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学 位 論 文 要 旨
Dissertation Abstract

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学位論文題目： The ontogeny of melyrid beetles (Cleroidea)
Title of Dissertation （ジョウカイモドキ科甲虫(カッコウムシ上科)の個体発生）

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On the ontogeny of Exopterygota, the presence of a peculiar developmental stage, which is between embryonic and nymphal stages is well known as “pronymphal stage”. It is believed that pronymphal stage is equivalent to larval stage of Endopterygota (Berlese’s theory), however, its truthfulness has been discussed for many years.

Verhoeff (1917) meanwhile found an existence of inactive and nonfeeding early stage between embryonic and larval stages in two cantharid beetles of elateroid. This phenomenon was interpreted as an abnormal metamorphosis in Endopterygota such as hypermetamorphosis, called “Foetometamorphosis”. However, this phenomenon had been forgotten without progress of study and 100 years have passed from the suggestion of Verhoeff to the present day.

Recently, I found similar to inactive and nonfeeding early stage (hereinafter referred to as “foetomorphic larval stage”) in a melyrids also. The melyrids ontogeny have been observed and reported in fragments so far. Therefore, I studied the ontogenic development from oviposition to larval stage of seven species of melyrids; five malachiines, a dasytines and a rhadalines; additionally, a clerids as an out-group, their structures and biological information are described and are compared for elucidation the evolution of ontogeny in this lineage and the factor of the foetomorphic larval stage.

Based on the results, egg was constantly about 1.0mm length and slender form, which is no significant difference from other cleroid families. By contrast, clutch size was various. It is believed that the variation of clutch size was due to the decreasing clutch size with the miniaturization of body in melyrid lineage and the increasing clutch size with the acquisition of flexible abdominal sternites in malachiines later.

The growth pattern was very various; each subfamily has peculiar characteristics. An ancestral growth pattern which is generally shown in cleroids was shown only in rhadalines. Dasytines and malachiines meanwhile showed the appearance of egg-bursters and egg burst

occurred before the completion of larval morphogenesis. This is the homology of dasytines and malachiines. However, foetomorphic larval stage was not shown in dasytines although shown in all observed malachiines. A comparison result suggests that the presence of the foetomorphic larval stage is directly attributable to wiggling the upper half of the body and hatch out immediately after egg burst, and that this characteristic is peculiar to malachiines. Also, though malachiines hatched most foetomorphic structure, mature larval body parts developed highest functioning in cleroids.

Beetles generally form the egg-bursters and rupture chorion after the completion of larval morphogenesis. Above growth patterns of malachiines and dasytines are very unusual in the order Coleoptera.

The results the applying ontogenic synapomorphy of melyrids and peculiar characteristics of each subfamilies to a molecular genealogical tree of Bocakova et al. (2012), it is suggested that the gradual evolutions of ontogeny; 1) miniaturization of body size, 2) clutch size decreased, 3) first hypermorphosis, 4) clutch size increased, 5) second hypermorphosis; occur in melyrids. In consequence, oviposition and larval growth pattern were diversified, and foetomorphic larval stage was secondary acquired by melachiines in this course of evolution, i. e. differ from “pronymphal stage” of Exopterygota in its origin. This phenomenon is able to interrupt an unusually metamorphosis in Endopterygota such as hypermetamorphosis. This result agrees with the suggestions by Verhoeff. Additionally, it follows from foetomorphic larval stage being malachiine synapomorphy, its directly attribution and the larval development after this stage, foetomorphic larval stage is neither embryonic stage nor larval stage, it may conclude the between of both, “prolarval stage” which were suggested by Verhoeff.

Crowson (1964) proposed that the subfamily Malachiinae is the most modern and successful group in the superfamily Cleroidea. They also live in the extreme arid environments. There is possibility that the compatibility of three essentially conflicting characteristics, “miniature body size”, “hypermorphosis” and “large clutch size” brings about an advantage of the extreme environments.

This study revealed that “prolarval stage” which is similar to pronymphal stage of Exopterygota is possible to obtain in the process of evolution in Endopterygota. In future, the carefully inspections its diffusibility and homology of cuticles to pronymph is necessary. I am sure that its result affect discussion on Berlese’s theory.