Why the tropics are an evolutionary hotbed

Ant family tree shows tropical New World hosts fast speciation while also keeping older lineages alive.

Lucas Laursen

26 April 2013

Tropical climates are famously rich in biodiversity, perhaps because old lineages persist well in those regions instead of being simply replaced by new ones, or perhaps because the tropical environment promotes fast speciation. A new study of the ant family tree suggests that both these explanations may be right.

Vincent Perrichot/antweb.org

A survey of modern and fossil ants — including those preserved in amber — points to the tropical Americas as a continuing source of their biodiversity.

For the study, published this week in *Evolution*, the researchers traced the locations and rates of ant speciation since they emerged 139 million–158 million years ago[1]. The results suggest that a region known as the neotropics — which includes South America, Central America and part of North America — is both the source of the first ants and the liveliest incubator of their diversity.

And the vast majority of that activity takes place in the tropical parts of the region, says Corrie Moreau, an entomologist at the Field Museum of Natural History in Chicago, Illinois, and a co-author of the study.

"If you spend time in the tropics anywhere in the world, what you see is that ants are everywhere," Moreau says. Other living things also flourish in the tropics, and biologists have put forth a few potential explanations.

One explanation, the 'museum hypothesis', suggests that if the environment in which species emerge does not change too much over time, then it will preserve those original species. In that case, ants might have arisen in an early burst of speciation in the tropics and stayed, with some overflow species migrating elsewhere. In the 'cradle hypothesis', a small number of species might have migrated to the tropics before diversifying into many more.

In 2006, Moreau and her colleagues analysed DNA from living ants and the morphology of ant fossils to create a rough sketch of the ant family tree[2].

That study, which included 149 specimens from 19 subfamilies of ants, together with 43 fossils, helped to push back the overall age of the ants from about 125 to about 168 million years ago. The present study includes twice as many specimens (295), covers additional taxa (21 subfamilies) and includes 45 ant fossils spanning 100 million years. The extra data gave Moreau and co-author Charles Bell, a biologist at the University of New Orleans in Louisiana, the ability to detect 10 periods over the course of ant evolution during which the speed of speciation has changed substantially.

The researchers also pinned those changes to locations on the map. They find that the neotropical zone seems to have hosted the oldest, most diverse lineages in the past and that it continues to serve as a species pump. That suggests that neither the museum nor the cradle mechanisms dominate ant biodiversity — both are important contributors.

The neotropics mentioned in the paper are not limited to tropical areas, but Moreau estimates that only a minority of the lineages in the study had a range that extended farther, to temperate regions. "All the rest have an entirely or mostly tropical distribution," she says.

Scott Powell, a biologist at George Washington University in Washington DC, says that the study's broad time coverage supports its credibility. And the combined molecular and fossil data give a "very clear demonstration" that the museum and cradle hypotheses can come together, he says. A 2006 study of beetles came to the same conclusion[3].

Powell says that he would next like to see the findings replicated at a lower taxonomic level, such as within a widespread genus of ants, rather than at the higher level of subfamilies.

"It's possible that this region has been important because it has had such large areas of uninterrupted wet tropics over such a long time span," says Naomi Pierce, a biologist at Harvard University in Cambridge, Massachusetts, and Moreau’s former adviser.

Nature | doi:10.1038/nature.2013.12846

References

1. Moreau, C. S. & Bell, C. D. *Evolution* http://dx.doi.org/10.1111/evo.12105/abstract (2013).
2. Moreau, C. S., Bell, C. D., Vila, R., Archibald, S. B. & Pierce, N. E. *Science* **312**, 101–104 (2006).
3. McKenna, D. D. & Farrell, B. D. *Proc. Natl Acad. Sci. USA* **103**, 10947–10951 (2006).