First evidence that the genome can adapt to temperature changes

June 5 2013

Researchers at the Universitat Autònoma de Barcelona are the first to have studied the effects of a heatwave on the genetic make-up of a species. The researchers have been monitoring the evolution of the fly Drosophila subobscura for 37 years, and they have observed that the European heatwave of spring 2011 caused dramatic alterations in the genetic make-up of its populations, due to a rapid proliferation of genotypes that were more tolerant of high temperatures.

The researchers have been tracking the evolution of *Drosophila subobscura*, a small fly that is very common all over Europe, since 1976. They are focusing on a specific type of genomic variability known as chromosomal inversion polymorphism. The study has compared how the flies' genomes change from spring to summer, summer to autumn and autumn to spring, over the years.

In pre-2011 studies of one of *D. subobscura*'s five chromosome pairs, performed in a population near the town of Santiago de Compostela, the researchers observed that this type of adaptation is related to changes in environmental temperature. Two types of genetic variation were identified: one that adapts to the cold, since its frequency always increases in winter, and another that adapts to heat, showing the opposite behaviour pattern. The relative frequency of both types of variation was seen to have evolved in consonance with climate changes. Present-day flies present more heat-tolerant varieties than those of the 70s.

In April, 2011, monitoring coincided with the intense heatwave that

struck western Europe and other parts of the world. The study was widened to cover not only the original chromosome pair but all the species' five chromosome pairs, and fly samples were collected from another population, in Gordexola, near Bilbao. The conclusions could therefore be extrapolated on a genome-wide scale and on a geographical scale, to the northern third of Spain.

In an article in the prestigious journal *Biology Letters*, of the British Royal Society, the researchers show that the 2011 heatwave dramatically altered the genetic constitution of natural populations of *Drosophila subobscura*. In the middle of spring, and over a single generation, the populations acquired a genetic constitution typical of the summer, because of the heatwave.

According to the study's findings, the difference in reproductive success between genotypes that were sensitive to the heatwave and those that were resistant to it was extremely high: during the heatwave, flies carrying genomic variants tolerant to the temperature increase left on average five times more descendents than those with variants that were sensitive to these changes.

It was also observed that, after the heatwave, the populations recovered their previous genetic make-up. This shows that some organisms possess high genetic resilience to this type of environmental disturbance.

"Our results indicate that resistance to heat has a genetic origin. However, we are not suggesting there is a gene for cold or a gene for heat, but rather that genetic factors for heat resistance are distributed throughout the genome, in these organisms at least", points out Francisco Rodriguez-Trelles, the UAB researcher who coordinated the study. "Our findings are substantial proof that the rise in temperature is affecting the evolution of certain species".

Provided by Universitat Autonoma de Barcelona