# IPS-141
# Sensory and Physiological Ecology of Plants

## 1: Introduction

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January–February 2022

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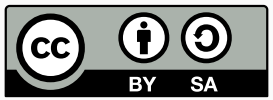


# Outline

Introductions

Course organization

Motivation

Why *sensory and physiological ecology*?

Plants and animals

# Introductions

# Let’s introduce ourselves 

- Name
- Subject of study and background
- Are you interested in the subject of the course?
- What do you expect to learn?
- Anything else relevant

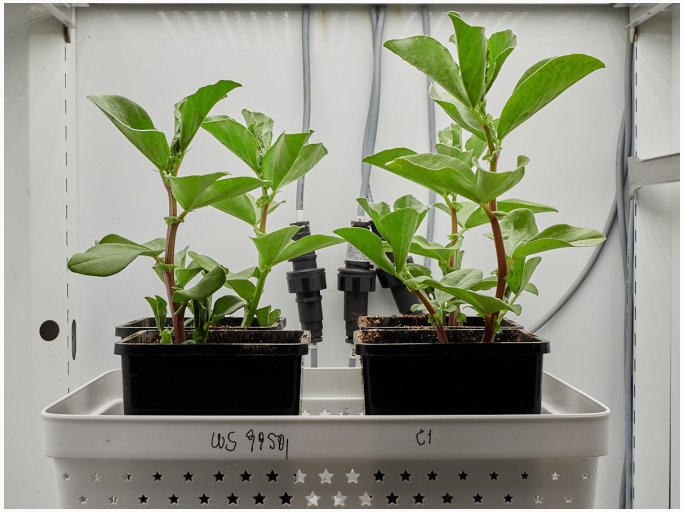
# Course organization

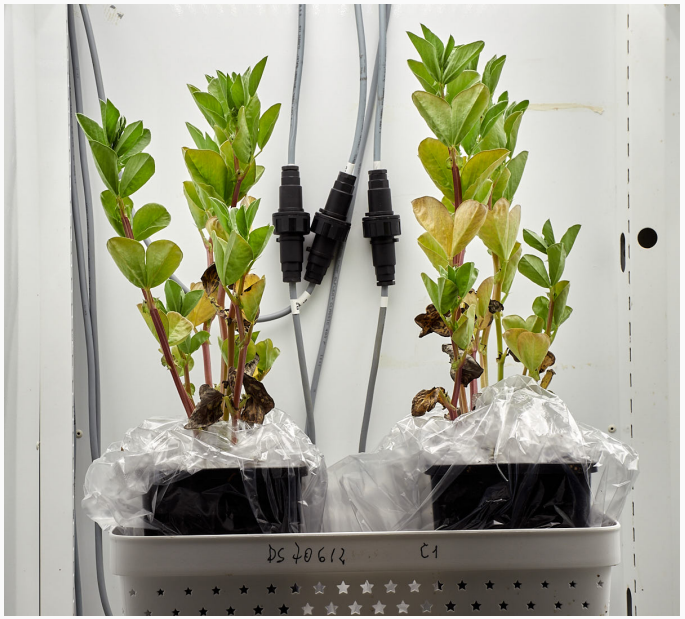
# Zoom and Moodle

- Due to COVID our learning space is virtual.
- Let's all together keep interaction active.
- Short lectures interspersed with discussion in groups.
- Feel free to ask any questions or challenge what I present.
- Photo in profile/video and Zoom recordings.
- Moodle: https://moodle.helsinki.fi/index.php?id=48992

# Motivation

# *Vicia faba* and “drought” × genotype





# Vegetation

# A systems view of the living world

- Many interactions ⇒ structural complexity
- Many feedback loops ⇒ complex dynamics
- Complexity ⇒ emergent properties
- …emergent properties cannot be predicted directly
- cellular processes are not enough predict plant responses
- individual plant responses are not enough to predict community behaviour/crop performance
- Can you think of specific examples?
- *We will focus on the role interactions and how plants exploit them and the connection between interactions and evolution*

# Some of the recent advances in plant researcch

- Synchronization of behaviour among individual plants
- Anticipatory responses to future conditions
- Strategies such as risk avoidance and bet-hedging vs. tolerance
- Role of correlations in the environment in plant responses
- “Darwinian agriculture”
- Implications of complexity of regulation for genetic manipulation
- Big data, machine learning…

# Why *sensory and physiological ecology*?

# Changing perspective in Biology +

**Era: Industrial revolution** Organisms studied as mechanical machines. Chemistry and Physics provide mechanisms.

**Era: Information revolution** Organisms viewed as processors of information. We add a new layer of explanation on top of earlier ones.

**Animals vs. plants** The role of information in animals was recognized earlier than in plants.

Examples?

# Physiology vs. ecology (typical definitions)

**Plant physiology** is the study of the function, or physiology, of plants. Fundamental processes such as photosynthesis, respiration, plant nutrition, water relations, and development are studied by plant physiologists.

**Plant ecology** is the study of the factors affecting the distribution and abundance of plants. It aims to show how pattern and structure at different levels of organization are influenced by abiotic factors (e.g. climate and soil) and biotic interactions (e.g. competition, facilitation, symbiosis and parasitism)

# Physiological ecology/Stress physiology

- Viewpoint: plants as "victims" of the environment.
- *Physiological ecology* $\approx$ *ecophysiology* seeks to describe the **physiological mechanisms** that underlie ecological observations.
- *Stress physiology* differs only by its focus on extreme environmental conditions instead of all conditions.
- *Ecophysiologists address ecological questions about the controls over growth, reproduction, survival, abundance, and geographical distribution of plants as these processes are affected by the "mass + energy" exchange between plants and their physical, chemical, and biotic environment.*

# Sensory ecology

- Viewpoint: plants as “navigators” in the environment.
- Sensory ecology studies the **mechanisms of information acquisition and emission** that underlie ecological observations.
- *Sensory ecologists address ecological questions about the controls over growth, reproduction, survival, abundance, and geographical distribution of plants as these processes are affected by the “information” exchange between plants and their physical, chemical, and biotic environment.*

# Fitness and evolution

 “Nothing makes sense in Biology except in the light of evolution”

*Fitness* is “measured” as the success in producing viable offspring (passing genes to the next generation).

The organisms we study are the result of the *evolutionary process*. To understand why organisms have the functions, morphology, life cycle and behaviour they have, we need to take into account how these features contribute to fitness.

These functions include both sensing leading to development “decisions” and regulation of metabolism and growth supporting reproduction and/or multiplication, and thus fitness.

# 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*.

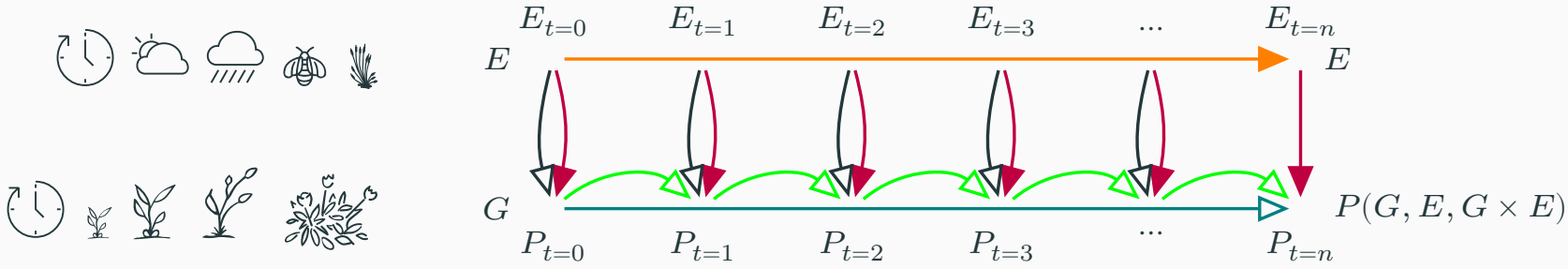


**Figure:** Time course of one realization of the environment ($E$) during the lifetime of an individual of a genotype ($G$) resulting in a phenotype ($P$).

# Adaptation vs. acclimation 5 min

**Examples of adaptation**

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

**Examples of acclimation**

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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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# Thought exercise for next class

1. Consider a plant you have at home (or another specific individual plant).
2. Write a list of the factors in its environment that vary through the day.
3. Consider the environment of roots, leaves and stems of this plant.
4. Consider what properties of these factors are most and least important to the growth of your plant.

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