PBIO-141
Sensory and Physiological Ecology of Plants

2: Terminology and viewpoint

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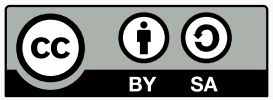

Outline

Adaptation vs. acclimation

Plants and animals

General system theory

Hierarchy and scale

Adaptation vs. acclimation

Wild plants vs. weeds vs. crops 10 + 5 min

- Most **crops** have been under artificial selection for a long time. Farmers and breeders have selected the most useful genotypes.

+ In addition natural selection is also active on cultivated plants, although in a managed environment. examples?

– Most crops have very low fitness in the wild. examples?

- Crop **weeds** are not subject to artificial selection, they are under natural selection but in a managed environment. examples?
- Natural selection in most populations of **wild plants** is affected by human activities. examples?

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Adaptation vs. acclimation

Adaptation Genetic variation + natural selection. It takes place over more than one generation. *There is change in the genotype*.

Acclimation Regulation within the lifetime of an individual, it involves changes in the phenotype in response to the environment. *There is no change in the genotype*.

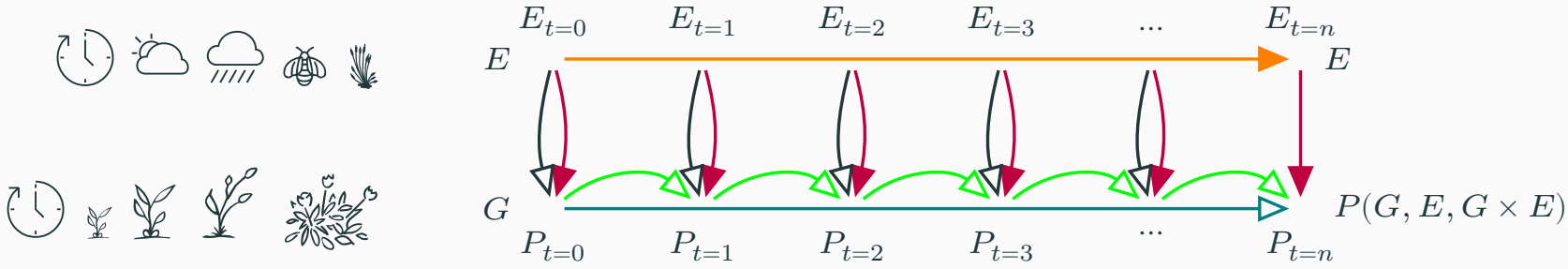

Figure: Time course of one realization of the environment (E) during the lifetime of an individual of a genotype (G) resulting in a phenotype (P).

Adaptation vs. acclimation 5 min

Examples of adaptation

Shade → larger and thinner leaves.
Drought → larger root:shoot weight ratio.
Hot + dry environment → CAM photosynthesis.

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You are a seed in the soil 10 + 10 min

Discuss this topic in groups of 2 or 3 students (10 min). Take notes while discussing and have them ready for general discussion (10 min).

Thought exercise: when should I germinate?

1. Write a list of dangers you are exposed to.
2. Write a list of good opportunities you have.
3. Write a list of conditions you can perceive around you.
4. What information can you obtain?
5. How would you use this information to decide to germinate of not?

Plants and animals

Plants $\neq$ animals

	Plants	**Animals**
Mobility	sessile	mobile
Structure	modular	fixed
Growth	indeterminate	determinate
Energy source	light	organic substances
Nervous system	no	yes

Plants $\approx$ animals

	Plants	Animals
Structure	complex	complex
Function	complex	complex
Behaviour	complex	complex
Sensing	yes	yes
Communication	‘yes’	yes
Memory	‘yes’	yes
Problem solving	‘yes’	yes
Learning	‘yes’	yes

Challenges of plant research +

- We need to recognize very different ways of behaving, communicating, and perceiving compared to our own.
- We should avoid projecting our own human image on the behaviour we observe in plants.
- We should analyse characteristics and behaviour in relation to life history and fitness.

Plants' 'senses' 5 + 5 min

What features of their environment can plants perceive?

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General system theory

Basic concepts

- Similar structures and properties are present in all systems.
- Possible behaviour is determined by the structure of a “whole thing”.
- The structure emerges from the interactions among its “component parts”.
- If interactions exist, then the contribution of the parts to the behaviour of the “whole” depends on the nature of interactions.
- Behaviour of a complex whole cannot be predicted from the behaviour of the parts.
- “Emergent properties” appear as a result of the interactions.

Basic concepts

- Systems can be nested in other systems.
- Thus a hierarchy appears.
- A crucial concept is feedback, which can be positive or negative.
- *Thinking in systems* is applicable to engineering, computing, human society, business administration, biology, ecology, medicine, etc.
- Even to managing everyday life by an individual.
- At its simplest, *Thinking in systems* .can be defined as being aware of the “big picture”.

Hierarchy and scale

What is hierarchy? 5 + 5 min

Hierarchies in biology

- Think examples of the application of the concept of *hierarchy* in biology.

Hierarchy I

The term *hierarchy* is frequently used in an intuitive way, but Allen and Starr (1982) have developed a theory, mainly focused on ecological systems.

> *By hierarchy we understand a system of behaviour relationships where upper levels limit and control the lower levels in a greater or smaller measure depending on the* ***time constants*** *of their behaviour.*

Hierarchy II

- Where *time constant* of a response is the length of time between when a response to a stimulus starts to be observable until it reaches a certain level close to the maximum that the given stimulus will induce. It is a measure of the speed of change of a response to an instantaneous stimulus.
- In contrast *lag* is the delay between the application of the stimulus and the start of an observable response.

Hierarchy III

The degree of control, that is the asymmetry of the relationship, depends on the time constants of the behaviour.

When we study the mechanism of a system at one level, we can ignore what changes much more slowly (has a larger time constant).

examples?

Hierarchy IV: examples

- For example if we study the evolution of plants on Earth we can ignore the big bang and the expansion of the universe (and many other things).
- If we are interested *only* (narrowly?) in the response of photosynthesis to light in Arabidopsis, we can ignore the evolution of plant species.
- If we are interested only in the primary reactions of photosynthesis we can use in our experiments isolated chloroplasts and ignore the plant.

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