# Scientists investigate how chemicals evolved into communication signals

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Insects are attracted to the chemicals in flowers, helping to pollinate the flowers. Image credit: John Severns, Wikimedia Commons.

(PhysOrg.com) -- Living things possess many diverse ways of communicating, but perhaps the oldest and most widespread form of communication involves the use of chemicals. From animals and plants to bacteria and fungi, organisms emit and receive chemical signals as a way of transferring information between one another. Organisms are sensitive to a very broad range of chemicals; for example, scientists estimate that rodents can detect thousands or even tens of thousands of odorant molecules.

Exactly how organisms evolved the ability to use chemicals to communicate is still an open question. In a recent review of the subject, researchers Sandra Steiger from Illinois State University and Thomas Schmitt and H. Martin Schaefer, both from the University of Freiburg in Freiburg, Germany, have proposed several mechanisms that help clarify the possible origin and evolution of chemical information transfer. Their study is published in a recent issue of the Proceedings of the Royal Society B.

As the scientists explained, chemical information can be found in mammal excrement, insects' cuticles, spider silk, plant nectar, and so on. Other organisms detect the chemical information in these substances to gain information. For example, red harvester ants have different chemicals in their cuticles that can reveal to other ants whether they are foragers or nest-maintenance workers. And wolves' feces contain sex hormone levels that indicate their status within the pack to other wolves.

The scientists suggested that these chemical cues originated for non-communicative purposes at first, and only inadvertently contained information that other organisms detected. Then, the chemical cues could have evolved into signals in a few different ways. If the organism that detected the original chemical reacted in a way that benefitted the organism that released the chemical, then the chemical's function as a means of communication should be enhanced through evolution. Enhancement could be done by, for example, the sender increasing the quantity of the chemical cue, adding behavioral components to the chemical cue, or modifying the chemical cue to become more conspicuous.

"In the last years, research on the evolution of chemical signals has largely focused on sex pheromones and their diversification due to speciation events," Steiger told *PhysOrg.com*. "However, there are other or additional reasons for the ubiquity and high abundance of chemical signals. Our concept that signals derive from cues is not a novel concept; however, it has been an astonishingly underappreciated topic. The studies we present in our review show that a wide range of organisms release waste products and chemical compounds with non-communicative functions. These chemicals can incidentally carry information and therefore provide multiple starting points for the evolution of chemical communication. As there are different ways how selection enhances the communicative function of these chemicals, several distinct evolutionary trajectories of chemical communication are possible."

Because organisms possess such a large number of different odor receptors, the scientists predicted that evolution may have tailored organisms' chemical signals to match the sensitivities of the intended receivers while avoiding those of predators.

To better understand this process, Steiger says that more phylogenetic studies are needed to support the concept that chemical signals can derive from cues, which is not well-investigated. Phylogenetic studies could also reveal how often organisms use different techniques for enhancing the efficiency of chemical communication (for example, how often behavioral elements are added and how often only the quantity of a chemical is increased).

"There is definitely a need for studies that evaluate the different selection factors acting on chemicals," Steiger said. "Chemicals can have both a communicative role and a non-communicative function (e.g., chemicals on the cuticles of insects protect against desiccation and bacteria, but also function frequently as sex pheromones). Are these multiple functions in conflict or in accordance?"

**More information:** Sandra Steiger, Thomas Schmitt, and H. Martin Schaefer. "The origin and dynamic evolution of chemical information transfer." *Proceedings of the Royal Society B.* DOI: 10.1098/rspb.2010.2285


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