Supersoldier ants created in the lab by reactivating ancestral genes

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A supersoldier communicates with a minor worker from the hyper-diverse ant genus Pheidole. Photo courtesy of Alex Wild/alexanderwild.com

(PhysOrg.com) -- There are over 1100 species of Pheidole genus ants, and most individual ants belong to either the worker or soldier caste. In only eight of the Pheidole species, some individuals can belong to a "supersoldier" subcaste instead, and these ants fight off predatory army ant species and bar their way by blocking off the entrances to the nest using their over-sized heads. Now, scientists have managed to create supersoldiers in other species by reactivating ancestral genes.

The international team of scientists, led by Dr Ehab Abouheif of the Department of Biology at McGill University in Montreal, Canada, looked at the genomes of two ant species that produce supersoldiers. They identified the genetics behind the supersoldier caste and were able

to activate the genes by treating ant larvae with methoprene, a growth hormone. As expected, the ant larvae became supersoldiers.

They then treated in the same way larvae of Pheidole morrisi, an ant species which lives in New York and that does not normally produce supersoldiers, but which lead author, Dr Abouheif, had previously noted produced large-headed ants resembling supersoldiers on rare occasions. The treated larvae grew to become large headed and jawed ants resembling supersoldiers. The same effect was produced in two other Pheilode species, which are not known to produce supersoldiers.

Dr Abouheif and colleagues report, in their paper published in the journal *Science*, that ant larvae normally develop into soldiers or workers depending on the levels of the "juvenile hormone": if levels are high the ants become soldiers, while if they are low they become the smaller worker ants. In the species that produce supersoldiers there is a second high threshold of the juvenile hormone, above which the larvae develop into the larger supersoldiers. The growth hormone methoprene, used in the experiments, mimics the effects of juvenile hormone.

The results of the experiments suggest that even those species that do not produce supersoldiers must have been able to do so in the distant past, some 35 to 60 million years ago, and that they still retain the genetic information for supersoldier production that can be reactivated under certain environmental or nutritional states. The researchers say that retaining the ancestral genetic tools could be important for the evolution of new physical traits.

Supersoldier ants occur naturally in species found in Mexico and the south-west of the USA. They were also known in ancestral species, and Abouheif and the team suggest the common ancestor of the entire Pheidole genus had the ability to produce supersoldiers.

It is not known why only eight of the species retain the ability and the remainder simply abandon the nests if they are invaded by predatory army ants, but Abouheif said the genes might have been repeatedly reactivated. This would explain anomalies such as the rare instances of supersoldiers he noted in the P. morrisi ants, which is a species not threatened by army ants.

Dr. Abouheif and colleagues think that their work in unlocking ancestral features could find application in fields such as agriculture, where it might be used to breed crops with greater nutritional value. Abouheif also suggests the work might also shed some light on the growth of cancers, which he said could be "the unleashing of some kind of ancestral potential," which might be reversible if it could be identified.

More information: Ancestral Developmental Potential Facilitates Parallel Evolution in Ant, *Science* 6 January 2012: Vol. 335 no. 6064 pp. 79-82. DOI:10.1126/science.1211451

ABSTRACT
Complex worker caste systems have contributed to the evolutionary success of advanced ant societies; however, little is known about the developmental processes underlying their origin and evolution. We combined hormonal manipulation, gene expression, and phylogenetic analyses with field observations to understand how novel worker subcastes evolve. We uncovered an ancestral developmental potential to produce a “supersoldier” subcaste that has been actualized at least two times independently in the hyperdiverse ant genus Pheidole. This potential has been retained and can be environmentally induced throughout the genus. Therefore, the retention and induction of this potential have facilitated the parallel evolution of supersoldiers through a process known as genetic accommodation. The recurrent induction of ancestral developmental potential may facilitate the adaptive and parallel evolution of phenotypes.