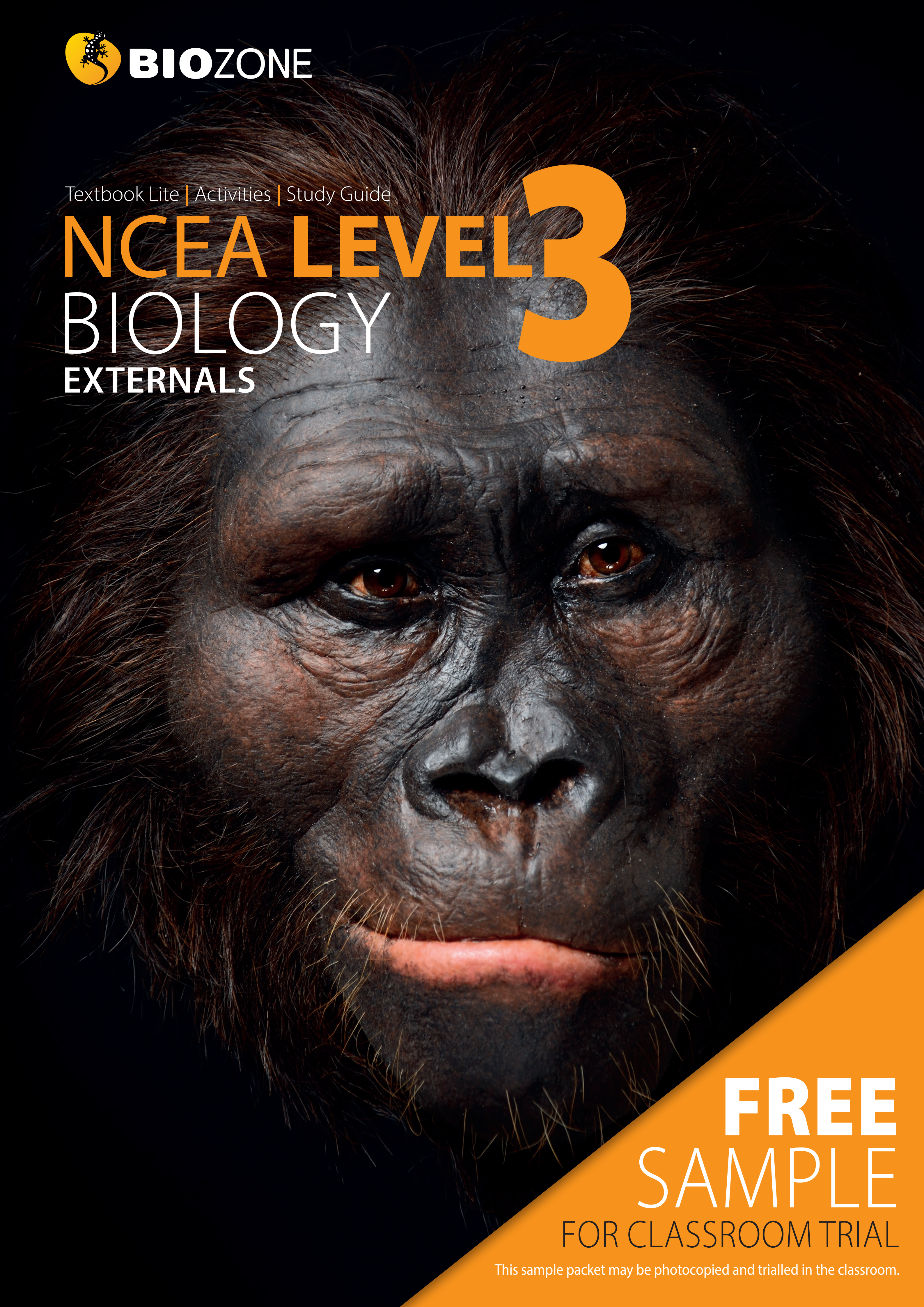


BIOZONE

Textbook Lite | Activities | Study Guide

NCEA LEVEL 3 BIOLOGY

EXTERNALS

FREE SAMPLE

FOR CLASSROOM TRIAL

Look inside our
NCEA Level 3 Externals

Key idea
The key idea provides a focus for each activity. It summarises the focus of the activity and provides a clear take-home message for the student.

Activity number
Activities are numbered to make navigation through the workbook easier, and to help students find related activities.

Visual impact
Annotated diagrams and photographs explain the content of the page, providing the information necessary to complete the activity.

Direct questioning style
The questions provide a tool to develop the content knowledge and skills for tackling end-of-chapter NCEA-style questions.

More space has been provided for students to answer questions.

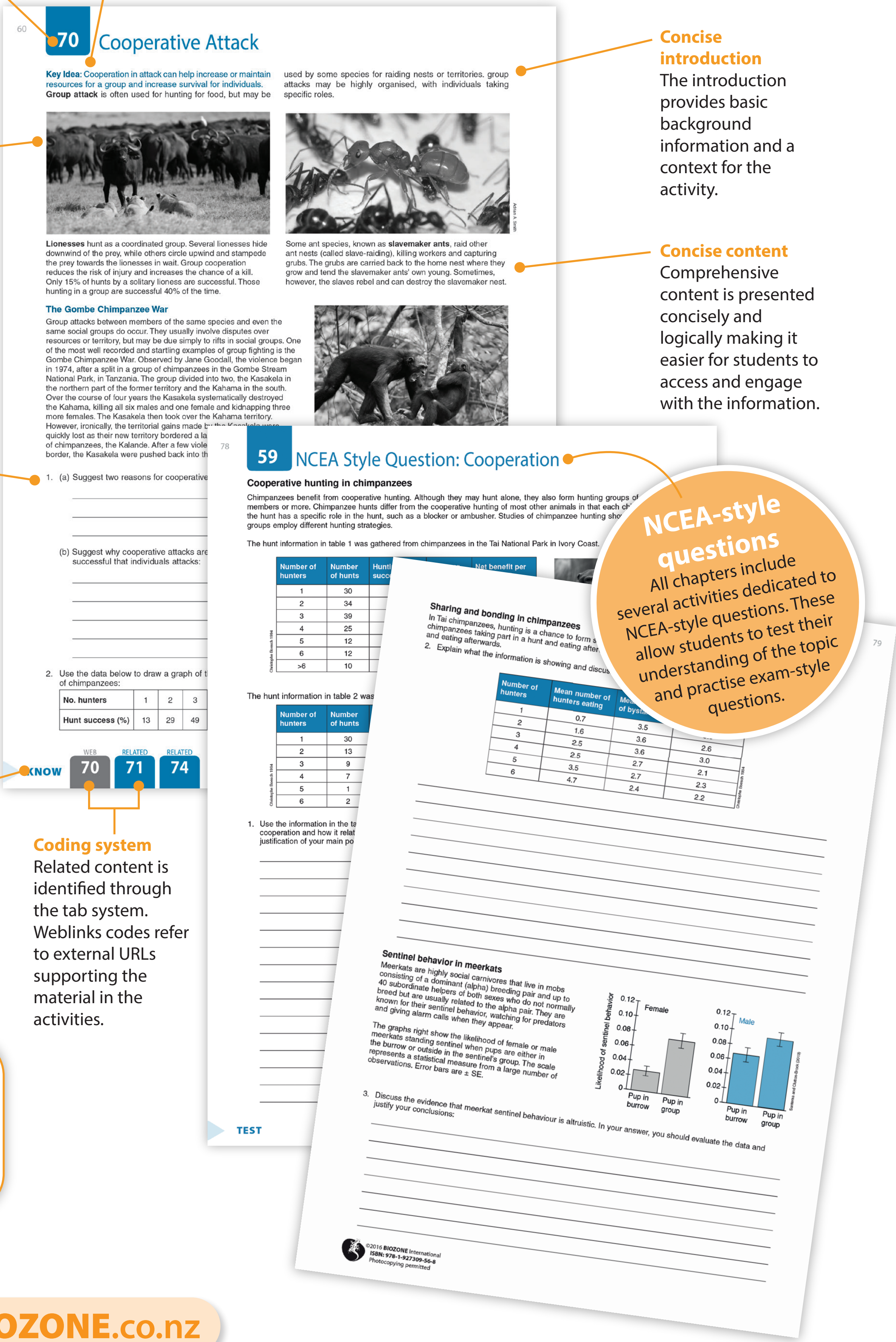
Task codes
Simplified page codes indicate the type of activity on each page.

Coding system
Related content is identified through the tab system. Weblinks codes refer to external URLs supporting the material in the activities.

Scholarship and extension
Material suitable for Scholarship is clearly identified.

Concise introduction
The introduction provides basic background information and a context for the activity.

Concise content
Comprehensive content is presented concisely and logically making it easier for students to access and engage with the information.



NCEA-style questions
All chapters include several activities dedicated to NCEA-style questions. These allow students to test their understanding of the topic and practise exam-style questions.

Achievement Standard 3.5

Evolutionary processes leading to speciation

Key terms

absolute (= chronometric) dating
adaptation
adaptive radiation
allele frequency
allopatric
analogous structures
biogeography
chromosome mutation
coevolution
common ancestor
comparative anatomy
convergent evolution
directional selection
disruptive selection
divergent evolution
fitness
fossil record
gene flow
gene pool
genetic drift
homologous structure
molecular clock
mutation
natural selection
phyletic gradualism
polyploidy
punctuated equilibrium
relative dating
reproductive isolating mechanism
speciation
species
stabilising selection
sympatric
transitional fossil
vestigial structure

Micro- and macroevolution involve the same processes on different time scales. Microevolution refers to changes in the allele frequencies of populations as a result of mutation, natural selection, genetic drift, and gene flow. Macroevolution involves the formation of new species, new genera and so forth and includes large scale patterns such as adaptive radiation.

Achievement criteria and explanatory notes

Achievement criteria for achieved, merit, and excellence

A Demonstrate understanding of evolutionary processes leading to speciation: Use biological ideas and/or scientific evidence to describe evolutionary processes leading to speciation.

M Demonstrate in-depth understanding of evolutionary processes leading to speciation: Use biological ideas and/or scientific evidence to explain how or why evolutionary processes leading to speciation.

E Demonstrate comprehensive understanding of evolutionary processes leading to speciation: Link biological ideas and/or scientific evidence about evolutionary processes leading to speciation. This may involve justifying, relating, evaluating, comparing, contrasting, or analysing the evolutionary processes leading to speciation.

Explanatory notes: Evolutionary processes

Evolutionary processes involve the following biological ideas

		Activity number
1	The four fundamental processes in evolution are mutation, gene flow, natural selection, and genetic drift.	68-75
2	Allopatric speciation occurs in geographically separated populations. Sympatric speciation occurs in populations within the same region (sympatric populations).	75-80
3	Reproductive isolating mechanisms (RIMs) contributing to speciation may be temporal, ecological, behavioural, structural, and/or genetic. Geographical isolation precedes reproductive isolation and is often a necessary precursor.	83-85
4	The fossil record and molecular evidence provide evidence for macroevolution:	
i	Large scale patterns of evolution include divergence (divergent evolution), adaptive radiation, coevolution, and convergence (convergent evolution).	86-100
ii	Models for the rates of evolutionary change include punctuated equilibrium and gradualism. We see evidence for both of these models in the fossil record.	87

Explanatory notes: Evidence for evolution

Scientific evidence for evolution comes from many disciplines

		Activity number
5	Scientific evidence for evolution, including examples for New Zealand's flora and fauna, could be selected from:	
i	Fossil evidence, including transitional fossil, and biogeography.	103-116
ii	Comparative anatomy: homologous structures as evidence for shared ancestry and analogous structures as evidence for convergence.	117-120
iii	Molecular biology (DNA and protein sequence analysis including immunology).	121-125
iv	Developmental evidence (master genes and the control of development).	126-128

What you need to know for this Achievement Standard

Mutation, genetic drift, natural selection, and gene flow

Activities 68-75

By the end of this section you should be able to:

- ☐ Describe sources of variation in populations including sexual reproduction and mutation.
- ☐ Use examples to show how mutation is the source of all new alleles.
- ☐ Explain the importance of variation in populations as the raw material for natural selection.
- ☐ Describe how natural selection sorts variation and establishes adaptive genotypes.
- ☐ Using examples, explain how differences in selection pressures can result in stabilising, directional, and disruptive selection.
- ☐ Describe the effect of genetic drift and gene flow on the genetic diversity of both small and large populations.
- ☐ Explain why genetic drift is more significant in small populations or those with an unrepresentative sample of alleles (e.g. as a result of the founder or bottleneck effects).

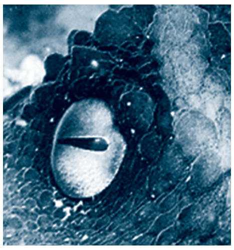
Speciation and patterns of evolution

Activities 76-85

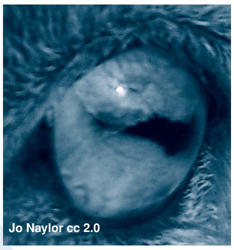
By the end of this section you should be able to:

- ☐ Explain what is meant by a biological species and describe the limitations of its definition.
- ☐ Explain ring species and their significance to our understanding of speciation.
- ☐ Explain the role of geographic isolation as a first step in the reproductive isolation of populations. Identify causes of geographic isolation and recognise that these can occur on different scales.
- ☐ Describe mechanisms of reproductive isolation, distinguishing between prezygotic and postzygotic isolating mechanisms and their significance.

- ☐ Use examples to explain allopatric (=different place) speciation in terms of migration, geographical or ecological isolation, and adaptation leading to reproductive isolation of gene pools.
- ☐ Explain sympatric (=same place) speciation and discuss the role of polyploidy in instant speciation events in sympatric populations.
- ☐ Describe stages in species formation, including how gene flow reduces as populations become increasingly isolated.
- ☐ Describe how New Zealand's geological history has influenced speciation events in New Zealand's flora and fauna.
- ☐ Distinguish different patterns of evolution to include divergence, convergence, coevolution, and adaptive radiation.



- ☐ Explain adaptive radiation in which there is rapid diversification of species to fill vacant niches.
- ☐ Explain convergent evolution in which unrelated species with similar niches converge in their structure or behaviour. Explain how analogous structures arise as a result of convergence.
- ☐ Explain how two or more species with close ecological relationships may coevolve.
- ☐ Distinguish between the punctuated equilibrium and phyletic gradualism (gradualism) models for the pace of evolutionary change (rate of speciation). Describe the evidence for each model.
- ☐ Use New Zealand examples to illustrate different patterns of evolution.



Evidence for evolution

Activities 86-128

By the end of this section you should be able to:

- ☐ Using examples, explain how the fossil record provides evidence for evolution.
- ☐ Explain how biogeography can help explain the origin and distribution of species.
- ☐ Explain the molecular evidence (DNA and proteins) for the common ancestry of living organisms.
- ☐ Explain how comparative anatomy, including homologous structures, analogous structures, and vestigial structures, help us understand evolutionary patterns and processes.
- ☐ Explain how evolutionary developmental biology (evo-devo) now provides some of the strongest evidence for the diversification of species and the evolution of novel forms.

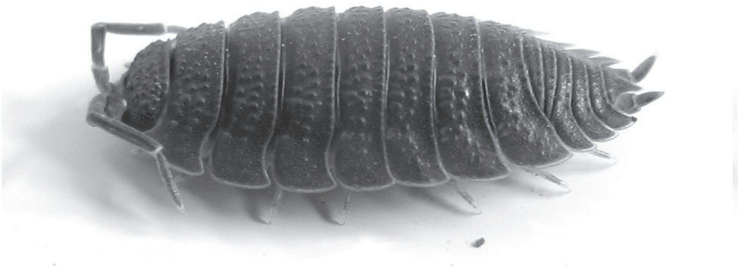
4 Kineses

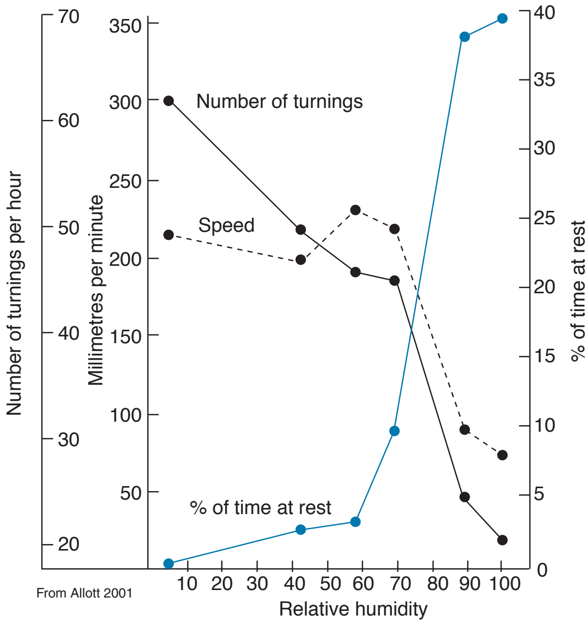
Key Idea: Kineses are innate locomotory behaviours involving non-directional movements in response to external stimuli.

A **kinesis** (*pl.* kineses) is a non-directional response to a stimulus in which the speed of movement or the rate of turning is proportional to the stimulus intensity. Kineses do not involve orientation directly to the stimulus and are typical of many invertebrates and protozoa. Two main types of kineses can be identified. In an **orthokinesis**, the rate of **movement** is dependent on the stimulus intensity. In a **klinokinesis**, the rate of **turning** is related to the stimulus intensity.

Kinesis in woodlice

Woodlice are commonly found living in damp conditions under logs or bark. Many of the behavioural responses of woodlice are concerned with retaining moisture. Unlike most other terrestrial arthropods, they lack a waterproof cuticle, so water can diffuse through the exoskeleton, making them vulnerable to drying out. When exposed to low humidity, high temperatures, or high light levels, woodlice show a kinesis response to return them to their preferred, high humidity environment.





From Allott 2001

Investigating kinesis in woodlice

Experiment 1

To investigate the effect of a light-dark regime on the orthokinetic behaviour of woodlice.

Method

A petri dish was laid out with 1 cm x 1 cm squares. The investigation was carried out at room temperature (about 21°C). A woodlouse was placed in the petri dish under constant light. The number of squares the woodlouse passed over in five minutes was recorded. This was repeated four times. The woodlouse was then placed in constant dark and the number of squares it passed over in five minutes recorded. Again, this was repeated four times. The results are shown below:

Results

	Number of squares crossed	
Trial	**Light**	**Dark**
1	122	15
2	206	68
3	103	57
4	70	59
Mean		

Experiment 2

To investigate the effect of a light-dark regime on the kilinokinetic behaviour of woodlice.

Method

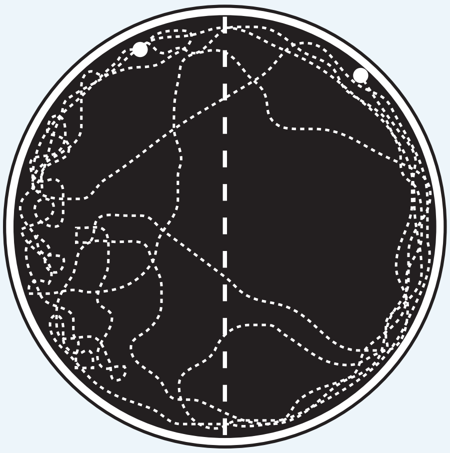
The woodlouse was again placed in the petri dish under constant light. The experiment was carried out at room temperature as in experiment 1. The number of turns the woodlouse performed in five minutes was recorded. This was repeated four times. The woodlouse was then placed in constant dark. Again the number of turns performed in five minutes was recorded. This was also carried out four times. The results are shown below:

Results

	Number of turns	
Trial	**Light**	**Dark**
1	80	10
2	165	20
3	110	122
4	90	55
Mean		

ISBN: 978-1-927309-56-8

Kinesis in body lice



In a circular chamber, lice make relatively few turns at their preferred temperature of 30°C, but many random turns at 35°C. This response enables the lice to increase their chances of finding favourable conditions and remaining in them once found.

1. Use the graph on woodlice at the top of the previous page to answer the following questions:

   (a) At which relative humidities do the following occur:

   i. Largest number of turnings per hour: ____________________

   ii. Highest speed of movement: ____________________

   iii. Largest percentage of time at rest: ____________________

   (b) Explain the significance of these movements: ____________________

   (c) What is the preferred range of relative humidity for the woodlice? ____________________

2. (a) Complete the results tables on the previous page by calculating the mean for each of the experiments.

   (b) Which regime (light or dark) does the woodlice appear to prefer? ____________________

   (c) Explain your reasoning: ____________________

   (d) Explain how increasing the number of turns or the speed of movement increases a woodlice's likelihood of survival when in a unfavourable environment.

3. (a) Identify the preferred temperature of a body louse: ____________________

   (b) The response of the body louse is a klinokinesis / orthokinesis (delete one)

   (c) Contrast the movements of the body louse when within and when outside its preferred temperature environment:

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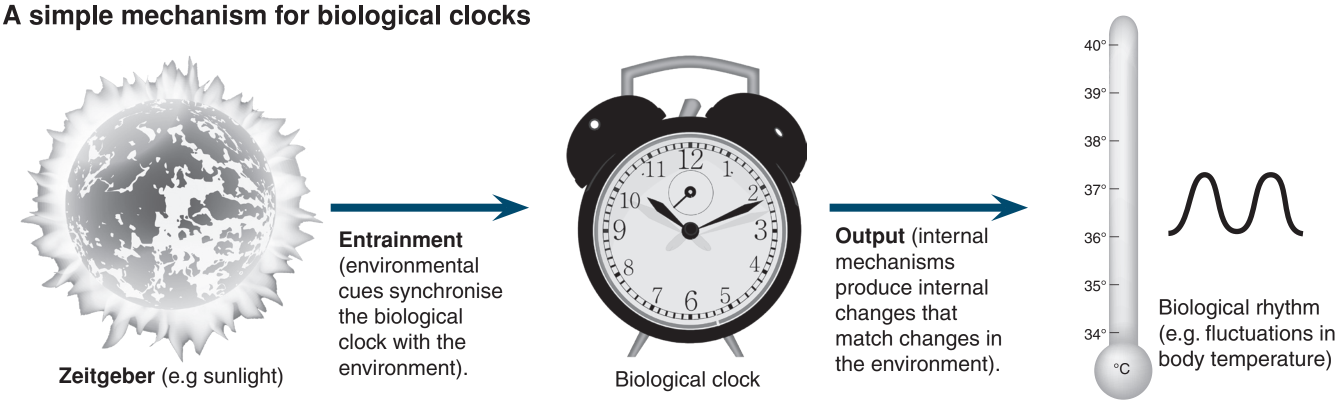
28 Biological Clocks and the Environment

Key Idea: External cues synchronise the biological clock with the environment.

Biological clocks stay synchronised with the environment because they are regularly reset by an external environmental cue or **zeitgeber**. The process of resetting the internal clock is known as **entrainment**. Endogenous rhythms that are synchronised to specific environmental cues are adaptive, contributing to fitness by ensuring the success of critical activities such as mating, birth, germination, foraging, and periods of torpor and dormancy.

A simple mechanism for biological clocks



Travelling and biological clocks

Most animals travel slowly enough that their biological clock is never far out of sync with the environment and entrainment by the rising of the Sun each day can reset any variation. Travelling west-east (or east-west) in plane can result in the biological clock being severely out-of-sync with environmental cues. This phenomenon is called **jet lag**.

Jet lag occurs because the **biological clock** is responsible for regulating the natural sleep-wake cycle, which involves being awake and active during the day and sleeping at night when it is dark. Rapid, long distance air travel can lead to disruption of the normal sleep-wake cycle. When travelling across multiple time zones, the body clock will not be synchronised with the destination time and must adjust to the new schedule.

The severity of jet lag is linked to the west–east distance travelled, rather than the length of flight.

1. (a). What is a zeitgeber? ____________________

____

(b) Identify a common zeitgeber in animals: ____________________

2. (a) What is entrainment? ____________________

____

(b) Why is entrainment important to an organism? ____________________

____

____

____

3. (a) Person A travels 5000 km east in 9 hours. Person B travels 500 km east in 9 hours. Which of these people is more likely to experience jet lag?

____

(b) Explain you answer to (a): ____________________

____

____

____

ISBN: 978-1-927309-56-8

59 NCEA Style Question: Cooperation

Cooperative hunting in chimpanzees

Chimpanzees benefit from cooperative hunting. Although they may hunt alone, they also form hunting groups of up to six members or more. Chimpanzee hunts differ from the cooperative hunting of most other animals in that each chimpanzee in the hunt has a specific role in the hunt, such as a blocker or ambusher. Studies of chimpanzee hunting show that different groups employ different hunting strategies.

The hunt information in table 1 was gathered from chimpanzees in the Tai National Park in Ivory Coast.

Number of hunters	Number of hunts	Hunting success (%)	Meat per hunt (kg)	Net benefit per hunter (kJ)
1	30	13	1.23	4015
2	34	29	0.82	1250
3	39	49	3.12	3804
4	25	72	5.47	5166
5	12	75	4.65	3471
6	12	42	3.17	1851
>6	10	90	9.27	5020

Christophe Boesch 1994

The hunt information in table 2 was gathered from chimpanzees in the Gombe Stream National Park in Tanzania.

Number of hunters	Number of hunts	Hunting success (%)	Meat per hunt (kg)	Net benefit per hunter (kJ)
1	30	50	1.23	4245
2	13	61	1.85	3201
3	9	78	1.61	1837
4	7	100	2.86	2494
5	1	100	3.00	2189
6	2	50	2.00	861

Christophe Boesch 1994

1. Use the information in the tables to discuss the differences between the two groups of chimpanzees in the extent of cooperation and how it relates to hunting success. Your discussion should include an evaluation of the results and a justification of your main points based on the data.

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Sharing and bonding in chimpanzees

In Tai chimpanzees, hunting is a chance to form social bonds. Study the information below showing the number of chimpanzees taking part in a hunt and eating afterwards and the mean (average) number of bystanders during the hunt and eating afterwards.

2. Explain what the information is showing and discuss the reasons why this might occur:

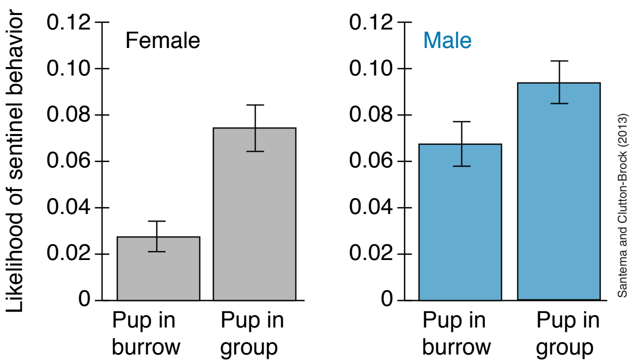
Number of hunters	Mean number of hunters eating	Mean number of bystanders	Mean number of bystanders eating
1	0.7	3.5	3.0
2	1.6	3.6	2.6
3	2.5	3.6	3.0
4	2.5	2.7	2.1
5	3.5	2.7	2.3
6	4.7	2.4	2.2

Christophe Boesch 1994

Sentinel behavior in meerkats

Meerkats are highly social carnivores that live in mobs consisting of a dominant (alpha) breeding pair and up to 40 subordinate helpers of both sexes who do not normally breed but are usually related to the alpha pair. They are known for their sentinel behavior, watching for predators and giving alarm calls when they appear.

The graphs right show the likelihood of female or male meerkats standing sentinel when pups are either in the burrow or outside in the sentinel's group. The scale represents a statistical measure from a large number of observations. Error bars are ± SE.



3. Discuss the evidence that meerkat sentinel behaviour is altruistic. In your answer, you should evaluate the data and justify your conclusions:

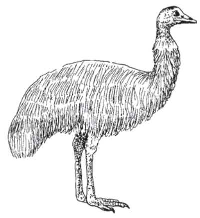
108 Divergent Evolution in Ratites

Key Idea: The ratites are group of birds descended from a single common ancestor that lost the power of flight very early on in their evolutionary development.

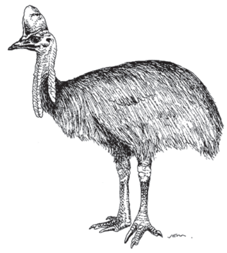
Ratites are flightless birds that possess two features that distinguish them from other birds; a flat breastbone (instead of the more usual keeled shape) and a primitive palate (roof to the mouth). Fossil evidence indicates that the ancestors of ratites were flying birds living about 80 million years ago. These ancestors also had a primitive palate, but they possessed a keeled breastbone. Flightlessness in itself is not unique to ratites; there are other birds that have lost the power of flight, particularly on remote, predator-free islands. All ratites have powerful legs, and many, such as the emu, can run very quickly.

Elephant bird
Two species, extinct,
Madagascar

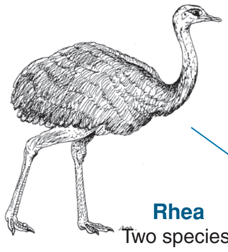
Ostrich
Struthio camelus,
Africa



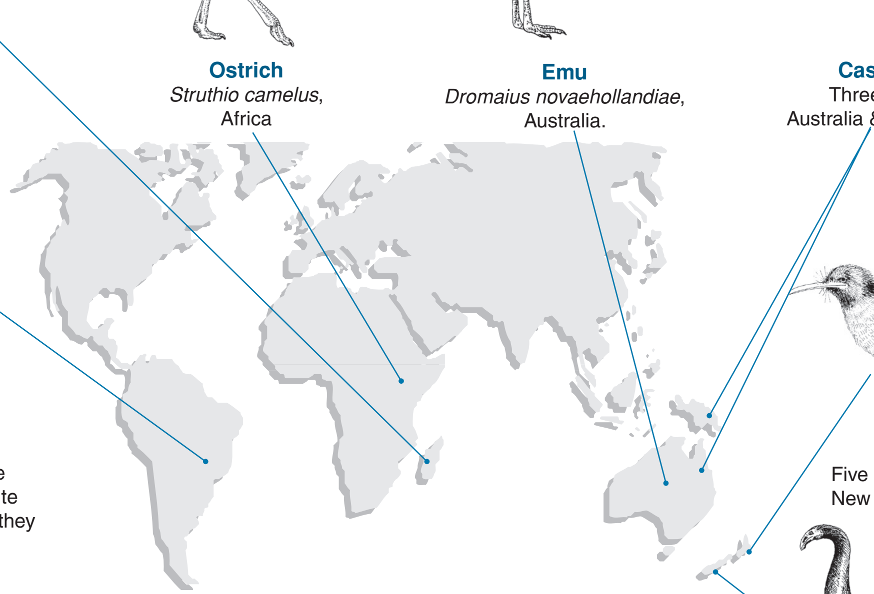
Emu
Dromaius novaehollandiae,
Australia.

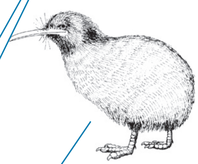


Cassowary
Three species,
Australia & New Guinea.



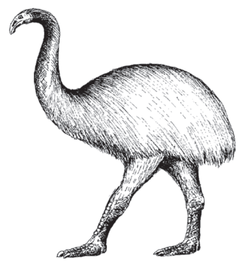
Rhea
Two species,
South America.





Kiwi
Five species,
New Zealand.

*Tinamous from South America were until recently thought to be related to but not part of the ratite group. New evidence suggests they should be included in ratites.

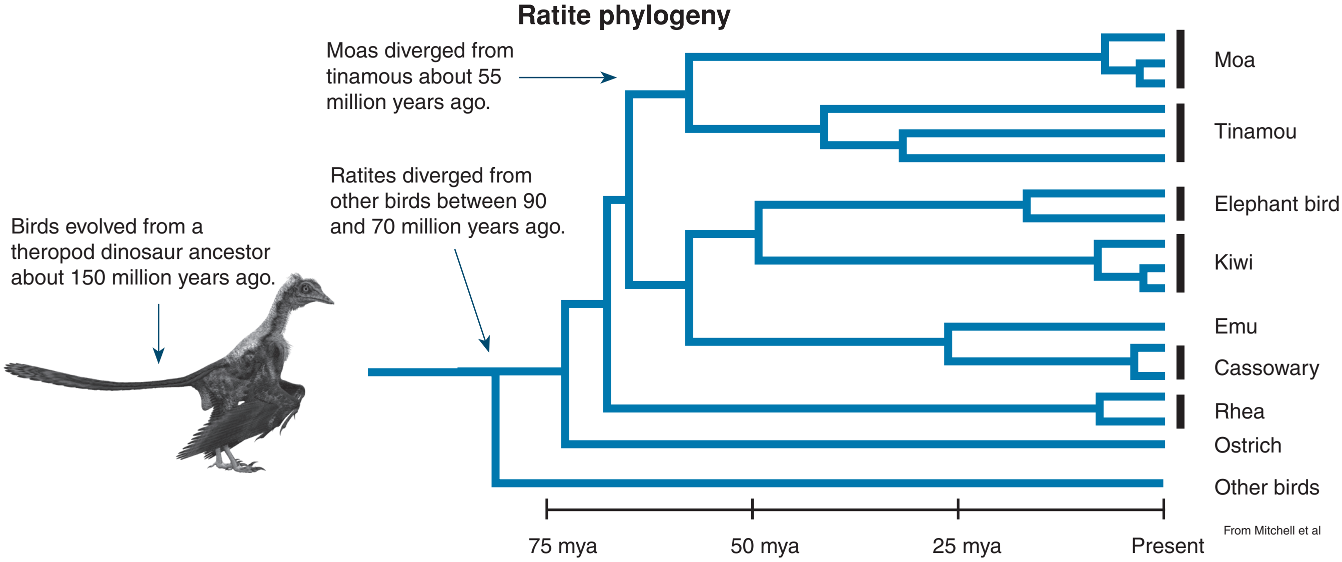


Moa
Eleven species (Lambert *et al.* 2004*), all extinct, New Zealand.

It had long been thought that the geographical distribution of modern day and extinct ratite species could be explained in terms of continental drift. The "rafting hypothesis" suggests that the ancestral ratite population existed at a time when the southern continents of South America, Africa, and Australia (and their major offshore islands) were joined as a single land mass called Gondwana. As the continents moved apart as a result of plate tectonics, the early ratite populations were carried with them.

New genetic studies have now cast doubt on this interpretation. Mitochondrial DNA (mtDNA) evidence now suggests kiwis are most related to the extinct elephant bird from Madagascar and slightly less closely related to emus in Australia. However, the ancestor to the kiwi arrived in New Zealand long after New Zealand separated from the rest of Gondwana. Ancestral kiwi must therefore have flown there. Moas are now thought to be closely related to tinamous (South America), which can fly. Ostriches were thought to be closely related to elephant birds but mtDNA now suggests they diverged from the other ratites early. The conclusions from these new findings suggest that the ratites evolved from flighted birds that flew between continents and independently evolved flightlessness at least six times.

Ratite phylogeny



From Mitchell et al

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1. (a) Describe three physical features distinguishing all ratities (excluding tinamous) from most other birds:

   (b) Why should tinamous be included in ratites?

2. Describe two anatomical changes, common to all ratites (excluding tinamous), which have evolved as a result of flightlessness. For each, describe the selection pressures for the anatomical change:

   (a) Anatomical change:

   Selection pressure:

   (b) Anatomical change:

   Selection pressure:

3. (a) Name two other flightless birds that are not ratites:

   (b) Why are these other flightless species not considered part of the ratite group?

4. Kiwis are ratites that have remained small. They arrived in New Zealand long after the moa. What part might this late arrival have played in kiwi species remaining small?

5. (a) On the phylogenetic tree opposite, circle the branching marking the common ancestor of moa and kiwi.

   (b) On the phylogenetic tree opposite, circle the branching marking the common ancestor of emus and kiwi.

6. (a) Based on the rafting hypothesis which ratite would you expect to be most closely related to ostriches?

   (b) Which ratite group is actually the closest related to the ostrich?

7. The diversification of ratites may still be explained in part by continental drift. Use the data on the opposite page to suggest a possible sequence of events for the distribution of ratites:

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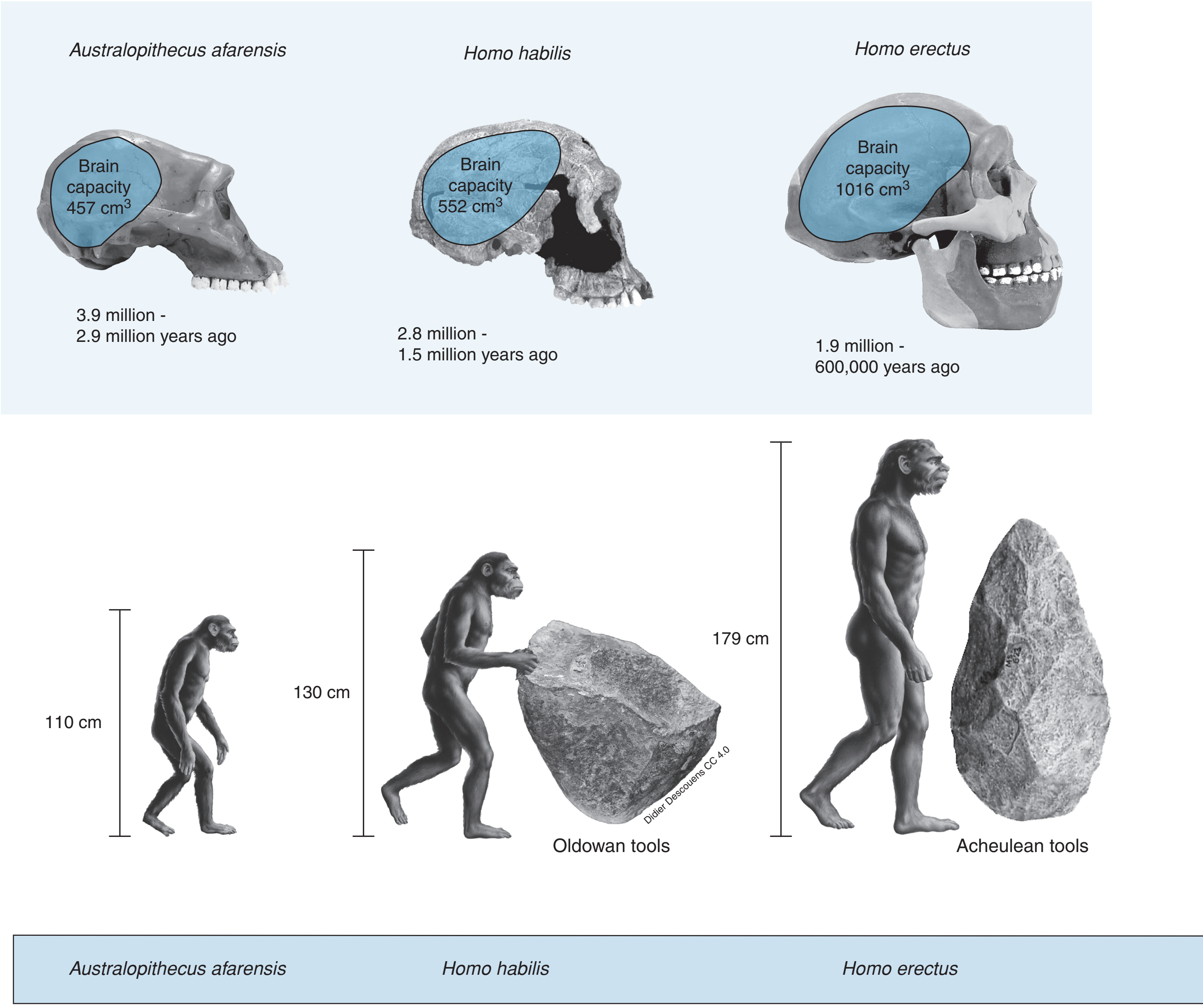
142 Trends in Human Evolution: Overview

Key Idea: The hominin fossil record shows clear evolutionary trends towards bipedalism, increased brain size, increased height, and increased technical ability.

The diagram below and opposite shows a consensus view of the trends in hominin evolution over time. Only the five species representative of the general trends are shown here. The early australopithecines were almost certainly ancestral to *Homo habilis*, which was ancestral to modern humans. Some populations of *Homo erectus* migrated out of Africa, eventually giving rise to populations of *Homo* in the Middle East and Europe. Neanderthals eventually evolved in Western Europe and modern humans in Africa.



1. Describe the general trends in the following features:

(a) Angle of the face: ______________________________

____

(b) Size of the brain and skull: ______________________________

____

(c) Height and stance: ______________________________

____

(d) Skill at tool making: ______________________________

____

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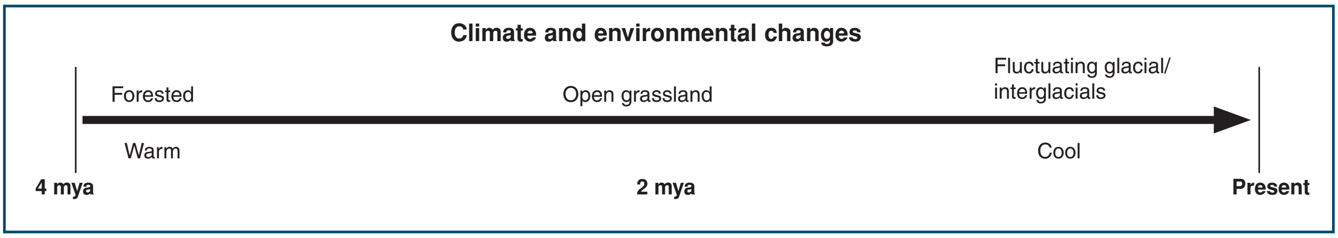
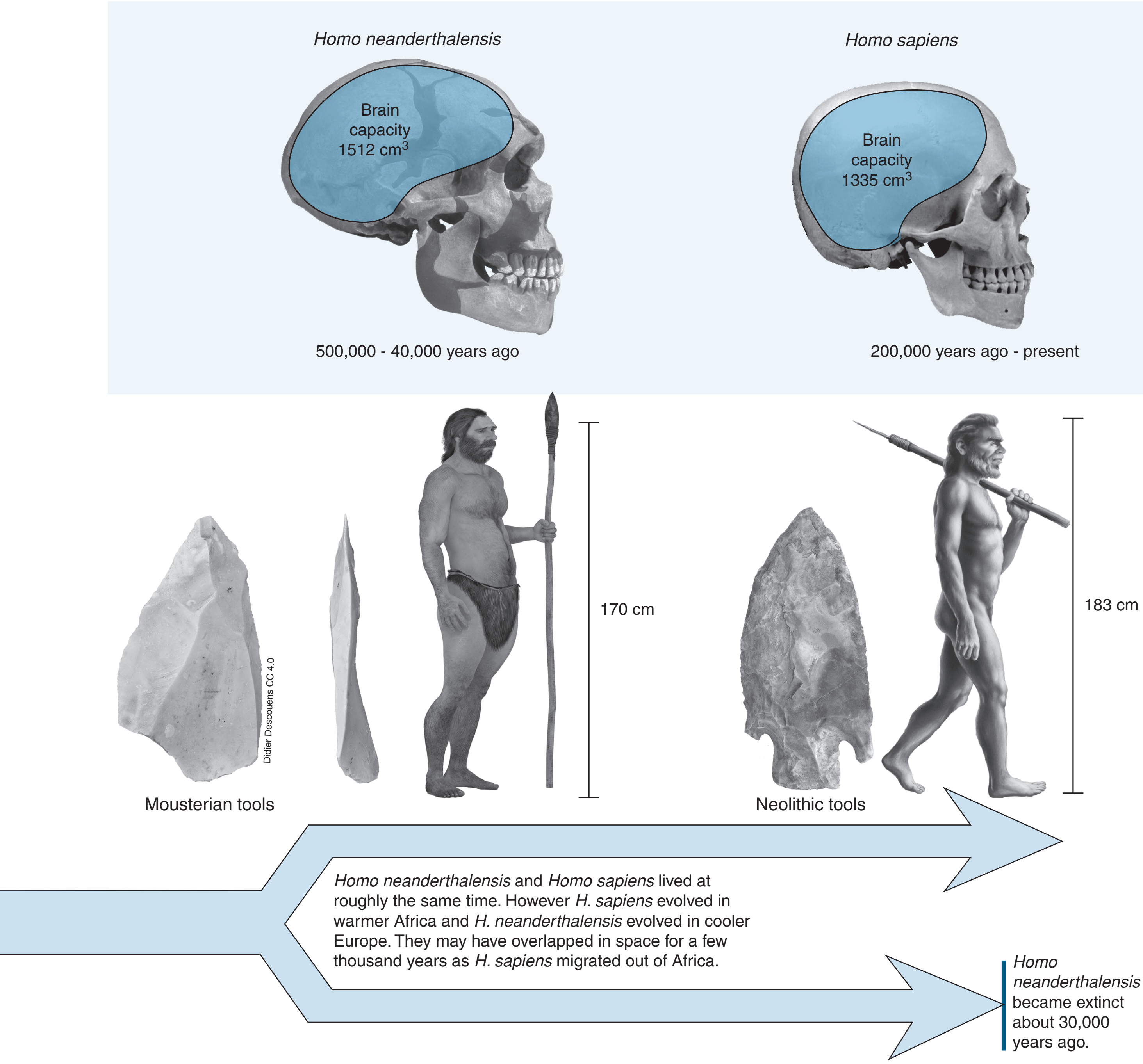




2. What was happening to the climate and environment as human ancestors evolved?

____

____

____

3. The skulls of *Homo neanderthalensis* and *Homo sapiens* are similarly sized. Describe the main differences between them:

____

____

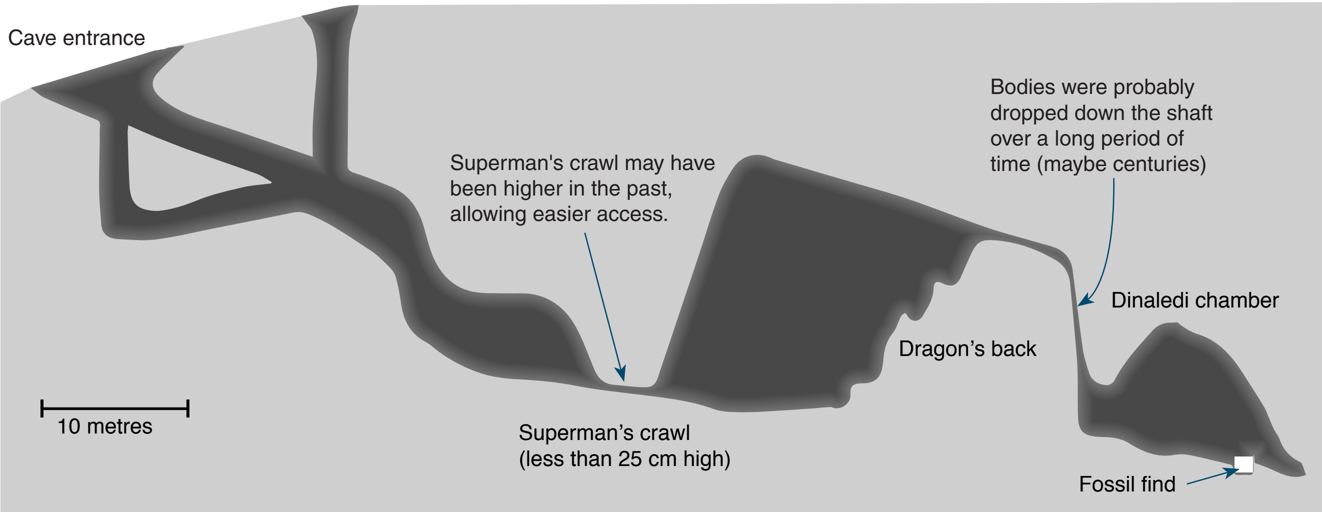
ISBN: 978-1-927309-56-8

168 Problems with Dating: *H. naledi*

Key Idea: The discovery of *Homo naledi* presents problems. The placement of the bones appears deliberate, which seems unlikely for an ancient hominin, and they are difficult to date because there are no dateable sediments around them.

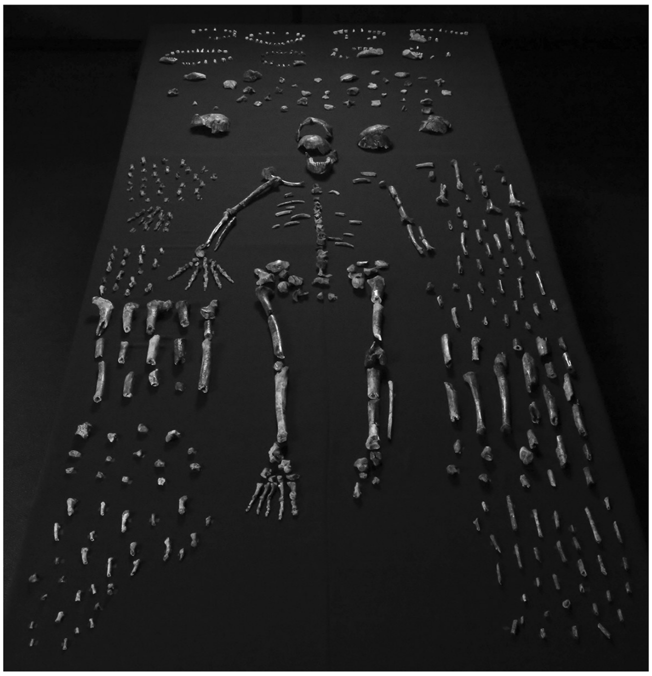
In 2013 two cavers exploring the Rising Star cave system near Johannesburg in South Africa found a passage that led to a chamber containing the bones of a new hominin species. Excavation has found more than 1500 specimens from at least 15 individuals including ribs, skulls, jaws, and dozens of teeth. Interestingly, no other types of animal or plant have been found in the cave and there is no indication of water flowing in the past. This has led the investigators to hypothesise that the bodies were deliberately placed there by other *Homo naledi*. Also the lack of other flora or fauna and sediments (other than cave dust) has made it very difficult to date the fossils. They have both advanced and primitive features, which some think puts them at the cusp of the transition between *Australopithecus* and *Homo*.

The Rising Star cave system



Dating *Homo naledi*

- Dating the *Homo naledi* bones is problematic because they were found deep in the cave. Ordinarily, fossils can be dated by relative dating. Other fossils in the sediment can be used to date the unknown fossils. For example, if the bones of a predator species of a known age had been found in the cave, then it may imply that *H. naledi* lived at the same time. However, only *H. naledi* bones have been found, expect for a few small birds on the surface. Radiocarbon dating cannot be used because it only dates accurately to 50,000 years of age and *H. naledi* is likely to be much older than that.
- If the bones had been washed into the cave by a river system it may have been possible to use the sediments deposited or other bones that had been washed in to provide a date. The excavation team has yet to find any evidence of a river or water flow. One other way of dating the bones is by dating the flowstones found in the cave. Flowstones are sheets of calcium carbonate built up by water flowing down cave walls (similar to stalactites). However the flowstones do not cover much of the cave floor and fossils.
- Various anatomical ways of dating the fossils have been tried, such as measuring parts of the skull and teeth and comparing them to other hominin fossils. These techniques have put the age of the bones at ~1-3 million years old.



1. Describe one of the problems in explaining the deliberate placement *Homo naldei* bones in the Dinaledi chamber.

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2. Describe two reasons why dating the *H. naledi* bones is difficult: ____

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