Changes in brain architecture may be driven by different cognitive challenges

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Workers from a Polybia dimidata wasp colony near the entrance to their closed nest. Queens in this type of nest rely on chemical communication and have different brain architecture than queens in open nests. Photo by Sean O'Donnell

(PhysOrg.com) -- Scientists trying to understand how the brains of animals evolve have found that evolutionary changes in brain structure reflect the types of social interactions and environmental stimuli different species face.

The study is the first to compare multiple species of related animals, in this case social wasps, to look at how roles of individuals in a society might affect brain architecture. The research looks at brain structure differences between species, asking how the size of different brain regions relates to each species' social complexity and nest architecture.

The results are being published Wednesday (June 24) in the British journal Proceedings of the Royal Society B. The Royal Society is the United Kingdom's national academy of sciences.

"It looks as if different brain regions respond to specific challenges. It is important to find these relationships because they can tell us which challenges guide brain evolution," said Sean O'Donnell, a University of Washington associate professor of psychology and co-author of the study.

O'Donnell and lead author Yamile Molina, who just completed work on her doctorate at the UW, looked at the brains of eight New World social wasp species from Costa Rica and Ecuador.

"One idea is that social interactions themselves put on demands for advanced cognitive abilities. We are interested in finding out exactly which social and environmental factors favor an increase in a given brain region," said Molina.

The UW researchers captured queens and female workers from colonies of the eight wasp species and examined their brains. For the most part, males usually don't play an important behavioral role in a social wasp colony's labor and other activities, according to O'Donnell. However, a follow-up study will look at the male wasp brain structure.

In examining the female wasps, the researchers found strong evidence that queens, rather than workers, have distinct brain structure that matches the species' cognitive challenges.

Social wasps form colonies differently and build two types of nests. In more primitive wasps, a queen mates and flies away separately to establish a small colony. Among the more advanced social wasps, several young queens and a group of workers leave a colony as a swarm to establish a new colony that has a much larger population. Independent founders and a few swarm founders build open-comb nests, while most swarm founders build enclosed nests with interiors that are much darker.

Molina and O'Donnell found that queens from open-comb nests had larger central brain processing regions that are devoted to vision than queens from closed-nest colonies. Queens from enclosed nests, where vision isn't as important and where they rely on chemical communication through pheromones, had larger antennal lobes to process chemical messages than queens from open nests.

Among independent-founding wasps, where queens regulate the behavior of a colony, queens had larger vision-processing regions (called mushroom body collars) than their workers. But among swarm-founders, which have a decentralized form of colony regulation, workers had larger mushroom body collars and larger optic lobes than queens.

"We can learn things about ourselves from a whole variety of animals. When neurobiologists use animal models they often look to rodents and primates," said Molina. "I would argue social insects like wasps are like us in some ways and should be an important model as well. In this study we found that it's not being social, but how you are social that explains brain architecture. The brain can be a mirror reflecting what an animal is using it for."

Source: University of Washington (news : web)