Effect of temperature on mito-nuclear interaction over male fertility in the gynodioecious snail Physa acuta

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Résumé

Beyond interaction between organisms which structure ecology and evolution, genomes within an organism also interact. Contrary to the idea that they interact harmoniously to form a functional whole, opposed evolutive interest between genomes can lead to conflicts within individuals, such as conflict between nuclear and mitochondrial genes. These genomes follow different strategies to maximize their own transmission. Unlike nuclear genes which are transmitted by both parents, mitochondrial ones are inherited usually by only female. This inheritance disparity may lead to conflict in sexual reproduction in hermaphrodites. Such a mito-nuclear conflict may result in selection of selfish mitochondrial lineages that sterilize the male reproductive function (cytoplasmic male sterility CMS). The sterilization of the male function is a loss of fitness for the nuclear genome; the latter can then trigger an arms race where each genome defends its own evolutionary interests. Indeed, some nuclear genes can be selected to restore male fertility caused by mitochondrial genes. In populations, this conflict led to the co-occurrence of male-sterile and hermaphrodite (non-CMS and restored) individuals, named gynodioecy. The maintenance of gynodioecy theoretically requires a female advantage (FA; i.e. a higher female fitness) for male-sterile individuals and a fitness cost associated with the restoration of male function in restored hermaphrodites. Well-known in Angiosperms, the first observation of CMS and gynodioecy in animals was recently reported in the freshwater snail *Physa acuta*. Two extremely divergent mitochondrial lineages were found relative to the classically normal one. The first divergent mitotype is associated with male-sterility individuals while the second mitotype is associated with restored male-fertility (i.e. nuclear genes counteract the sterilizing mitochondria). The effect of CMS and restorers genes can be influence by environmental conditions. Our aim was to test the theoretical predictions about a FA and a restoration cost and to investigate how temperature influences the CMS, the male-fertility restoration and, if they exist, the FA and restoration cost. We raised the three *P. acuta* mitotypes in two thermic conditions, low and high temperatures to compare male fitness (male sterility, seminal vesicle area and number of spermatozoids) and female fitness (eggs production), growth rate and whole-body metabolism. The results demonstrated a FA in male-sterile individuals and a cost in restored hermaphrodites that

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were temperature-dependent. This study also showed for the first time that the maintenance and the evolutionary dynamics of gynodioecy in populations may be driven by temperature and more generally by environment.

Mots-Clés: mito, nuclear conflict, cytoplasmic male sterility, gynodieocy, temperature, Physa acuta, female advantage, cost of CMS, cost of restoration