Queen-destined parthenogenetic daughters as a preadaptation for asexual queen succession in termites

Author(s): Tomonari Nozaki, Tomonari Nozaki , Toshihisa Yashiro , Kenji Matsuura

Institution(s): Laboratory of Insect Ecology, Graduate School of Agriculture, Kyoto University, Kyoto, Japan ; School of Life and Environmental Sciences, University of Sydney, Sydney, Australia ; Laboratory of Insect Ecology, Graduate School of Agriculture, Kyoto University, Kyoto, Japan ; Laboratory of Insect Ecology, Graduate School of Agriculture, Kyoto University, Kyoto, Japan

Social insects have evolved diverse and sophisticated breeding systems. In some termite species, queens produce their neotenic replacements parthenogenetically while producing other colony members sexually. This asexual queen succession (AQS) system enables the colony to boost reproduction by increasing the number of queens without king–daughter inbreeding, which must otherwise result in loss of genetic diversity in the workforce. To date, the AQS system has been reported in six termite species, including three *Reticulitermes* termites and three neotropical higher termites. The evolution of this unusual breeding system requires both parthenogenetic ability and parthenogens' developmental propensity to become neotenic queens. However, the evolutionary process of these two components is unknown. Recently, we demonstrated that the parthenogenetic daughters of the non-AQS termite species *R. okinawanus* have higher developmental privilege to become neotenic queens than do sexually produced daughters. In *R. okinawanus*, one-third of the daughters produced by tychoparthenogenesis developed into neotenics, while no sexually-produced daughters differentiated into neotenics. This suggests that developmental linkage between parthenogenesis and queen differentiation likely evolved prior to the AQS system. In the genus *Reticulitermes*, parthenogens are almost complete homozygous due to automixis with terminal fusion. In contrast, parthenogenesis produces heterozygous daughters through automixis with central fusion in some AQS species in higher termites. Therefore, parthenogenetic daughters carrying only maternal chromosomes likely to be predisposed to develop into neotenic queens regardless of AQS. We demonstrate that the preadaptation for AQS in termites can be reasonably explained by the genomic imprinting model, in which maternal and paternal epigenetic marks antagonistically influence the caste fate of offspring.