Chemical modules that mimic predator-prey and other behaviors

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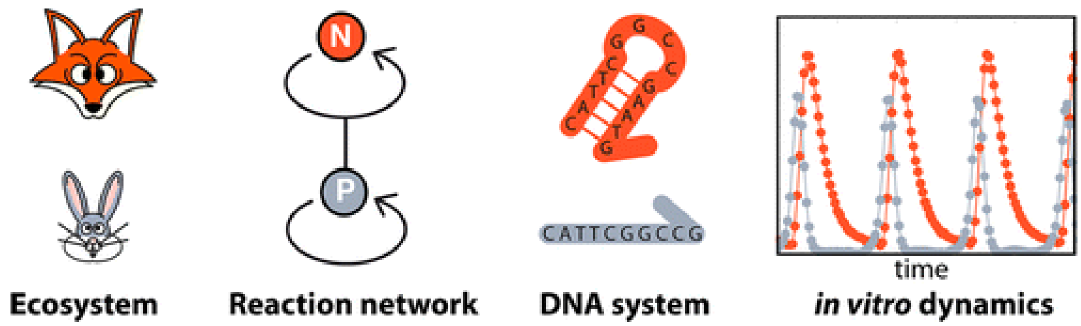

Scientists are reporting development of chemical modules that can reproduce, on an "unprecedented" molecular level, changes and interactions that occur in natural populations of plants and animals, including those of hunting and being hunted for food, conducting mutually beneficial relationships and competing for resources. The report on these new "predator-prey biochemical oscillators," which could become building blocks for molecular machines and computers, appears in *ACS Nano*.

Yannick Rondelez and Teruo Fujii explain that just as plants and animals interact in complex ways in vast "ecosystems" in nature, molecules, such as small synthetic DNA fragments, can be made to interact in complex ways within test tubes. Therefore, animal behaviors, like hunting (as a predator) and being hunted (as prey), could also be applied to molecules, they say. Currently, researchers can build simple circuits with molecules. But to make complex molecular machines and computers (which would provide information-processing ability to wet systems), they need to understand and control how groups of molecules interact with each other, as animals do in nature.

The scientists describe reproducing predator-prey interactions, mutually beneficial relationships and competitive conditions using DNA and enzymes that build up or break down DNA. "Therefore, beside opening the way to the study of fundamental issues of chemical dynamic systems, we also expect that this approach will provide a useful building block in the scaling-up of molecular computers and machines," they say.

More information: "Predator-Prey Molecular Ecosystems" *ACS Nano*, Article ASAP. DOI: 10.1021/nn3043572

Abstract
Biological organisms use intricate networks of chemical reactions to control molecular processes and spatiotemporal organization. In turn, these living systems are embedded in self-organized structures of larger scales, for example, ecosystems. Synthetic in vitro efforts have reproduced the architectures and behaviors of simple cellular circuits. However, because all these systems share the same dynamic foundations, a generalized molecular programming strategy should also support complex collective behaviors, as seen, for example, in animal populations. We report here the bottom-up assembly of chemical systems that reproduce in vitro the specific dynamics of ecological communities. We experimentally observed unprecedented molecular behaviors, including predator–prey oscillations, competition-induced chaos, and symbiotic synchronization. These synthetic systems are tailored through a novel, compact, and versatile design strategy, leveraging the programmability of DNA interactions under the precise control of enzymatic catalysis. Such self-organizing assemblies will

foster a better appreciation of the molecular origins of biological complexity and may also serve to orchestrate complex collective operations of molecular agents in technological applications.

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