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Lecture 8:
CULTURE IN INSECTS
Introduction
- A brief history of animal culture
- Main empirical approaches
- Patterns versus mechanisms

Insect social learning
Evidence for insect culture
Defining animal culture

Cultural transmission of sexual preferences in *D. melanogaster*
General conclusion
Final remarks
Challenges for the future
A brief history of animal culture

- Until the end of the 1980s: culture was mainly human centered
  - Definitions adapted to humans (captured human specificities)
  - Inappropriate to study animal culture
  - Mainly theoretical. Few experiments
  - Historically human sciences started the study of culture

- From the early 1990s: animals culture emerged
  - From Animal Social Learning (see Lectures 2 & 3)
    - First in vertebrates,
    - After 2000 examples emerged in insects

- Late 2000s became part of Behavioral Ecology
  - Textbook: e.g. Chapter 20 in Danchin, Giraldeau and Cézilly 2008
  - Emergence of more experimental approaches
Three main approaches

- 1- Modelling: conditions of emergence and potential impacts
- 2- Animal social learning (see Lectures 2 & 3)
- 3- Reporting on persistent patterns of behavioral variation across populations (ie traditions)
- Produced the wealth of data presented in this module

Limitations

- Quasi no experiments
- Social learning: not sufficient to generate a cultural process
- Traditions: Hard to rule out other explanations for the observed patterns of variation among populations:
  - Ecological correlates/causes
  - Genetic correlates/causes

=> Other approaches necessary
Patterns versus mechanisms

- The same pattern (traditions) can be produced by many different mechanisms

- Focus on the mechanism to show that the observed traditions are actually produced by the characteristics of social learning

- Implies rethinking the definition of animal culture
Three contexts of insect social learning

**Foraging:**
- Bee dance (Von Frisch & Chadwick, 1967)
- Detecting cheating flowers (Baude et al. 2008. *Animal Behaviour*)

**Danger**
- Crickets: (Coolen et al. 2005. *Current Biology*)

**Mate choice:**
- Mate copying in Drosophila (Mery et al. 2009. *Current Biology*)
Foraging
The first and most famous example
Bumble bees (*Bombus terrestris*)
Cheating Plants don't provide nectar
Detection and Learning by Bumble bees
Experiment

*Baude et al. 2008. Animal Behaviour*
Cheating flowers

4 µL of water

Flowers with nectar

4 µL of sugar
30% w/w without odour

30 mm
20 mm
Ø 2 mm
Depth 3.5 mm

Filling and cleaning after every round
Guide in the know?

Cheating

With nectar
Social learning in Bumble bees in a foraging context

Social learning about **danger** (Crickets and Spiders)

- **Demonstrator crickets**
- **Observer crickets**

**Measurements**

- **Significant difference**
- **More hidden**

Coolen *et al.* 2005, *Current Biology*
Social learning and mate-choice

Observer Female: I Love Green!

Chosen green male

Observer Female: I Love Green!

Copulation Demonstration

Observer Female: I Love Green!

Rejected pink male

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One live Demonstration of one female choosing between 1 green and 1 pink males.

**Demonstrator female** $F_d$

1 green & 1 pink male

**Glass partition** (Transparent or opaque)

**Observer female**

**Demonstration**

Mery et al. 2009 Current Biology; Dagaeff et al. 2016 Anim Behav
One live **Demonstration** of one female choosing between 1 green and 1 pink males
Results

Females showed a bias for males of the accepted than the rejected phenotype during demonstrations.

Evidence for insect culture
String pulling in bumble bees
- Training phase to pull a string to get reward
- The introduce a trained individual in its colony
- Observe the string pulling performance of colony members
- Is there a diffusion of string pulling within the colony?

Latency to reward (s)

Foraging bouts

Diffusion of string pulling within a colony

Number of interactions

Before treatment

Learning ‘generations’

Fascinating

But,…
- => it is only transmitted within colony
- No transmission among colonies

What is animal culture exactly?
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What is animal culture?

In the light of what we now know about Social Learning and the history of the field.
1990s authors underlined that social learning is not sufficient to generate culture. Social learning is just one criterion (**criterion 1**) of culture. The socially learned trait must also be

- Transmitted from older to younger individuals in order to persist in time (across generations). ([Avital & Jablonka 2000](#)). **Criterion 2: transmission across age classes**
- Memorized for sufficient time to allow other individuals to copy it ([Brooks 1998](#)). **Criterion 3: Durability**
- Trait- rather than individual-based **Criterion 4: Trait-based**

**Four criteria integrated into a single definition of animal culture** ([Danchin & Wagner, *Oikos* 2010](#))
1) “The part of phenotypic variation that is transmitted across generations through social learning”

Socially inherited variation among populations = Patterns

Danchin & Wagner, 2010. Oikos
2) Study the properties of social learning that can lead to patterns of cultural traditions

Most striking marker of Culture = Mechanisms

Danchin & Wagner, 2010. *Oikos*
4 criteria of culture

- Be demanding: the four criteria to be met simultaneously to be able to claim that a trait is at least partly culturally transmitted
- Applying this mechanistic definition to a given animal model

- By testing the $4 + 1$ criteria in that system