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学位論文内容の要旨

博士の専攻分野名称：博士（農学）　　氏　名：Cheng Zixin

学位論文題名

Comprehensive understanding of the origin and function of the “female penis” in cave insects
（雌がペニスを持つ昆虫の交尾器の起源と機能の総合的理解）

A cave insects having reversed genital structures Neotrogla (Psocodea: Trogiomorpha: Prionoglarididae) was recently discovered in Brazil. The female has a highly specific penis-like intromittent organ, called gynosome, which penetrates deeply into the male vagina-like cavity during copulation to receive voluminous and nutritious semen. This study is to conduct a morphological, functional and evolutional analysis of the female genital structures including associated muscles of the sexual reversed insects, and revert the detailed copulating process of the Neotrogla on the basis of deepening the understanding of the genital structures and associated muscles of the various psocopteran females.

This article is divided into three chapters

1. **Exploration of the homology among the muscles associated with the female genitalia of the three suborders of Psocodea (Insecta)**

By using μCT technology, I reconstructed 3D models of the female genital structures and associated muscles of seven species from three suborders of Psocodea (free-living species only, formerly known as an independent insect order “Psocoptera”). The homology of the female genital structures and associated muscles of different species was discussed. A total of 21 muscle groups were observed, and except for one muscle, all were homologized throughout the order. Moreover, some of the homologous muscles could be identified confidently with those of the holometabolan insects. Using the muscles as landmarks, I discuss the homology of the ovipositor valves between Psocodea and other neopteran insects. The ovipositor of the suborder Trogiomorpha was identified to consist of the well-developed external valve plus a remnant of the dorsal valve. I also examined the phylogenetic information included in the female genital muscles and found that certain muscles provide useful information and support deeper

nodes (e.g., monophyly of the suborder Psocomorpha). The study of female genital muscles provides a solid foundation for the study of the female penis.

2. Acquisition of novel muscles enabled protruding and retracting mechanisms of female penis in sex-role reversed cave insects

The protruding and retracting mechanisms of the *Neotrogla* female penis, including their evolutionary origin, are poorly understood. By using the μCT technique, I compared the genital morphology and musculature between species with a gynosome and others lacking this structure. As a result, I discovered two groups of novel muscles related to the protrusion and retraction of the gynosome. These muscles were also observed in species having a primitive, nonprotrutable gynosome (prepenis). This strongly suggests that evolution of these muscles preceded the acquisition of the protruding function of the gynosome, originally having a putative stimulatory function to receive nutritious semen. This intermediate stage probably allowed the reversal of genital functions.

3. Functional morphology of *Neotragla* male and female genitalia analyzed using μCT (Insecta: Psocodea: Trogiomorpha)

By using μCT technic, I present 3D-models of genital structure and connected muscles of the male and female genitalia of *Neotrogla curvata*. By comparing the morphological changes of those structures and muscles before and during copulating, I clarified the functions of the male and female genital structures and analyzed the complete copulating process in *Neotrogla*.