Ant communication—secrets of the antennae

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Fig. 1: Communication between Japanese carpenter ants Using one of the antennae on its head, an ant accesses information provided by hydrocarbons on the body surface of another ant, enabling nestmate and caste recognition, and instruction about occupational tasks.

A research group has identified chemosensory proteins (CSPs) that play important roles in communications between worker ants. CSPs may represent a starting point for elucidation of the molecular mechanisms involved in the sophisticated system of communication that supports ants' complex societies, and the evolution of these mechanisms. These findings were published in *Scientific Reports* on August 27.

Ants, being social insects, form highly organized societies on the basis of very close communication between individuals, mediated by pheromones and other chemical substances. Information about the genomes of several ant species has been obtained to date, and genes linked to chemosensitivity in ants have been shown to be diverse. However, almost no elucidation of the modes of expression and functioning of these genes in chemosensory organs has previously been achieved.

This research group previously showed that one type of CSP, CjapCSP1, binds with cuticular hydrocarbons that play important roles in ant inter-individual communication, and that this is linked to nestmate recognition behavior by worker ants (Ozaki et al., 2005).

In the present research, Project Assistant Professor HOJO Masaru's research group extracted RNA from the antennae of the Japanese carpenter ant (Camponotus japonicus), with support from the laboratory of INOUE Kunio at Kobe University's Biology Department, and comprehensively analyzed the genes expressed on the antennae using a next-generation DNA-sequencer and supercomputer at the National Institute for Basic Biology. The nucleotide sequences of 11 novel CSPs were thus elucidated.

The research group then performed molecular phylogenetic and evolutionary analyses using sequence information for CSPs from various insect species, and analyzed the CSP expression levels by quantitative polymerase chain reaction. The group thus succeeded in identifying two CSPs, CjapCSP12 and CjapCSP13, that are particularly diverse among ants, and that are expressed specifically by the principal chemosensory organs of worker ants, especially the antennae.

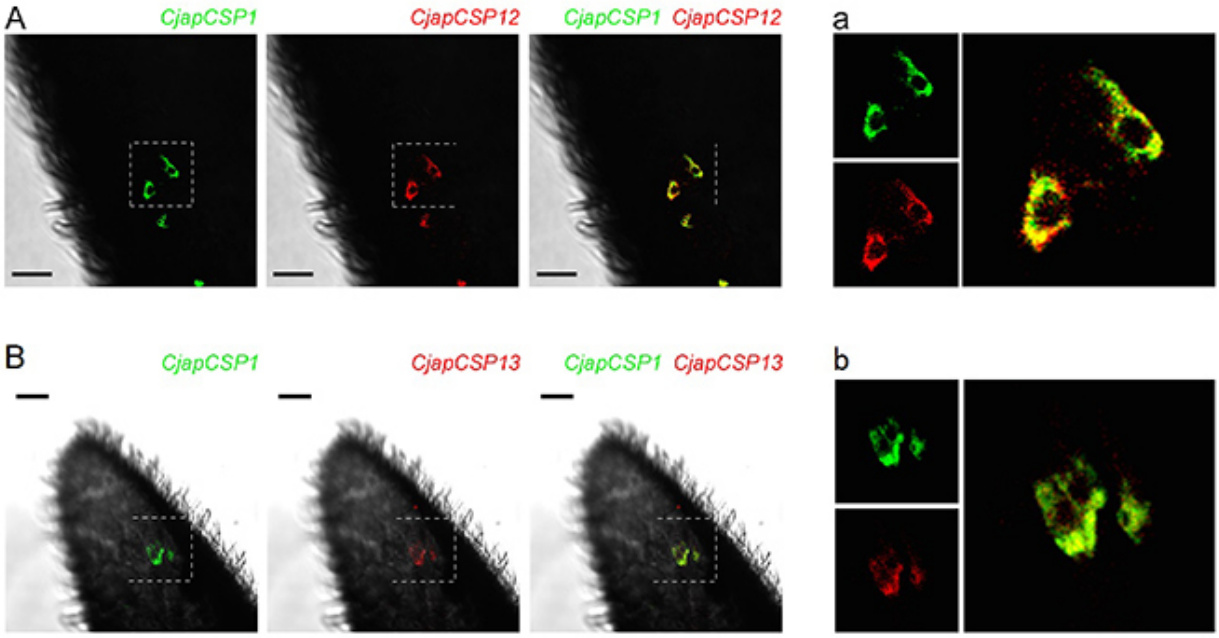

Fig. 2: Expression loci of CSPs on antennae of Japanese carpenter ant workers (A) Expression loci of CjapCSP1 (green) and CjapCSP12 (red). (B) Expression loci of CjapCSP1 (green) and CjapCSP13 (red). (a) and (b) show magnified images of the regions enclosed by broken lines in (A) and (B), respectively. Yellow indicates regions where two genes are co-expressed at a single locus.

In addition, detailed investigation of the expression loci of these genes showed that, as in the case of CjapCSP1, which is linked to receptors of cuticular hydrocarbons, they are co-expressed inside the antennae (Fig. 2).

These findings suggest that complex CSPs that have evolved specifically in ants have cooperative modes of operation in the antennae, and have the capacity to recognize complex individual information transmitted by cuticular hydrocarbons.

Project Assistant Professor HOJO Masaru makes this comment: "This provides a starting point for elucidation of the molecular basis for, and evolution of, the sophisticated communication seen in ant societies. We therefore hope that these findings will make major contributions to future work on elucidation of the molecular mechanisms supporting the complex social organization seen in ants, and the evolution of these mechanisms."

More information: "Antennal RNA-sequencing analysis reveals evolutionary aspects of chemosensory proteins in the carpenter ant, Camponotus japonicas." *Scientific Reports*. DOI: 10.1038/srep13541

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