゾガシラシロアリ科における加害および水利用能力に関する生態学的・分子生物学的研究）

Termites are serious pests for wooden materials. In Japan's mainland (Honshu), two species of rhinotermitid subterranean termites, *Coptotermes formosanus* and *Reticulitermes speratus*, are economically important and are controlled by different methods, which had been established on the basis of their feeding and water utilization abilities. However, another *Reticulitermes* species, *R. kanmonensis*, recently recorded from the western part of Honshu, could not be controlled effectively when the control method for *R. speratus* was employed, presumably because of differences in water utilization abilities between *R. speratus* and *R. kanmonensis*. Thus, it is expected that more appropriate control methods based on the species-specific water utilization ability might be developed for *R. kanmonensis*. Furthermore, in order to develop the novel methods for controlling termites such as specific inhibition of their water utilization, the molecular mechanisms of water utilization in termite should be investigated in detail.

In this study, to confirm the differences between *R. speratus* and *R. kanmonensis*, the feeding and water utilization abilities were compared. In addition, as the first step for understanding the molecular mechanisms of water utilization in termites, aquaporin (AQP, water channel) cDNAs were cloned from *C. formosanus* and their expression in termite bodies were also investigated.

Firstly, the nesting habitats preferences of two *Reticulitermes* species were examined both in the sympatric and allopatric distribution cases. When the two species inhabited allopatrically, they both selected rather highly damaged woods of the same level. When they coexisted, however, *R. kanmonensis* tended to choose less damaged woods and *R. speratus* tended to choose the same rather damaged woods as in the allopatric case and a habitat segregation occurred between the two species. These results suggest that *R. kanmonensis* seems to be capable of adapting themselves to less favorable habitats (less damaged woods) if necessary. This predicts the possibility that even living woods and houses are vulnerable to termite damages by *R. kanmonensis* due to the coexistence with *R. speratus*. Furthermore, unlike *R. speratus*, *R. kanmonensis* constructed covered runways on the tree trunk, facilitating to expand their feeding sites.

Secondly, feeding activities of *R. speratus*, *R. kanmonensis*, and *C. formosanus* were compared and water transporting ability of the two *Reticulitermes* species were also investigated. The feeding

activities of the two *Reticulitermes* species under several different conditions (the ambient temperature, the number of workers and the proportion of soldiers) were almost similar to each other, but different from those of *C. formosanus*. In contrast, there are significant differences in water transporting abilities between the two *Reticulitermes* species: *R. kanmonensis* transported water, whereas *R. speratus* did not. When both species were supplied with air-dried wood blocks and liquid water, the survival rate of *R. kanmonensis* was significantly higher than that of *R. speratus*, suggesting that *R. kanmonensis*, unlike *R. speratus*, can easily attack dry parts of houses due to its water transporting ability.

These comparative ecological studies on the feeding and water utilization abilities have revealed that some features such as flexibility of wood preference, feeding site expansion and water transporting ability of *R. kanmonensis* are remarkably different from those of *R. speratus* and similar to those of *C. formosanus*. Thus, for the control of *R. kanmonensis*, employing the control method for *C. formosanus* will be more appropriate than that for *R. speratus*.

Finally, cDNA cloning of AQP from the digestive tracts of *C. formosanus* was conducted, and a cDNA encoded an AQP homolog designated as CfAQP with 249 amino acids and another cDNA of its putative splice variant with the identical amino acid sequence lacking C-terminal 3 amino acids were obtained. The sequence analysis predicted that CfAQP and its variant are water-specific AQPs (Orthodox AQPs). Phylogenetic analysis of CfAQP with other insect MIPs as well as human AQPs indicated that insect MIPs could be classified into 4 groups, designated as insect MIP Group 1 to Group 4, and that CfAQP is a member of Group 1 which is a sister group of vertebrate AQPs. The expression analysis revealed that CfAQP mRNA was expressed in most parts of the digestive tract, suggesting that CfAQP may play important roles in water recycling, while a negligible expression of the variant mRNA was detected only in the midgut, suggesting that the variant would have few roles if any in the midgut. A significant expression of CfAQP in water sacs imply that CfAQP may contribute to water transport from hemolymph to water sacs, and thereby may be involved in water transporting behavior of termites.

The studies have clearly indicated the importance of understanding species-specific feeding and water utilization abilities of termites to establish methods for controlling termites efficiently. In addition, further studies on CfAQP may provide us useful ideas for the development of novel termite control methods in relation to the water utilization abilities.