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A / DESCRIPTION OF THE FLASH ANIMATION

The flash animation explains that "phenology" is the study of a species' rhythm of life. A number of things determine the rhythm of life of a species, such as the seasons, the temperature, the duration of daylight, the rhythm of other species, etc. Over the past few years, a new phenomenon has also started to play a role: climate change. The effects of climate change vary from one species to another.

Within the present information sheet, we will focus on the phenological changes of 4 different species: the oak tree, the great tit, the caterpillar and the pied flycatcher. Each one of these species reacts differently to rises in temperature, which can result in what is known as a "phenological time-lag".

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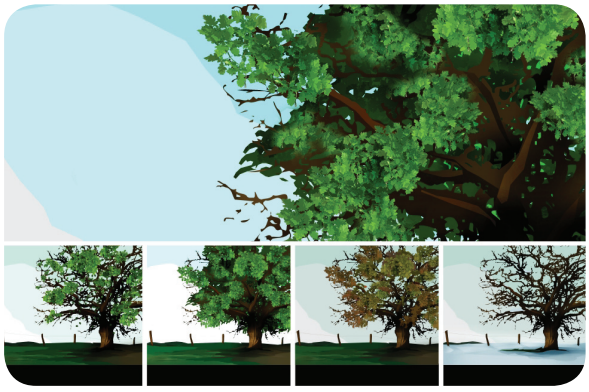
B / LET'S TAKE A CLOSER LOOK...

1. PHENOLOGY

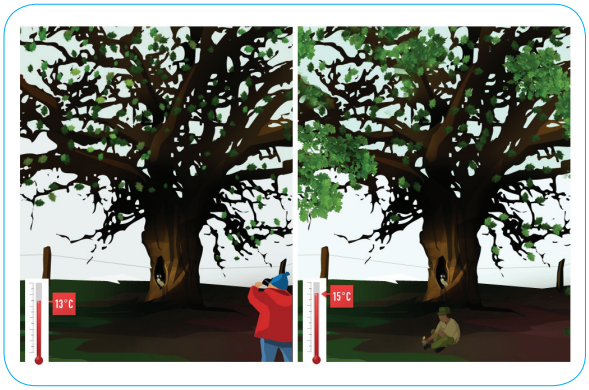
Phenology studies the dates on which certain events punctuating the life of a species take place – in other words, it studies the species' annual cycle of development.



Events punctuating the annual cycle of development for a tree might include the dates on which it blossoms, forms buds, on which the buds open, etc. These distinct stages are essential for the reproduction and survival of a species. If the sequence of these stages is disrupted for any reason, the tree's reproduction and/or survival may be threatened.

Phenological changes in the oak tree

In our particular example, the oak tree comes into bud earlier than usual in response to the temperature increase. This is called a **phenological change**. It means that, in the case of the oak tree, the species' annual rhythm has changed and that the tree's blossoming and leaf appearance have occurred each decade for the past 30 years 3 to 5 days earlier. At the other end of the seasons, autumnal events, such as when leaves start turning in colour, tend to occur later in time.



2. THE EFFECTS OF CLIMATE CHANGE ON ANIMAL AND PLANT SPECIES

Case study: the oak tree, the caterpillar, the great tit and the pied flycatcher

As the seasons progress and time passes, the various species are given signals that help them identify milestones in the cycle of their development. In the spring, for example, both the increased amount of daylight and the seasonal increase in temperature trigger a particular event within the lifecycle of plants and animals.
Let us take a closer look at how the oak tree, moth, great tit and pied flycatcher react to climate change.

The oak tree and the caterpillar: working in harmony

The oak tree is highly sensitive to early rises in temperature which prompt the tree's buds to open into leaves. In the same way, the development of the caterpillar that will later turn into a moth is very much affected by the temperature. Because it eats leaves, the caterpillar adjusts its development to the rise in temperature so as to develop in time to feed on the oak's maturing leaves.

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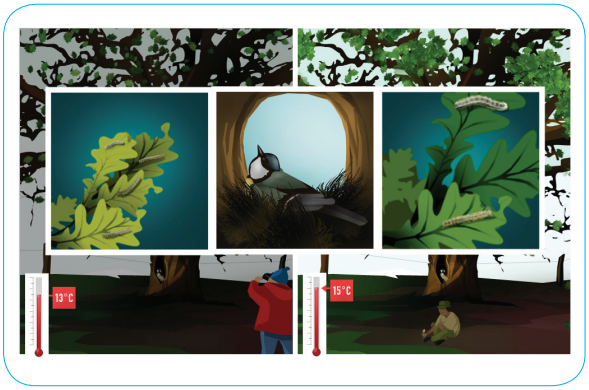

The caterpillar and the great tit: out of synch

Under normal circumstances, great tits synchronise the hatching of their chicks to coincide with the peak abundance of caterpillars, the main food for the young birds. To ensure that these two events happen at the same time, tits base themselves on the duration of daylight in a day. For the past few years now, caterpillars have been appearing earlier in the year so as to adjust to the period during which the oak tree's buds open into leaves. However, though the temperature may have increased, the duration of daylight has not. The tit hen thus doesn't lay her eggs any earlier.

This means there is a phenological time-lag between the caterpillar and the great tit. While caterpillars are appearing earlier in the year in response to the rise in temperature, the great tit is still laying at the same time, based on the duration of daylight. Consequently, when the tit hen goes off hunting to feed her chicks, she no longer finds as many caterpillars as before. As a result, the reproduction and possibly even the survival of the great tit are under threat from this unavoidable time-lag.

Yet, in spite of everything, some females are now demonstrating flexibility by laying their eggs earlier. This adjustment to the rhythm of the caterpillars can, however, be dangerous for the young birds if a cold snap occurs after an initial earlier rise in temperature.

The pied flycatcher

Birds that migrate in winter, such as the pied flycatcher, have to cope with a double difficulty: in addition to adjusting their period of reproduction to the rise in temperature, they also have to match the rhythm of their food source, depending on where they migrate to.

The pied flycatcher is a little sparrow that spends the winter in equatorial Africa, returning to the woodlands of Holland in the spring. Under normal circumstances, the period during which these birds lay their eggs corresponds to the peak emergence of insects. But, since climate warming has set in, insects are now appearing on average 16 days earlier. In response to this shift in timetable, the flycatchers have started laying 10 days earlier than before; but this adjustment is still not enough. Most of the flycatchers that go off hunting do not find enough food for their young. This has resulted in a significant increase in the mortality rate of pied flycatchers. In fact, since 1980, the species' population has fallen 90%.

3. THE FOOD CHAIN

The interdependence between the oak tree, the caterpillar and the great tit provides a good illustration of the **food chain** concept. The food chain, also called the food web, is a succession of living beings, in which each one eats the species found below it in the chain.
Essentially, the **food chain** is made up of three categories of organisms: producers, consumers and reducers.

– the **producers** are plants. Plants are capable of producing organic matter by making use of solar energy. In our example above, this is the oak tree.

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– the **consumers** are animals. There are several different types of consumers:

1. **herbivores** (= primary consumers), which feed on producers, such as the moth caterpillar.

2. **primary carnivores** (= secondary consumers), which feed on herbivores, like the great tit.

3. **secondary carnivores** (= tertiary consumers), which feed on primary carnivores, such as the sparrow-hawk.

Depending on the species present in the food chain, there can be even more levels of consumers (quaternary, etc.). Species belonging to the final level of consumers are called "super-predators", which means they are not eaten by any other predators. In our example, the buzzard is a super-predator.

– the reducers are the various organisms and micro-organisms found in soil or water (bacteria, mushrooms, earthworms, etc.) whose role it is to convert dead plant and animal matter into mineral elements.

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C / GROUP ACTIVITY TO BE CARRIED OUT IN CLASS

THE FOOD CHAIN

Aims

– Understanding how the food chain works
– Making pupils aware that the food chain can be fragile

Timing : 45 minutes approximately

Equipment per group of 4

– sticky tape or glue
– pictures or photos of: rabbit, great tit, snail, buzzard, earthworm, dandelion, moth caterpillar, vole, oak trees, human.
– sheets of paper (credit card size) prepared to make ID cards of the various species (adjust the quantity to suit the number of cans, see Note).
– 20 cans (or small pots).

Note: You can use more cans as long as you keep the proportions the same: 30% for producers, 20% for herbivores, 15% for primary carnivores, 5% for secondary carnivores and 30% for reducers.

Step 1: Procedure A 15 minutes

1. Present the species in random order on the blackboard: 3 oak trees, 3 dandelions, 2 rabbits, 6 earthworms, 2 caterpillars, 2 great tits, 1 vole and 1 buzzard.
2. Distribute ID cards to be filled in*, making sure you have the same number of sheets as there are of species (see Equipment). This is important for the rest of the activity.
3. Glue each sheet to a can (or small box).
4. Build a pyramid with four levels, like this:

   a) Place the following cans in a line: the plants (dandelions, oaks, etc.).
   b) Identity the animals that eat these species. And so on until you have completed all four levels.

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My name is:
Moth caterpillar

I am a predator of:
Oak leaves

I am prey for:
Great tits and voles

My name is:
Earthworm.

I am a predator of:
Dead leaves

I am prey for:
Great tits and voles, Campagnol, mésange

My name is:
Oak tree

I am a predator of:
No-one, but I need sunshine, water and nutrients to grow

I am prey for:
Moth caterpillars

My name is:
Dandelion

I am a predator of:
No-one, but I need sunshine, water and nutrients to grow

I am prey for:
Rabbits

My name is:
Buzzard

I am a predator of:
great tits rabbits, voles

I am prey for:
No-one, except perhaps humans

My name is:
Great tit

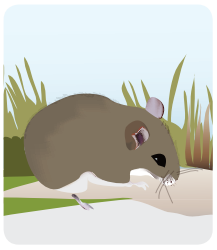
I am a predator of:
moth caterpillars, earthworms, elderberries

I am prey for:
Buzzards

My name is:
Rabbit

I am a predator of:
dandelions

I am prey for:
Humans, buzzards



My name is:
Vole

I am a predator of:
moth caterpillars, earthworms, elderberries

I am prey for:
Buzzards

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Step 2: Explanation 15 minutes

1. Having thought about the topic and discussed it together, the teacher then positions the pictures on the blackboard in the form of a pyramid with "prey/predator" arrows and explains how to "classify" them by group in the food chain:

– Secondary carnivores (= tertiary consumer): buzzard
– Primary carnivores (= secondary consumers): great tit - vole
– Herbivores (= primary consumers): moth caterpillar - rabbit
– Producers (= plants): dandelions – oak trees

2. Where do the earthworms go? Below the plants.
In actual fact, earthworms are reducers: they feed on dead leaves and convert them into mineral elements that are essential to plants.

Step 3: Procedure B 10 minutes

1. Simulation of the way species become extinct, by removing as many cans as possible from the bottom row without making the pyramid fall over:

– what happens if parts of the pyramid are re-arranged?
– which species is at the top of the pyramid? the buzzard

The buzzard is what we call a super-predator, in other words a species that is not eaten by the others.

2. Imagine a gardener who is allergic to dandelions and who decides to eradicate them all! What happens if he sprays them with herbicide? They will die.

– Ask the children to remove the "dandelion cans" without the rest falling down.
– How many cans it is it possible to remove before everything falls down?

Step 4: Observation B 2 minutes

If one level of the pyramid is disturbed, the entire pyramid is weakened!

Step 5: Explanation & conclusion 5 minutes

Compare these situations with nature: "The same thing happens in nature!"

– When some species disappear, it upsets all of the other species, disturbing the entire ecosystem. Important: point out that, sometimes, it takes a number of extinctions before a disruption to the ecosystem becomes visible.
– Where would you place humans in this pyramid? At the top, because humans are super-predators, even though they depend on all of the species "down below".

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Conclusion: It is vital to protect all forms of life, even those on which an individual does not depend directly (= dandelions), because they enable the whole ecosystem to survive.

Other proposed activities:

- Go on a walk in the woods and focus on the way animals and plants adapt to their environment. You can call on the services of a nature guide through the Natagora (www.natagora.be) organisation, for example, or from Natuurpunt (www.natuurpunt.be) in Flanders.
- Contact a CRIE (Regional Centre for Initiation to the Environment) in Wallonia: they have school animations dealing with wild birds. Build nesting boxes to hang up and feed the birds in winter. Important: make sure you stop feeding them at the very beginning of spring! Fat and peanuts can kill young birds.

D) RESOURCES / REFERENCES

- WWF report on the impact of global warming on birds. Can be downloaded from http://www.wwf.de/fileadmin/fm-wwf/pdf_neu/wwfsummary.pdf