Natural 'keystone molecules' punch over their weight in ecosystems

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Naturally occurring "keystone" molecules that have powerful behavioral effects on diverse organisms often play large but unrecognized roles in structuring ecosystems, according to a theory proposed in the June issue of *BioScience*.

The authors of the theory, Ryan P. Ferrer of Seattle Pacific University and Richard K. Zimmer of the University of California at Los Angeles, liken such molecules to keystone species, animals or plants that may be uncommon but exert a controlling influence, through predation or in other ways. Keystone molecules function in chemical communication and defense, and likewise have dominant consequences in nature.

Ferrer and Zimmer give four examples of keystone molecules. DMSP is a simple chemical, synthesized by single-celled marine organisms, that has powerful effects on bacteria, and through its breakdown products, on the foraging of seabirds. Saxitoxin is a potent poison, also produced by marine microbes, that repels some grazing animals but can cause massive die-offs of fishes, seabirds, and marine mammals. Tetrodotoxin is another toxic keystone molecule, but produced in the skin of newts. It prompts newt larvae to hide to avoid being cannibalized and also deters some predators. Garter snakes that feed on newts, however, can accumulate the toxin in their own tissues, which in turn provides them with predator protection. Pyrrolizidine akaloids, which are synthesized by many plants, repel most plant-eaters, but are consumed by some moths, which recycle the alkaloids and convert them into a powerful volatile pheromone that attracts mates.

Because of their multifunctional effects and importance in the sea, in fresh water, and on land, keystone molecules deserve special attention from managers seeking to conserve species, Ferrer and Zimmer argue. The loss of a species that produces or captures a keystone molecule in an area could have far-reaching effects, as could the arrival of a non-native species that disrupts flows of the molecules. Future research, Ferrer and Zimmer suggest, is likely to reveal more keystone molecules and unseen webs of natural control.

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