Unique gene expression patterns underlying ant slavemaker raiding and host defensive phenotypes

March 7 2018

A colony of slavemaker ants Temnothorax americanus together with subjugated Temnothorax longispinosus. Credit: Barbara Feldmeyer

Certain ants attack and enslave other species, and integrate their offspring into their own colonies in order to survive. Researchers at the Senckenberg Nature Research Society and the Johannes-Gutenberg University Mainz have recently discovered that the raids required to achieve this are controlled by different genes in each of several closely related ant species of the genus Temnothorax. This indicates that the evolution of closely related species through changes in the genetic material is a random process in which several paths may lead to the same outcome. Moreover, the researchers were able to identify two specific attack genes in slavemaker ants. The study was recently published in *Scientific Reports*.

Barely 3 mm long, the North American ant species Temnothorax americanus should not be underestimated. It belongs to a group of ants that capture closely related ant species and make them work in their own colonies. The task of these so-called slaves is to raise their conquerors' broods and to supply food. In order to acquire slaves, ants such as Temnothorax americanus conduct raids. Researchers from the Senckenberg Biodiversity and Climate Research Center and the University of Mainz study which genes control these raids.

"Our experiments show that the combat strategies of Temnothorax americanus and its relatives, Temnothorax dulocticus and Temnothorax pilagens, are basically very similar. However, the details of the attacks differ from species to species," explains Dr. Barbara Feldmeyer of the Senckenberg Research Center for Biodiversity and Climate, and she

adds, "During the raid the differences in the tuning of individual genes become particularly apparent."

This, together with other findings, suggests, that in the slave-raiding ants differences in gene expressions, i.e., the reading of the gene sequence and the transcription into proteins, is solely geared toward the raid. Similar patterns were also discovered in the potential slaves, which showed different, genetically based defense patterns.

The Temnothorax americanus ant in the middle is battling with two ants from the species Temnothorax longispinosus in order to enslave them. Credit: Barbara Feldmeyer

Figuratively speaking, different gene expression means that that in the genetic material of the three ant species, certain buttons are pressed at different levels of intensity – yet, ultimately, this leads to the same result in all species: a successful raid. The team was surprised by these findings, since for closely related, genetically similar species it was assumed that they would all follow similar genetic paths to achieve a specific goal.

However, this study now shows that genetic evolution among closely related species may well be the result of random selection. "The results suggest that many evolutionary adaptations can be traced back to random mutations. These mutations lead to genetic differences even between closely related species. However, since these species are often subject to similar selective pressure, the result of the adaptive processes, i.e., the behavior, is similar," explains Professor Susanne Foitzik of the University of Mainz.

Despite their differences, the three slave-holding Temnothorax species appear to share two genes that are important for the raids. "Acyl-CoA Delta (11) Desaturase causes the attackers to emit chemical scents during the raid. These scents mask the attackers, thereby increasing the chances for a successful raid. On the other hand, the gene Trypsin-7 appears to affect the recognition potential, thus enabling – at least in part – the identification of the host colonies required for a raid," adds Feldmeyer in summary.

More information: Austin Alleman et al. Comparative analyses of co-evolving host-parasite associations reveal unique gene expression patterns underlying slavemaker raiding and host defensive phenotypes, *Scientific Reports* (2018). DOI: 10.1038/s41598-018-20262-y