

Development of Mysterious Morphology of Treehopper Helmet*

Hiroki GOTOH

Department of Biological Sciences, Faculty of Science, Shizuoka University, Shizuoka, Shizuoka 422-8529, Japan
E-mail: goto.hiroki@shizuoka.ac.jp

The “helmet” of treehoppers (Hemiptera, Membracidae) is a structure derived from the pronotum (Stegmann, 1998; Fisher et al., 2019). Helmets are not only elongated structures, but are highly diverse among species. Although shape and size of helmets are prominent and diverse in adult stage, these are not seen in nymphal stages. Even in the last nymphal stage, only small helmet-bud can be recognized at dorsal side of the body (Stegmann, 1998). Considering that size and shape of helmet-bud are similar among species, the development of highly complex and diverse shapes of treehoppers should occur inside of the helmet-bud of the last nymphal stage. Recently, we histologically investigated the development of adult helmet in the last nymphal instar of *Antianthe expansa* (Membracidae, Smillinae) using paraffin sections and micro-CT scanning (Adachi et al., 2020). According to the observation, we found that the development of helmet was achieved through two transitions; 1) single layered bag-like structure turned

into a double-layered plywood-like structure, and 2) small helmet-bud turned into the large adult helmet (Adachi et al., 2020). Also, we found that developing helmet was once formed as a “miniature” of adult helmet. We presume that forming a miniature of the adult helmet during the last nymphal stage is a common developmental step in other species with diverse helmet shape.

References

- Adachi, H., K. Matsuda, K. Nishida, P. Hanson, S. Kondo and H. Gotoh (2020) Structure and development of the complex helmet of treehoppers (Insecta: Hemiptera: Membracidae). *Zoological Letters*, **6**, 1–9.
- Fisher, C.R., J.L. Wegrzyn and E.L. Jockusch (2019) Co-option of wing-patterning genes underlies the evolution of the treehopper helmet. *Nature Ecology & Evolution*, **4**, 250–60.
- Stegmann, U.E. (1998) An exaggerated trait in insects: The prothoracic skeleton of *Stictocephala bisonia* (Homoptera: Membracidae). *Journal of Morphology*, **238**, 157–78.

* Contribution to the symposium “Acquisition of Functional Diversity of Insects” in the 57th Annual Meeting of the Arthropodan Embryological Society of Japan, July 9–10, 2021, Ushiku-numa, Ibaraki, Japan.