

HYBRIDIZATION AND INTROGRESSION OF THE TWO STRAINS OF HOKKAIKDO GYPSY MOTHS AS INVASIONS BY ALIEN SPECIES

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ABSTRACT

Male-killing refers to the death of male embryos or larvae, and is well known in a variety of organisms, such as plants, mites, and insects (Hurst et al. 1997). We have found male-killing by about 10 percent females in a Bibai, Hokkaido, Japan, population of the gypsy moth, *Lymantria dispar* L., and have found maternal inheritance of the trait (Higashiura et al. 1999). These male-killing females have no cytoplasmic bacterial symbionts, which have been found in many male-killing organisms (Hurst et al. 1997). Male-killing and mitochondrial DNA (mtDNA) are both maternally inherited (Schulenburg et al. 2002). The mtDNA haplotypes of the male-killing gypsy moth in Hokkaido are different from Hokkaido types, and is the same as that distributed widely in Asia (Bogdanowicz et al. 2000), including Tokyo. Goldschmidt obtained all female broods by means of backcrossing, i.e. F₁ females of a cross between Tokyo females (subspecies *japonica*) and Hokkaido males (subspecies *praeterea*) mated with Hokkaido males (Goldschmidt 1930). We got all-female broods by the double check of Goldschmidt's results. Moreover we found that male-killing

females in Hokkaido mated with Asian type males produced normal sex ratio broods just as Goldschmidt's theory of sex determination states (Goldschmidt 1934). Therefore all-female broods (or male-killing females) found in Bibai, Hokkaido, are thought as an invasive alien species, because those females have Honshu and Asian types of mtDNA haplotype.

Where do those alien species come from? We studied the genetic distribution of the gypsy moth using mtDNA sequences in Hokkaido, Japan. We found that there were two widely diverse lineages in Hokkaido, or Hokkaido and Asian haplotypes, that have 2 percent differences in each other in mtDNA sequences. The genetic distribution of the two lineages were clearly divided by the Ishikari Lowland (the Lowland between Sapporo and Tomakomai); the Hokkaido haplotypes were in the eastern side and the Honshu and Asian haplotypes were in the western side.

The Ishikari Lowland had been under the sea until 60,000 years ago. There had been no straits between Honshu and the western Hokkaido until 1 million years ago. Hokkaido gypsy moths met

Honshu ones about 20,000 years ago, because the Ishikari Lowland has been found since 20,000 years ago. Since then, the two distinct strains have crossed and introgressed each other.

We studied the genetic distribution of mtDNA haplotypes in the Ishikari Lowland. The two lineages contacted at the Ishikari Lowland. The contact zone was very narrow. All-female broods were only found in the Ishikari Lowland and east of there. They existed at the rate of 10 to 50 percent.

Hokkaido gypsy moth is a subspecies, *Lymantria dispar praeterea* Kardakoff, now. Although there were two distinct genotypes in mtDNA in Hokkaido gypsy moths, we found no morphological differences between the two genotypes in Hokkaido. Honshu males have dark wings, and are somewhat larger than Hokkaido males. The wing color of Hokkaido males was lighter than that of Honshu one. There were some varieties in Hokkaido males. But these variations were not relation to genotypes. These indicate that the gene exchanges have occurred between the two types. But the mtDNA is maternally inherited, and remains in the previous regions.

Throughout the introgression, Honshu morphological gypsy moths were disappeared in Hokkaido. We are investigating what genes and functions were disappeared through the introgression. Hokkaido gypsy moths became a model organism to study the outcome of alien species invading after tens of thousands years.

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