DP Biology – D4.3 (HL extension)

Timing, life cycles and evolution

- What is driving climate change?
- How does climate change affect ecosystems?

HL statements D4.3.9–12. Textbook pp. 834–837.
Image: a tawny owl. Akumiszcza, CC BY 3.0.



Objectives for each class

Class	Statements	By the end of the class, you can...
1	D4.3.9–10	Explain what controls the timing of biological events, and how climate change disrupts it
2	D4.3.11	Explain why warming gives insects more life cycles in a year
3	D4.3.12	Explain evolution in response to climate change

Phenology

- **Phenology** is the study of the timing of biological events
- Examples: flowering, budburst, bud set, bird migration and nesting
- Long records come from scientists and citizen volunteers
- Many records show spring events arriving earlier



Flowering time is a phenological event. Phil aplosh, CC BY 2.0.

Do it

Choose a tree at school. Record the date of budburst each year and share it with a phenology network.

Two main cues

D4.3.9

	Photoperiod (day length)	Temperature
Changes with climate?	No: set by date and latitude	Yes: warming brings changes earlier
Example	Bud set in autumn; timing of bird migration	Budburst in spring; insect development

Key idea

Species in the same ecosystem may use different cues. If one follows temperature and another follows day length, climate change shifts one but not the other, and events that used to happen together drift apart.

Out of step: reindeer and Arctic plants

D4.3.10



Arctic plants, Alaska. BLM Alaska, public domain.

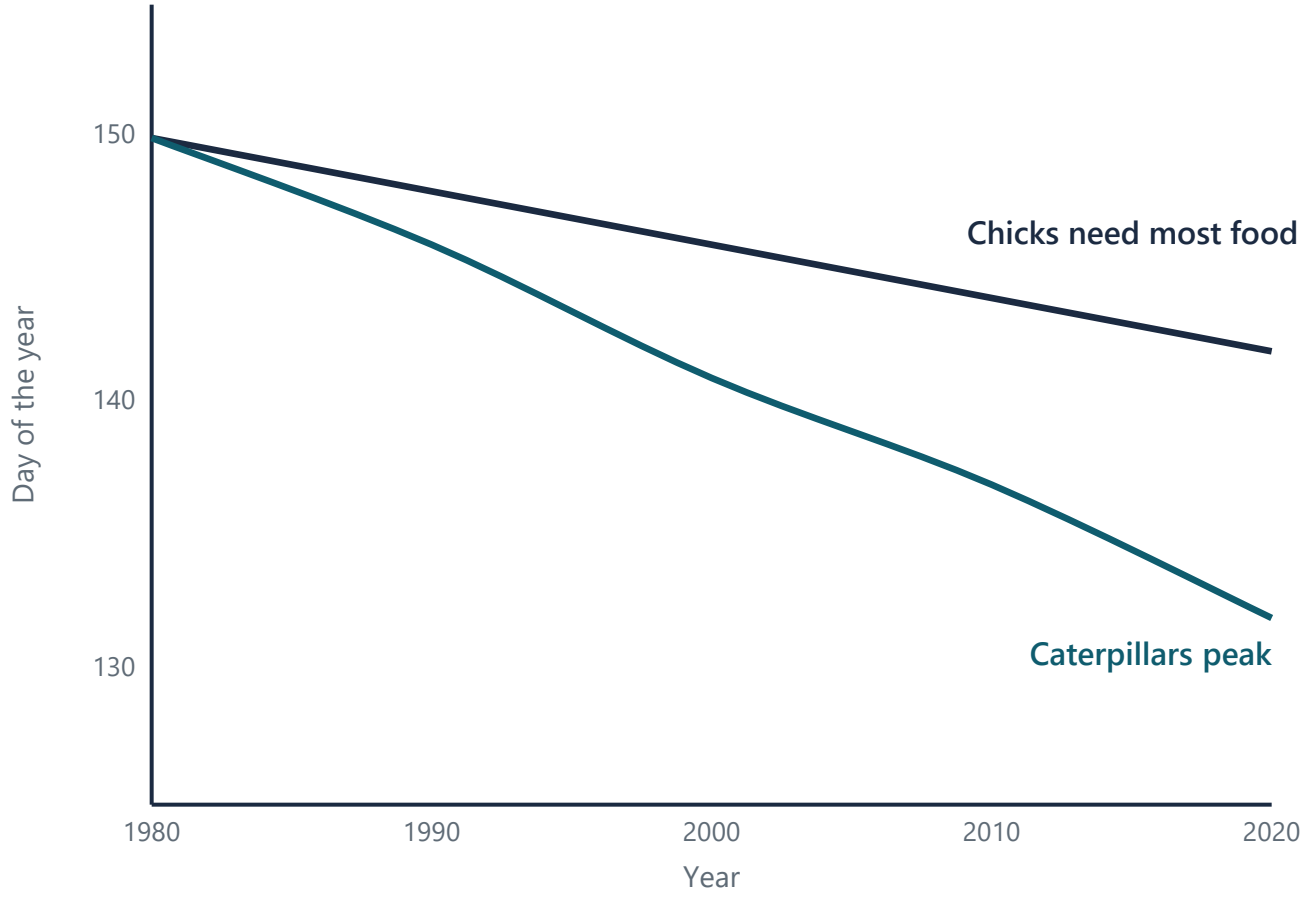
- Arctic mouse-ear and other plants start growing earlier as temperatures rise
- Reindeer migrate in response to day length, so they arrive at about the same date
- Females need the most food when calving
- Plants are now past their most nutritious stage, and fewer calves survive

Think about it

Why does the warming matter more for an animal whose journey is set by day length than for one that responds directly to temperature?

Out of step: great tits and caterpillars

D4.3.10



Schematic trends, not measured values.



Great tit. Dan Davison, CC BY 2.0.

- Caterpillars track spring warmth
- Great tits shift laying less
- Chicks hatch after the food peak

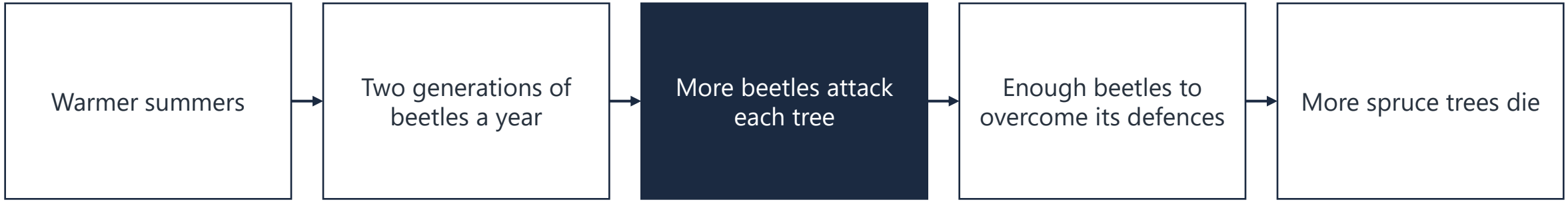
More insect generations

D4.3.11



Spruce bark beetle, Ips typographus. Daniel Adam, Bugwood.org, CC BY 3.0 us.

- Insects develop faster in warmth
- Northern spruce bark beetles have had one generation a year
- Warming allows **two generations** a year
- Beetles can also spread further north



Link

Dead forests can release carbon, adding to warming (D4.3.2–3).

Evolution: tawny owl colour

D4.3.12



Tawny owl. Akumiszcza, CC BY 3.0.

- Tawny owls are pale grey or brown; the colour is heritable
- Grey owls were best hidden in snowy Finnish winters
- Brown owls rose from about 30% to about 50% of the Finnish population

Less snow cover in winter → Pale owls are easier to see against dark ground → Pale owls catch less food and survive less → **Allele for brown feathers rises in frequency**

Key idea

A changed climate changes which variant has the highest adaptive value.

Evolution: bud set in Scots pine

D4.3.12

- **Bud set** is when a tree stops growing and forms protected buds for winter
- Trees differ in the date of bud set, and part of this difference is heritable
- Too early: growing time is wasted. Too late: frost damages new growth
- A longer growing season favours trees that set bud **later**

Prediction

Over generations, the mean date of bud set should move later, as alleles for later bud set rise in frequency.

Limits

Trees have long generations, so evolution may be too slow to keep up with fast climate change. Which species do you think will adapt fastest, and why?

Check that you can explain

1. What phenology is, and the roles of photoperiod and temperature
2. Why different cues cause loss of synchrony
3. The reindeer and great tit examples
4. Why warming gives spruce bark beetles more generations, and its effects
5. How climate change alters selection on tawny owl colour
6. How a longer growing season can change the date of bud set in Scots pine

Exit activity: 5 minutes

On your own and without notes. Hand this in as you leave.

1. Define phenology.
2. Explain why climate change can put two species out of step.
3. Explain why the proportion of brown tawny owls has increased.

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