Science AMA Series: I'm Jozsef Vuts here to discuss the science behind chemical ecology and how this knowledge can be used to tackle pest insects. AMA!

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April 17, 2023

Abstract

Edit: Hi everyone! Many thanks for those who were interested in this topic, I really enjoyed answering your thought-provoking questions. I am signing out now, but will try to check back later and answer a few more. Hello Reddit! I'm a chemical ecologist at Rothamsted Research in the UK. Up until the age of eight I had wanted to become a pilot, an ambition that was stopped short after a failed attempt to fly a home-made glider. However, I think it was my innate curiosity that eventually made me realise that I wanted to do something connected to nature. Endless hours a day spent in the back garden, natural history books, influential teachers and, later in life, great mentors supported me on my way to becoming an ecologist. First at the Plant Protection Institute of the Hungarian Academy of Sciences (http://marton.agrar.mta.hu/start.php?lang=en), and later at Rothamsted (https://www.rothamsted.ac.uk/). I was amazed by the dedication and focussed work of inspiring scientists who wanted to make a difference, thereby setting a standard for me. After my third level studies, I was introduced into the amazing world of semiochemicals (behaviour- and development-modifying chemicals). Since then, I have found myself immersed in this magical world of chemical communication that invisibly governs key interactions among organisms! It is fascinating stuff! I mainly work with insect pests in agro- and forest ecosystems. I identify volatile compounds from the pests' host plants or the insects themselves. I then use these compounds to manipulate the behaviour and development of the plant, or the insect, to help keep the pest's population under control. I recently also started to study the chemical ecology under our feet. The soil is a tough one, because it is much less accessible, and therefore harder to research, than the environment above the ground. However, when something is discovered here, it has the potential to be ground-breaking! In a world where environmental, human and food safety are fortunately becoming increasingly important, we need alternative, non-toxic ways to tackle pests, and chemical ecology research offers such solutions. The recent ban of many key pesticides is also driving the focus of plant protection in this direction. It would be great to discuss my research with you. Feel free to ask me anything! On Thursday 26th October at 4pm (BST) I will be live on Reddit Science AMA. In the meantime, you are welcome to find out more about me in a blog entry I wrote for Rothamsted's 'A day in the life of a research scientist' blog series (https://www.rothamsted.ac.uk/articles/day-life-dr-jozsef-vuts). (Rothamsted Research is a company limited by guarantee, registered in England at Harpenden, Hertfordshire, AL5 2JQ under the registration number 2393175 and a not for profit charity number 802038.)

the WINNOWER

REDDIT

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JOZSEF_VUTS R/SCIENCE

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CORRESPONDENCE:

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ARCHIVED:

Hi and thanks for joining us today!

With pyrethroid, organochlorine, carbamate, and organophosphate resistance now an ever-growing problem, do you see any forerunners on the next go-to mosquito insecticide?

Should repellents like icaridin be more heavily utilized in an attempt to delay and possibly subvert the development of resistance?

PHealthy

October 26, 2017

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The development of resistance to semiochemicals should be a slower process than to toxins, so I wouldn`t expect mosquitoes to develop resistant strains against repellent semiochemicals quickly. I think the way forward is heavier use of naturally occurring repellent-based products, together with reduced amounts of insecticides.

Hello! Thank you for doing this AMA.

So as I understand it, you could potentially use these chemicals to dissuade creatures from eating certain crops, etc rather than killing them with other methods such as poisons which could leach into the food supply?

If I may try two questions:

1) Is the potential for human consumption of these semiochemicals of greater risk than that of consumption of traditional pesticides?

2) What might be the comparative effects on the local ecosystem's food chain in comparison to outright killing the pests, sending them to go eat other plants, for example?

StonedPhysicist

Hi! Normally, semiochemicals are applied in small amounts that do not cause harm to humans, i.e., they work in a non-toxic mode of action. They effect of repelling the pest to a nearby location should not cause much effect on the local ecosystem. Collecting them by mass-trapping, however, means a direct reduction in pest numbers, but I think it depends on a particular pests local abundance what kind of effect this may have on the local ecosystem. I dont yet know of any study measuring it.

Hi Jozsef! I've got a few questions- I hope that's okay :-)

1. How do plants release volatile compounds from their leaves and why has this evolved?
2. Is there an 'evolutionary arms race' between plants and insects? If so, is there any way of studying the semiochemicals of the past?
3. Your work on soil- is this a radically different way of looking at volatile compounds? I can imagine a volatile coming from a leaf diffusing in the air so that eventually an insect can detect it, but in soil, how do the semiochemicals move around the soil?

Thanks!!

mcgrhr

Hi mcgrhr! Good questions - I try my best! 1) Volatiles can be released directly from epidermal cells through the cuticle, or through stomata from parenchyma cells. Direct cell damage cause immediate volatile release. Volatiles mediate many processes, including plant thermotolerance, and they can give protection against oxidative stress. In terms of biotic stresses, the opinions are divided. Many argue that a primary aim of plant volatiles is to communicate with third trophic levels, such as the natural enemies of the herbivores, to lure them to the site of damage. Others question this deterministic evolutionary path and say that they play a bigger role in plant physiology/abiotic stresses, and perhaps defence against pathogens, and parasites opportunistically use these stress volatiles to find their prey. Whichever is the case, they are a great target for semiochemical-based interventions! 2) Arms race: again, very divided topic. The final verdict I think will depend on if we can ever prove if herbivore insects can pose such a big pressure on populations of plants that it affects a whole plant species. Some argue that the abundance of plant material is vast compared to that of herbivore insects, so only

microevolutionary processes can happen. Others assume an arms race, i.e., macroevolution. Herbivore pressure can cause development and inheritance of defence traits, but it is yet to be figures out if this happens on larger scales. I don`t think we can ever study semiochemicals of the past, because they degrade quite quickly. Would be good though!! 3) Volatiles move within the soil in the crevices and cracks (soil atmosphere), and they can penetrate water films covering particles, but only very slowly. And because there is no air movement down there, small lipohilic molecules travel by diffusion.

What is the biggest hurdle you have come up against during your research?

TrivialBudgie

Thanks for your question. Perhaps the toughest topic was the identification of the sex pheromone of the dried bean beetle. The males emit their volatile blend in such small amounts that it took us many years to figure out their structures. We even attempted to purify one of the compounds from the bouquet by preparative-scale GC for NMR analyses, so we needed to collect a lot of material! In the end, we succeeded, but it took many long days spent in the lab until we gathered enough. http://onlinelibrary.wiley.com/doi/10.1002/ejoc.201500196/abstract

Fascinating topic! I'd like to ask if you could share an interesting or demonstrative example of how chemical ecology has been or could be applied to pest control to improve environmental outcomes?

GaryFrewin

Hi GaryFrewin! The push-pull system in East Africa is a prime example of how chemical ecology can make a real impact (http://www.push-pull.net/). Other example can be sea louse control using repellent volatiles acting under the sea (http://onlinelibrary.wiley.com/doi/10.1002/ps.510/full). ANd there are many more.

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GaryFrewin

Pheromone- and other semiochemical-baited traps are now used successfully worldwide to detect and monitor pest populations, and they offer better timing of interventions if considered together with weather variables.

Hello, thank you for joining us:)

How big of a threat is pesticide resistance? Also, what are the mechanisms behind how insects develop resistance to insecticides?

Hitlers_Gas_Bill

Hi! Insecticide resistance can be a great threat indeed. One of the most recent examples is pyrethroid resistance of the cabbage stem flea beetle, Psylliodes chrysocephala, in the UK. It has now become a serious pest of oilseed rape, for example, and alternative control approaches are urgently needed. We are working on its pheromone at the moment, so hopefully this will provide a good, more environmentally benign alternative. The development of resistance happens through chance mutations

that give the insect protection against pesticides.