Gold medal address / Allocution du médaillé d'or

By Peter Kevan

Entomology: A celebration of Little Wonders

How does a plant gynoecologist qualify for an entomological Gold Medal? Yes, I can be considered a plant gynoecologist - "Spread those petals!" That also makes me a plant androecologist. Most flowers are boystrous, and girlstrous. At the same time they are flamboyant and flamgirlant adverstisements for sex. The "naughty bits" may be hanging out for all to see, or demurely hidden within the corolla.

That's all very well, be lewd, but for sexual consummation, the union of male and female parts is needed. How do plants copulate? They use our "Little Wonders". Yes, insects, especially are plants' winged penises. And, the plant world is full of penis envy: "Mine is bigger than yours!"; "Mine stay longer than yours!"; "It's not how big it is, it's how you use it!"

Indeed, the jolly fun of plant procreation has given me a career of insect study in Botany and Ecology. *Flagrante delicto, coitus interruptus plantarum*, is how to collect pollinators. Who could ask for more?

I want to tell you about the "more". Plants may brag about their sexual prowess, but what about their sexual agents? How do insects experience flowers? That's Entomology and the subject of my thoughts in this address.

Flowers are bowers for insectan pleasure. At least, that's what I maintain, at the risk of being dubbed anthropomorphic. Insects, when they visit flowers, are not altruistic matchmakers. They demand recompense. What do they get? Mostly food. Nectar is sweet, but much more than that, it is an elixir. Sugar for energy, amino acids for building the body beautiful, minerals as electrolytes, water for thirst. We can understand Shakespear's implication when he wrote "Where the bee sucks, there suck I; In a cowslip's bell I lie; ...". Nectar is like Gatorade®. Pollen is nutritious. It's as nutritious as steak and eggs. Bees "bake" bread with it, and feed it to their young. Not only honeybees, but almost all bees. Those myriad bees that nest alone in the ground, or in twigs, or in beetle bore holes, they lay their eggs on carefully prepared and shaped bee-bread-loaves within carefully prepared, constructed and waterproofed cells of mud, leaves, waxes, or self-made polyester. Some beetles and flies eat pollen, digest it, and turn the protein into eggs. Some special flowers provide special oils for special bees. Stranger still are flowers that provide gums for bees' nest building. Males of orchid bees take orchid scents to woo mates. Some beetles dine of floral parts. Thank a weevil for soap! Yes, it contains palm oil. Oil palms are pollinated by weevils with life histories intimately bound to the male inflorescences.

In evolution, what came first - nectar or pollen - as the recompense for pollination? A decade or so ago the answer would have been "probably pollen". Now, it seems that flies sought nectar from the flowers of the earliest Angiosperms, 160 million years, or more, ago. Not only that, those smallish flowers probably produced heat, as do

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Peter G. Kevan FRES, recipient of the 2005 ESC Gold Medal, became interested in insects through the encouragement of his grandfather, D. K. Kevan, and amateur coleopterist in Scotland, and his father, well known in Canada and internationally for his interest in the Grasshoptera and soil ecology. Peter's main interests are in pollination from both zoological and botanical viewpoints, applied ecology, and conservation. He is presently Professor at the University of Guelph. E-mail: pkevan@uoguelph.ca, www.uoguelph.ca/~pkevan.

their extant relatives today.

"Hot flowers", you say. Yes, sexually hot and physically hot. And, scientifically hot!

As a student with Professor Brian Hocking at the University of Alberta, I learned a great deal about hot flowers. He published on them. He inspired me. I owe him many thanks for his generosity with ideas, his patience, and his encouragement in thinking "outside the box". I don't think I appreciated his mentorship as much then, as I do today.

Brian was interested in how insects interacted with flowers. He considered insect vision, the sense of smell in insects, foraging and flight energetics (his own doctorate study), and general anthecology. I followed his leads.

Did you know that a honeybee, and probably any bee, can't see the flower of a Prairie Rose, or any other rose for that matter, unless it is about 10 - 20 cm close? Did you know that the petals of a Prairie Rose, or any other rose, smell differently from the "naughty bits". (I mention the Prairie Rose because it is the Provincial Floral Emblem for Alberta.) Scent and vision interplay in attraction and orientation. Both sensory modalities are complex, but those complexities are cracking apart as senses are understood, and as floral attractants are analysed.

Flowers, those flamgirlant sexual advertisements for reward seeking sex-slaves, offer banquet tables adorned with colours. Some, like ultraviolet, we can not see with our human, and inferior, system of colour vision. The tables emit sensory delights of smells, fascinating shapes, variety of size of plates, and a smorgasbord of tasty comestibles. The tables may be found by insects quite easily, but obtaining the rewards can be problematic. How does an insect find its way into a delphinium flower? It must learn! Insects learn and remember. My friend and colleague, Terence Laverty, taken from us too soon, studied how with his elegant and simple experiments. Some insects, notably honeybees and stingless bees, have intricate ways of communicating with each other to convey what they have learned about where flowers are. Karl von Frisch earned his Nobel Prize for his studies on that.

By training bees, as did von Frisch, I have discovered marvellous things. How they see colours. What colours are more important than others to them. (Green is the most important: it is used for colour appreciation, but is also the main modality for detection of edges, shapes, symmetry, contrast, and motion.) With colleagues, I have learned how shapes and sizes are perceived. Bees use micro-Braille through their feelers at microscopic levels to distinguish surfaces.

Life's Little Wonders, indeed! But, what happens when, as individuals, they come together in nature, or when we try to coerce them to our own ends.

Asking those questions has not been easy. I am still using data from the High Arctic as gathered for my doctorate research under Brian Hocking. Linked to that is another interesting story. It comes from my work in New Brunswick on the adverse effects of insecticides on native bee assemblages (70 or so species) that service the pollination needs of lowbush blueberries.

The blueberry growers lost crops because pollinating bees were poisoned. They lost about 0.7 million kg per year for about five years. My surveys in the 1970s were unpopular, to say the least, with the insecticide spray programme aimed at protecting trees from the ravages of spruce

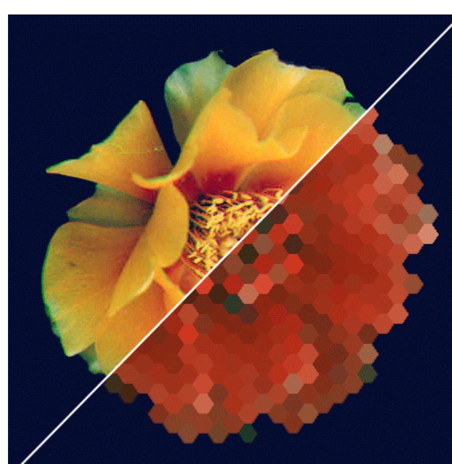

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Figure 1. View of a flower as bee might see it.

budworm. My surveys were popular with blueberry growers, who sued the spray operators. That was my first encounter with litigation, and a learning experience.

To cut to the chase - my results stimulated more studies over broader geographic and ecological ranges. The eventual upshot, a national change to much reduced pesticide use in Canadian forestry.

I am now very much involved in sustainability and conservation in pollination, and using pollinators in novel ways.

On the practical take, let me relate a quick story. Dan Esikowitch came from Tel Aviv University to my laboratory for his sabbatical leave. He had the idea of studying pollination in field milkweed in Canada to compare with his findings at home. We knew that milkweeds secrete nectar from the "very naughtiest of bits", the stigmatic receptive surface (is that the G-spot of the flower?). We also knew that the nectar was the magic juice in which the pollen would germinate. We extracted nectar from milkweed flowers that had opened in the field and from flowers that had opened in the lab. In Petri dishes, lab-opened flowers' nectar had the magic property - pollen germinated in it. From the field - the nectar inhibited pollen germination. What was going on?

Pollinators carried the pollen in packages called pollinia. They drank nectar from the flowers. What we discovered was that the pollinators infected the flowers with yeast. It was a yeast infection like no other - with contraceptive properties! We had discovered a plant venereal disease.

Another plant STD (sexually transmitted disease to be more politically correct than my earlier terminology) is grey mould. Grey mould rots your strawberries. John Sutton, my office neighbour at the University of Guelph, and I plotted to use the flying penises of strawberry and of raspberry to deliver to the flowers another fungus that was antagonistic to grey mould. Would it work? It did, in spades! The rate of rot dropped to levels obtained by sprays of fungicide. Now, a team of entomologists, plant and insect pathologists, and pollination ecologists uses honeybees and bumblebees to disperse biocontrol agents to crops in greenhouses (tomatoes and peppers) against plant pathogens, and plant bugs, thrips, aphids, and

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It's not how big it is - it's what you do with it. A tiny bee buzz pollinates a large solanaceous flower in Brazil .

white fly. Does the technology work? Indeed!

We have a double whammy - better pollination with higher quality and more crop plus biocontrol of pests. We are even trying to turn pests beneficial. Fungus gnats can transmit biocontrol agents that inhibit the growth of the very pathogens they carry. Little Wonders at Work!

Greenhouses and field crops present simple ecosystems. In returning to my roots in natural ecosystems, I am convinced that it is not just more pollinators that matter, but more kinds of pollinators.

The three basics of ecology are Diversity, Abundance, and Activity. Those conjoin in pollination to assure ecosystemic productivity and sustainability in agriculture, and in nature. A few community ecologists working in pollination systems are finding that results from our studies apply to the fast growing subject of "biocomplexity" through diversity, ecosystem function and stability. Members of my team at the University of Guelph, with friends and colleagues in Mexico, Brazil, Israel, USA, and UK are discovering that greater diversity and size of pollinator forces better serve communities of plants with more complex sets of interactions than does simply flooding smaller areas with a few pollinator types. Those ideas seem to apply not just to natural areas but also in agricultural systems as seemingly simple as greenhouses to the complexities of plantation cropping.

For the reasons introduced above, and others, pollination is regarded internationally as an important area for conservation. The Rio Convention on Biological Diversity has embraced the concern, spear-headed from Brazil. Now there are initiatives around the globe promoting the crucial importance of pollination for the sustenance of life on earth. Little pollination, few fruits and seeds, wildlife food shortages, human food and fibre security at risk, natural community regeneration adversely affected.

Just a glimpse of my major studies and interests. Life's Little Wonders have filled my time in ways that I would never have imagined. My personal curiosity about life on earth and how it is all inter-related has been satisfied, not fully, of course. I have travelled and worked from the High Arctic and high alpine, to tropical rainforests in Southeast Asia, Africa, and the Americas, and places in between. My personal curiosity about how the Little Wonders perceive their world has got me to "thinking like a bug". I don't see flowers the same way as before, anymore. I have gained immense personal satisfaction from sharing discoveries with friends and colleagues in so many disciplines, not just Biology, Ecology, Botany, and Entomology. Using my ideas and findings to address practical and environmental problems has been no less exciting. I have sought new ways to expand the generality of knowledge to utility in issues of sustained, cleaner, and more efficient agricultural productivity, notably into crop protection by biocontrol. Pollination is one form of biocontrol! Pest biocontrol is another. They have been combined. Ultimately, my quest to understand the basis for Ecology through interactions of Diversity, Abundance, and Activity is bing satisfied through studies of one of natures major and critical mutualisms - Pollination.


Victoria MacPhail

Polistes on *Caltha* (marsh marigold)

I need to thank people, and I do. My Grandfather was a coleopterist and naturalist. He showed me, a small boy, my first stinkhorn fungus in Pennycuik Woods in Scotland. His sense of humour and temper may have rubbed off. My Father, a grasshopterist and soil zoologist: I have so much to thank him for, I can not say. He is a Gold Medalist too. His was also presented in Alberta, in 1981. My Mother has always been so encouraging; insects in the house, Norma the newt, and life in the English countryside until I was 14. I thank Anthony Downes for asking me eclectic questions, and expecting similarly eclectic answers. I have mentioned Brian Hocking who helped immeasurably with eclecticism. Randolf Menzel gave me opportunity to study at the Institut für Neurobiologie in Berlin. That rekindled my interest in how insects perceive flowers. I thank Joe Shorthouse for such a long friendship, and co-authoring our first scientific paper. Rob Roughley and I have a "dog and pony" show called Arctic & Boreal Entomology. What fun! I thank Bruce Hemming for calling me a "chronic generalist". That was in about 1968! He, with Dan Johnson, another gifted grasshopterist and all round insectologist, were instrumental in my being nominated for this award. Thank you both! The list goes on in my mind, so I must apologize for omitting so many others, Entomologists, Botanists, Ecologists, in Canada and around the world. In finishing, though, I thank all my wonderful students over the years (they started a collection for a one-way ticket for me to visit Mars), my colleagues, friends, and kindred spirits. Thank you ESC, and The Little Wonders.

So much more to learn! Think outside the box! Thank you all for your support!