Adaptive Significance of the Experimentally Obtained Diploid Male Fertility in the Japanese Bumblebee Bombus ignitus with Complementary Sex Determination

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The sex of Hymenopteran insects is determined by allele combination of sex-determination locus. This is called complementary sex determination (CSD), where diploid males develop from fertilized eggs when sex locus have the same alleles. These diploid males are mostly sterile due to defects of CSD and are believed to cause defects in population growth. However, it was reported that diploid males and triploid females were occasionally found in the field-adapted population of the European bumblebee, Bombus terrestris, originally introduced into greenhouses in Japan. This indicates that inbreeding does occur. We have a hypothesis that the accidentally obtained diploid male fertility contributes to a reproductive adaptation which enables the foundation of next generation colonies and production of normal haploid males. In order to examine the above hypothesis, we produced polyploids by repeated inbreeding in the Japanese bumblebee, B. ignitus. Karyotype analysis and microsatellite genotyping revealed that diploid males and triploids were produced. Queens mated with diploid males successfully founded triploid colonies and maintained fitness through their male offspring which received nursing from triploid workers. Comparison of sperm counts and sperm head length revealed that triploid males produced large-sized sperm. These results strongly support our hypothesis and give new insight into the evolutionary ecology of eusocial insects with CSD. If the triploid male successfully copulates, a tetraploid is born in the Hymenoptera. As the triploid female of B. ignitus is sterile, triploid female producing colonies will be quite useful as ecologically-safe commercial pollinators with no risk of field naturalization.