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CHEMICAL ECOLOGY

OF PUSHY WEEDS AND TOXIC FROGS

Weeds invade using small molecule; frogs defend with beefed-up toxin

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Nature's versatility in chemical warfare is highlighted in two newly published studies. The first reveals the role of a small molecule in helping an invasive plant occupy new territory. The second shows that certain frogs can make diet-derived toxins more potent by chemical transformation.

Jorge M. Vivanco, assistant professor of horticultural biotechnology at Colorado State University, Fort Collins, and coworkers have laid out evidence of chemical warfare by the spotted knapweed (Centaurea maculosa, shown). According to Vivanco, this invasive plant spread from Eurasia to North America at the beginning of the 20th century, causing huge problems in some states.

The weed's chemical weapon is (–)-catechin, a well-known secondary plant metabolite. Previously, Vivanco and others showed that this compound and its enantiomer are produced by the weed but that only (–)-catechin is phytotoxic.

Now, they complete the case for its role in the weed's proliferation. They find that (2)-catechin is present in infested U.S. soils at levels that are highly toxic to native North American grasses but not to the weed itself [*Science*, **301,** 1377 (2003)]. Vivanco suspects that the weed releases (–)-catechin to the soil as it is produced and that some kind of pump prevents its reentry.

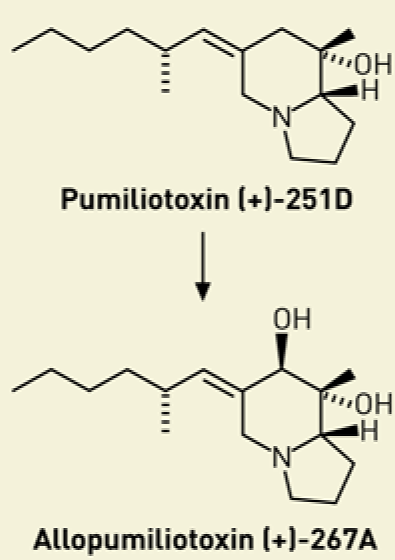
In addition, the researchers find that (–)-catechin initiates a cascade of events in susceptible plants leading to altered gene expression in the roots and culminating in cell death. The whole root dies within one hour.

Meanwhile, in the labs of John W. Daly at NIH, the alkaloids in poison frogs continue to surprise.

Daly and coworkers have established that the alkaloids are derived from diet, except in one rare case (C&EN, April 15, 2002, page 39). Now, they show that frogs of the genus *Dendrobates* (shown) that are fed pumiliotoxin (PTX) (+)-251D metabolize up to 80% of the alkaloid to allopumiliotoxin (aPTX) (+)-267A [*Proc. Natl. Acad. Sci. USA*, **100,** 11092 (2003)]. But if the enantiomer--the nonnatural compound PTX (2)-251D--is fed to the same frogs, it is unchanged. The hydroxylation that occurs in Dendrobates does not occur in other genera, such as Epipedobates and Phyllobates.

aPTX (+)-267A is five times more toxic than PTX (+)-251D.The metabolism may be viewed as an adaptation to enhance the protective value of defensive compounds from the diet, the researchers suggest.

The two studies "show the dynamic role of organic chemistry in natural interactions," comments Jerrold Meinwald, a chemistry professor at Cornell University and a pioneer of chemical ecology. It is not enough to know the structures of natural compounds and how to synthesize them, he says. "What's really interesting is what these structures do."



FROG CHEMISTRY
Metabolic hydroxylation yields more potent toxin

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