Sub-Theme II: Impacts of Animal-Mediated Pollination on Gene Flow

Cognition, Choice, Carryover, Constancy, and Context: Pollinators as Agents of Pollen and Gene Dispersal

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Reasons for interest in pollen/gene dispersal:

♥ Agriculture—e.g., crop contamination, escape of transgenes
♥ Conservation/restoration of plant populations
♥ Structure of plant communities
♥ Nature and genesis of plant species
Pollination by animals is a mutualism but not a cooperation.

The plant seeks pollen transfer; The animal seeks resources . . .
The sensory abilities of pollinators (information receipt) and their cognitive abilities (information processing) . . .
must be appreciated to understand their choices of flowers to visit . . .
... as the animals encounter floral *phenotypes* in the context of the spatial *metacommunity* of plants they fly through
The community of floral phenotypes
The metacommunity context

The mixture of floral and pollen phenotypes also influences the mechanics of pollen transfer—how pollen is picked up, carried over and deposited on later flowers.
Pollen carryover across flowers can be characterized experimentally.
Chilled bumble bee queens
“Highly leptokurtic” carryover distributions—due to pollen layering, compartments, etc?—W. Morris et al. 1994 *Evolutionary Ecology*
Finally, transfer mechanics combines with the itinerary of floral choices to determine where pollen goes.
. . . Which can be studied by direct observation in the field

(Flower of *Ipomopsis aggregata* with green fluorescent dye applied to dehiscing anthers)
Long-tailed distributions within continuous populations

But likely more complex in real metapopulations
Example: Delphinium nuttalianum (= nelsonii)
Short flights to neighbors *within* populations—“skips” *among* populations in a metapopulation


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<thead>
<tr>
<th>POLLINATION MEASURE (means)</th>
<th>CONTROLS</th>
<th>ISOLATES</th>
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<tbody>
<tr>
<td>Approaches per hour</td>
<td>13.3</td>
<td>9.4</td>
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<tr>
<td>% Flowers receiving pollen</td>
<td>87.7%</td>
<td>82.1%</td>
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<tr>
<td>% Seed set</td>
<td>74.3%</td>
<td>69.8%</td>
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Pollinators observed = *Bombus appositus* Q, W; *B. flavifrons* Q, W; *B. californicus* Q; *B. nevadensis* Q, W; *Psithyrus* sp.; *Selasphorus platycercus* M, F; *S. rufus* M; *Stellula calliope* M
BUT THAT’S NOT ALL:

Postpollination events are a final filter
Postpollination events—an arena for:

Female choice!

Male-male competition!
THE END RESULT IS REALIZED GENE FLOW

Distribution of double-herbicide resistance genes away from source; oil-seed rape (Champolivier, Gasquez & Messéau)
Is it better to measure pollen dispersal or realized gene dispersal?

Each has advantages and disadvantages:

-- pollen dispersal: insight into mechanisms, but rare events are missed

-- gene dispersal: captures rare events but includes postpollination filter, confounding the inference of process from pattern

Would be nice to merge the two!
Example: here the 2 measures are similar (although how general is this?)

Black = microsatellite marker, white = fluorescent dye; *Primula elatior*

From: Fabienne Van Rossum, Vrije Universiteit Brussels, Belgium
Let us return to the community context. .
Actual pollination interactions form a well-connected web . . .

(Kaiser, CN 2006 Functional integrity of plant-pollinator communities in restored habitats in Mauritius. PhD, Universität Zürich, Zürich, Switzerland)
WHAT CAN COUNTERACT THE POSSIBILITY OF INTERSPECIFIC POLLEN TRANSFER?

SHORT-TERM SPECIALIZATION OF INDIVIDUAL POLLINATORS
Simple optimal diet theory predicts specialization.
Recognition of flowers by pollinators
Lars Chittka and Nigel E Raine

The flowers of angiosperm plants present us with a staggering diversity of signal designs, but how did this diversity evolve? Answering this question requires us to understand how pollinators analyze these signals with their visual and olfactory sense organs, and how the sensory systems work together with post-receptor neural wiring to produce a coherent percept of the world around them. Recent research on the dynamics with which bees store, manage and retrieve memories all have fundamental implications for how pollinators choose between flowers, and in turn for floral evolution. New findings regarding how attention, peak-shift phenomena, and speed–accuracy tradeoffs affect pollinator choice between flower species show that analyzing the evolutionary ecology of signal–receiver relationships can substantially benefit from knowledge about the neural mechanisms of visual and olfactory information processing.

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WHAT HAPPENS IF POLLEN DISPERsal DOES OCCUR BETWEEN SPECIES?

POLLINATORS AS AGENTS OF POLLEN DISPERsal AND NATURAL SELECTION TOGETHER
One example is selection to minimize the loss of pollen or stigma surface (an “opportunity cost”) that interspecific pollen transfer can cause (a form of interspecific plant competition)

Targets of selection: the mating system, flowering phenology, precision of pollen placement, etc.
Formation of species hybrids is common when pollen is transferred among relatives.

For example see E. Hersch and B. Roy *Evolution* 61:111-124 (2007)
THE TWO FACES OF BIOLOGICAL SPECIATION

DIVERGENCE OF THE PHENOTYPE

CESSION OF GENE EXCHANGE

Here the example is possible selection to reinforce reproductive isolation
Thus the study of pollen and gene dispersal by animals has had many starting points.

Allons, enfants de la patria! Much work and collaboration remains to connect these different perspectives!!