What's in a Name? Classification Explained

FUTURE MAKERS TEACHER RESOURCE

QGC | FUTUREMAKERS | QUEENSLAND MUSEUM | Queensland Government

Future Makers

Future Makers is an innovative partnership between Queensland Museum and Shell's QGC business aiming to increase awareness and understanding of the value of science, technology, engineering and maths (STEM) education and skills in Queensland.

This partnership aims to engage and inspire people with the wonder of science, and increase the participation and performance of students in STEM-related subjects and careers — creating a highly capable workforce for the future.

This teacher resource is produced by Future Makers, a partnership between Queensland Museum and Shell's QGC business, with support from the Australian Research Council and other parties to ARC Linkage Project LP160101374: The University of Queensland, Australian Catholic University Limited and Queensland Department of Education.

Contents

Workshop Overview

Kingdom, phylum, class, order, family genus, species...

What do these words mean and why do they matter? This workshop explores our present system of scientific classification, investigating how and why living things are named and the processes used by scientists to accurately differentiate between, and determine the relatedness of, living things.

Biological collections in museums are the basis for effective taxonomy (i.e. the scientific classification of living and extinct organisms). These collections validate and underpin species identifications and faunal inventories - scientific studies which identify the diversity of species occurring in a specific area at a specific time. A 'new' species can be unequivocally tested and verified against associated collection objects or specimens.

Queensland Museum's biological collections presently consist of several millions of specimens. These collections:

- Underpin biodiversity research, providing verifiable information about life - past and present.
- Provide material evidence that can be used unequivocally for environmental assessment, planning, management and conservation decisions.
- Contain DNA that can be used for recognising species; their evolutionary relationships; conservation biology; and today they are also important for biotechnology.
- Include pivotal assets of iconic ecosystems, forming a large part of our cultural identity.
- Define areas that contain high numbers of species and unique species, which provide fundamental data used for managing conservation priorities.
- Provide material for displays.

This workshop has been structured using the 5E's instructional model.

The following topics and concepts are explored in each aspect of the workshop:

ENGAGE **EXPLORE**	**Exploring Binomial Names** Explore binomial names, what they look like and how they sound, and investigate how Greek and Latin can be been used to structure these names.
EXPLORE **EXPLAIN**	**Writing Scientific Descriptions: Insects** Write a scientific description for an insect.
EXPLORE **EXPLAIN** **ELABORATE**	**Shell Classification: Dichotomous Key** Use a dichotomous key to identify common Queensland shells.
EXPLORE **EXPLAIN** **ELABORATE**	**Shell Classification: Family Plates** Identify the family of a variety of shells, and observe similarities and differences of various shell families.
EXPLAIN **ELABORATE**	**Classifying Butterflies** Identify which butterflies are likely to belong to the same species using short DNA sequences.
ELABORATE **EVALUATE**	**DNA Sequencing: Skinks** Use known DNA sequences from three species of skink to determine where six unidentified species belong in a phylogenetic tree.

ENGAGE - EXPLORE

Exploring Binomial Names

Teacher Resource

The scientific process of naming any life form involves assigning each species a unique two word scientific or binomial name. The first word is the generic name (genus) and the second is the species name. The author or describer of a species is the first person to publish the description and species name in a recognised manner, according to rules set out in the International Code of Zoological Nomenclature. At any one time, there can only be a single valid scientific name for a species. However, some species may have inadvertently been named more than once. When this occurs, the oldest name generally has priority and others are regarded as junior synonyms, which are not used to identify the species.

The binomial name of a species is usually presented in Latin or Greek, and often relates to a distinctive aspect of its body form. For every binomial name, the genus must be capitalised and the entire name must be written in italics.

For example, the Dusky Flathead's scientific name is *Platycephalus fuscus*. The genus (*Platycephalus*) is derived from the Latin *platy*, meaning flat and *cephalus*, meaning head. The species name, *fuscus*, refers to this fish's dusky, or dark, colouration.

Dusky Flathead, *Platycephalus fuscus*. Queensland Museum, Gary Cranitch.

However, some scientists choose to have a little fun when naming new species. For example, Dr Paul Oliver, Senior Curator of Vertebrates at Queensland Museum, recently described a new species of frog, *Litoria vivissimia*. When talking about how the frog was named, Dr Oliver stated, "*Litoria vivissimia* translates to 'cheeky monkey' - we have probably walked past dozens of them but have only ever seen one. We think they are probably up there in treetops laughing at us."[1]

Litoria vivissimia. Image credit: Stephen Richards

This activity is designed to:

- Expose students to binomial names, what they look like and how they sound; and,
- Investigate how Latin and/or Greek has been used to structure these names.

Detailed step-by-step instructions for this activity can be seen below. It is recommended that you use these instructions to guide your students through the activity.

1. Divide students into groups of two or three. Distribute animals to students. Provide students with time to closely observe each animal and to discuss the following questions in their groups:
    - Do you recognise any of these animals?
    - What are their common names?
    - Where have you seen these animals? When?
    - What do you already know about these animals?

[1] Queensland Museum. (2019). Remarkable frog discoveries have scientists hopping. Retrieved from https://www.qm.qld.gov.au/About+Us/Media+Centre/Media+Releases/2019/06/Remarkable+frog+discoveries#.XYARJi4za70

2. Distribute binomial names and the worksheet, *Exploring Binomial Names: Greek and Latin Roots*. Ensure the worksheet is placed face down on students' tables. Provide students with time to look at and practise pronouncing each binomial name.

3. Introduce learning task: to match the binomial name to the correct animal species. Ask students to turn over the provided worksheet. Inform students that they can use this table of useful Greek and Latin root words to help them complete the task. Remind students that the Greek and Latin root words will only form part of the binomial name, but these small clues should provide them with enough information to match a binomial name to its animal. Students may like to circle, underline or highlight the Greek or Latin roots within the binomial name when they have been found. Provide students with time to complete the activity, before asking students to share and justify their decisions. See below for answers:

Red Kangaroo	*Macropus rufus*
Leatherback Turtle	*Dermochelys coriacea*
Green Treefrog	*Litoria caerulea*
Platypus	*Ornithorhynchus anatinus*
Bearded Dragon	*Pogona barbata*
Southern Blue-ringed Octopus	*Hapalochlaena maculosa*

4. Students then work independently or in small groups to apply their knowledge and create a binomial name for a mythical creature, using their list of Greek and Latin root words. Students can share the creature and the name they devised with the class. Alternatively, students could play a guessing game where they only read out the devised name and the rest of the class determines which creature belongs to the name based on the Greek and/or Latin roots used.

   This activity could also be extended to identifying:

   - Where the mythical creatures may live based on their observed features.
   - How these features help the mythical creatures survive in their environment/s.
   - How to classify these creatures and/or the making of a dichotomous key.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

Science Inquiry Skills

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS148)

YEAR 7

Science Understanding

Classification helps organise the diverse group of organisms (ACSSU111)

Science Inquiry Skills

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

General Capabilities

Literacy

Word knowledge

Exploring Binomial Names

Student Activity

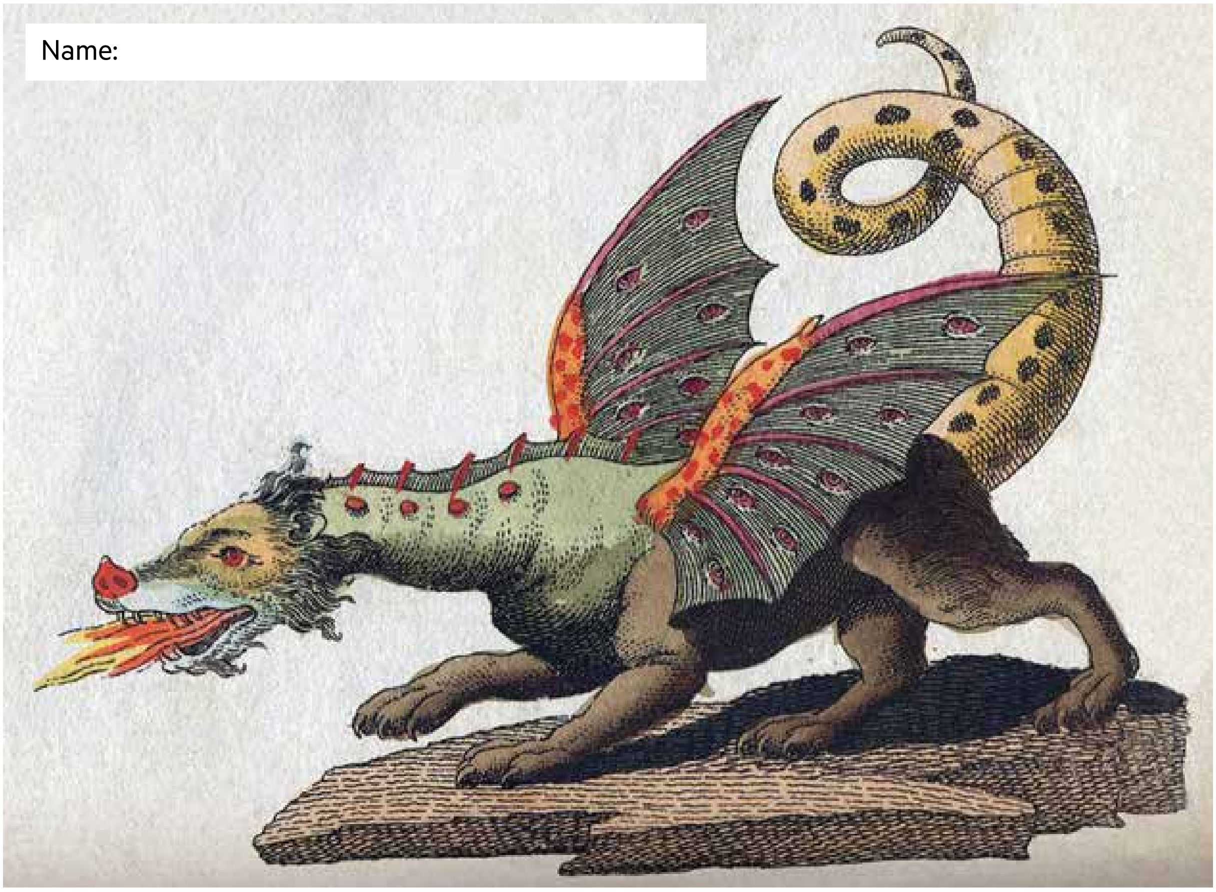
Animals

Binomial Names

Macropus rufus
Dermochelys coriacea
Litoria caerulea
Ornithorhynchus anatinus
Hapalochlaena maculosa
Pogona barbata

Macropus rufus
Dermochelys coriacea
Litoria caerulea
Ornithorhynchus anatinus
Hapalochlaena maculosa
Pogona barbata

Mythical Creatures




Name:

Exploring Binomial Names

Student Activity

Latin and Greek Root Words

Numbers		
Greek	di	two
	hex	six
Latin	quad	four
	mult	many

Colours		
Greek	xanth	yellow
	chlor	green
	melan	black
Latin	rufus	red
	caeruleus	blue
	alb	white

Description		
Greek	macro	large
	micro	small
	chelys	tortoise
	ornith	bird
	pogon	beard
	acantha	thorn
	dasy	shaggy
Latin	corium	leather
	anas	duck
	maculosus	spotted
	volans	flying
	punctata	dotted
	ruga	wrinkled
	crispus	curled
	curvi	curved
	luna	moon
	macula	spot
	sagitt	arrow

Body Parts		
Greek	dermo	skin
	rhynchus	bill
	poda	foot
	uro	tail
	rhino	nose
	ptera	wing
Latin	penna	feather
	pede	leg
	dentata	toothed

EXPLORE - EXPLAIN

Writing Scientific Descriptions: Insects

Teacher Resource

The classification of living things involves systematically grouping and sorting organisms based on common or shared features, and providing organisms with a unique scientific name. The classification process also involves the writing of scientific descriptions; all organisms require a written scientific description to assist in the accurate identification of their species.

Within this activity, students explore what makes a well-written scientific description. They then use their learning to write a scientific description for an insect. There are a number of ways for students to complete this task:

- Students collect insects from their local community. Queensland Museum describes methods for collecting, preserving and displaying insects online.
- Students observe insect specimens contained within a Queensland Museum Loans Kit. You can search 'insect' in the catalogue search to view and book kits that contain insects.
- Students visit the Discovery Centre on Level 4 of Queensland Museum in Brisbane and write a scientific description of insects on display.
- Students observe images of insect specimens from the collection via Queensland Museum's Google Arts and Culture website. or on the Queensland Museum Learning Resources website

Detailed step-by-step instructions for this activity can be seen below. It is recommended that you use these instructions to guide your students through the activity.

1. Ask students to close their eyes and visualise the following description of an animal as it is read out loud.

   Oval in shape. The head section is smaller than the back section. Two large eyes positioned on either side of the head. Six legs. Lots of spiky hair coming out in middle part of insect, just behind the head. Cream shell. Two brown blobs on the hard part that covers the wings.

2. Provide students with one minute to draw what they visualised. Students can then stand and move around the room to see how their peers responded to the description. Ask students: What do you notice about the drawings? Why are we noticing these patterns?

   NB: Missing, vague, imprecise information in the description will result in noticeable variation between students' drawings.

3. Show students the following insect images:

   - Dung Beetle, Onthophagus toopi
   - Stag Beetle, family Lamprima
   - Tiger Beetle, Cicindela shetterlyi lutamatrix
   - Leichhardt's Grasshopper, Petaside ephippigera

   Ask students: do any of these insects look like the animal that you drew? Inform students that the description read out loud belongs to one of these four insects. Ask students: Which insect could this description belong to?

   NB: The description belongs to the Tiger Beetle, Cicindela shetterlyi lutamatrix.

4. Provide students with an opportunity to look at the image of the Tiger Beetle and the description. Ask students: how effective is this description in communicating information about this insect? Why? What is needed to improve this description?

5. Co-write a new and improved scientific description of the insect. This description should include the use of specific scientific terminology, as shown on the worksheet, *A Selection of Insect Terms*.

6. Students work independently or in pair to write their own scientific description of an insect. Before writing the description, ask students to spend one minute silently observing the insect. Students could use a magnifying glass during this time. Ask students to consider:

   - What do you notice about the insect's appearance?
   - Does the insect have any striking or defining features? What are these?
   - How would you describe this insect to your partner/a classmate?

   Provide students with time to share their observations with their partner or a classmate.

7. Provide students with time to write their scientific descriptions. After writing, students could swap insects and descriptions with a classmate, then analyse and evaluate the descriptions based on previously devised success criteria.

Curriculum Links (Version 8.4)

Science

YEAR 7

Science Understanding

Classification helps organise the diverse group of organisms (ACSSU111)

Science Inquiry Skills

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

General Capabilities

Literacy

Comprehending texts through listening, reading and viewing

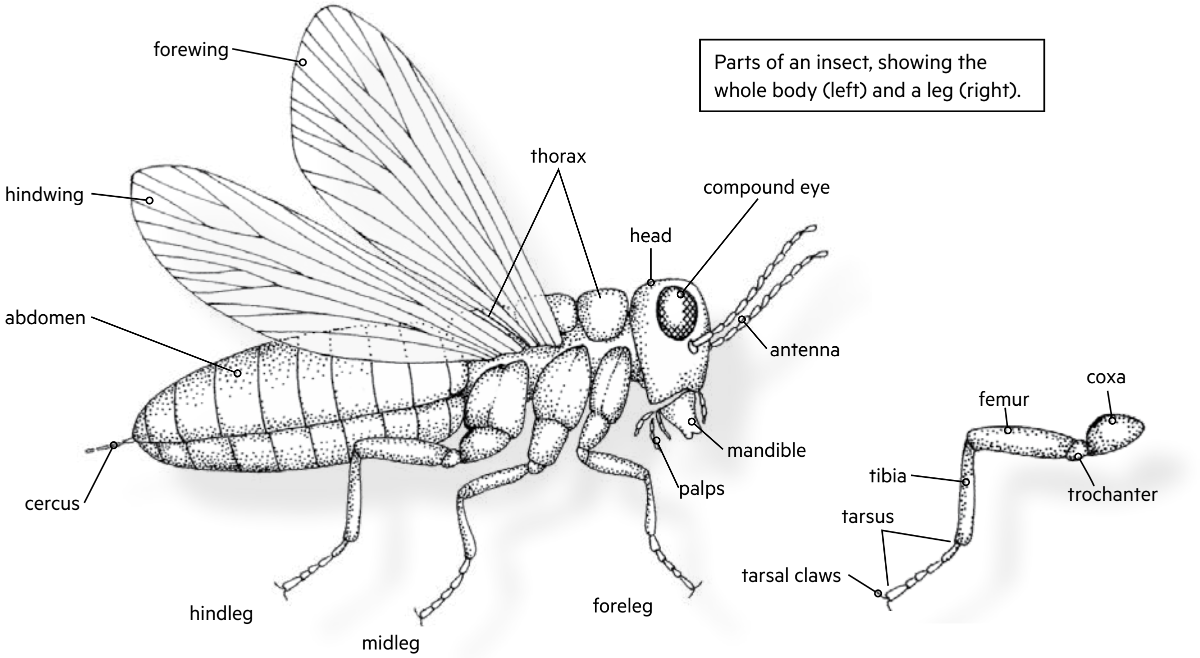
Composing texts through speaking, writing and creating

Word knowledge

Writing Scientific Descriptions: Insects

Student Activity

A Selection of Insect Terms



ANATOMY TERMS

Cells: the spaces enclosed by veins on the wing

Cercus: a paired appendage on the posterior end of the abdomen; cerci may function as sensory or reproductive organs, or be used for defence

Compound eye: an eye consisting of many separate visual components

Exoskeleton: the external skeleton that protects the insect body

Mandibles: first pair of jaws in the mouth

Mesothorax: the second part of the thorax, bears the midlegs (second pair of legs) and the forewings in adults

Metathorax: the third part of the thorax, bears the hindlegs (third pair of legs) and the hindwings in adults (reduced to halteres in flies)

Ocelli: small eyes often grouped in three on a triangular mound between the compound eyes

Palps: elongated appendages or feelers near the mouth

Prothorax: the first part of the thorax, bears the forelegs (first pair of legs)

Scutum: the plate on the dorsal (upper) surface of the thorax

Spiracles: holes found along the body that open into tubes that carry air to the cells

Sternites: the plates on the ventral (lower) surface of the abdomen

Tarsus: the insect foot

Tergites: the plates on the dorsal (upper) surface of the abdomen

Veins: the lines on the wing

LOCATION TERMS

Anterior: close to the head/front of body

Posterior: close to the hind end/ back of body

Proximal: close to the centre of the body

Distal: away from the centre of the body

Dorsal: upper surface

Ventral: lower surface

FUN ADJECTIVES!

Claviform: club-shaped

Fusiform: spindle-shaped (thicker in the middle and tapering on both ends)

Hirsute: hairy

Hyaline: clear like a window

Penniform: feather-like

Unguiform: claw-shaped

EXPLORE - EXPLAIN - ELABORATE

Shell Classification: Dichotomous Key

Teacher Resource

In this activity, students use a dichotomous key to identify common Queensland shells. They learn about the organisms that make shells and why the accurate identification of these animals is important. To complete this activity, teachers can access the following resources, which are available online via Queensland Museum Learning Resources:

- Shell Classification: Dichotomous Key
- Shell Classification: Student Shell Cards
- Shell Classification: Teacher Shell Cards

Students could also work collaboratively to devise their own dichotomous keys for various groups of living things.

Curriculum Links (Version 8.4)

Science

YEAR 7

Science Understanding

Classification helps organise the diverse group of organisms (ACSSU111)

Science Inquiry Skills

Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships in data using digital technologies as appropriate (ACSIS129)

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

EXPLORE - EXPLAIN - ELABORATE

Shell Classification: Family Plates

Teacher Resource

In this activity, students view 20 photographic plates of common Queensland shells, and read interesting facts about these shell families. To complete this activity, download the Shell Classification: Family Plates resource via Queensland Museum Learning Resources.

This resource can be used in many ways both in and outside the classroom. For example, students can use these plates to identify shells they have found, or to explore the similarities and differences of various shell families. Students can also use this resource to learn more about the structural features and adaptations that help these animals survive in their environment, how the physical conditions of their environment affects their survival, how these animals interact with other organisms and the ways in which people throughout history have used these familiar items.

Curriculum Links (Version 8.4)

Science

YEAR 5

Science Understanding

Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

Science as a Human Endeavour

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE083)

Science Inquiry Skills

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS093)

YEAR 6

Science Understanding

The growth and survival of living things are affected by physical conditions of their environment (ACSSU096).

Science as a Human Endeavour

Scientific knowledge is used to solve problems and inform personal and community decisions (ACSHE100)

Science Inquiry Skills

Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110)

YEAR 7

Science Understanding

Classification helps organise the diverse group of organisms (ACSSU111)

Interacting between organisms, including the effects of human activities can be represented by food chains and food webs (ACSSU112)

Science Inquiry Skills

Communicate ideas, findings and evidence based solutions to problems using scientific language, and representations, using digital technologies as appropriate (ACSIS133)

YEAR 9

Science Understanding

Multi-cellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment (ACSSU175)

Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (ACSSU176)

Science Inquiry Skills

Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS174)

EXPLAIN – ELABORATE

Classifying Butterflies

Teacher Resource

The classification of organisms based on appearance (morphology) can be problematic. This is because morphology can be influenced by the environment. It is not uncommon for unrelated organisms to independently evolve similar features as a result of having to adapt to live in similar environments. This is known as convergent evolution.

Another problem with morphology is that speciation, the formation of new and distinct species in the course of evolution, is not always accompanied by morphological changes. Some groups of organisms are morphologically austere; that is, these groups of organisms lack distinguishing features that can be used to tell the difference between species, like sponges. In some groups, morphology is highly conserved. Morphological conservatism means that individuals show little or no change in their physical appearance, even though their DNA sequences have changed significantly. Both issues can lead to two or more species being classified as the same species because they are superficially indistinguishable.

This is why museums have genetic labs. The Molecular Identities Lab at Queensland Museum provides scientists with an opportunity to analyse and use DNA sequence data to identify new species. The comparison of DNA sequences from different organisms, and measurement of the number of changes (mutations) between them, also allows scientists to determine if species are closely or distantly related.

Molecular Identities Lab. Queensland Museum, Peter Waddington

In this activity, students use their understanding of classification to hypothesise which pairs of butterflies are likely to belong to the same species, based on their morphology. Students should be encouraged to justify their responses. Short DNA sequences are then revealed and used to support or refute students' hypotheses.

Note: DNA sequences presented in each exercise have been created specifically for this activity and do not reflect real data. These DNA sequences would only represent a tiny fraction of a real butterfly genome, which can be hundreds of millions of base pairs in length. However, even small fragments like these can help provide clues about the identity of a specimen.

Curriculum Links (Version 8.4)

Science

YEAR 10

Science Understanding

Transmission of heritable characteristics from one generation to the next involves DNA and genes (ACSSU184)

Science Inquiry Skills

Formulate questions or hypotheses than can be investigated scientifically (ACSIS198)

Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS204)

Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS208)

Classifying Butterflies

Teacher Resource: Answers

Butterfly Pair 1

A

B

A	G	T	A	C	C	A	C	A	T	C	G	A	A	G	G	G	T	C
B	G	T	A	C	C	A	C	A	T	C	G	A	A	G	G	G	T	C

These two specimens look the same, and their DNA sequences are identical. These data support the hypothesis that these two specimens belong to the same species. **These two specimens are both Blue Triangles *(Graphium sarpedon)*.**

Butterfly Pair 2

A

B

A	G	T	A	C	C	A	C	A	T	C	G	A	A	G	G	G	T	C
B	G	T	A	C	G	A	C	A	C	C	G	A	A	A	G	T	T	C

These two specimens look very different, and their DNA sequences differ significantly (by 4 bases out of 18, or 22%). The DNA sequences of closely related species often only differ by a few percent; for example, human DNA sequences are about 97% identical to chimp DNA sequences. Therefore, these data strongly support the hypothesis that these two specimens belong to different species. **Specimen A is a Blue Triangle (*Graphium sarpedon*), and Specimen B is an Orange Dart**

Butterfly Pair 3

A

B

A	G	T	A	C	G	A	C	A	C	C	G	A	A	A	G	T	T	C
B	G	T	A	C	G	C	C	A	C	C	G	A	A	G	G	T	A	C

Although these two specimens look similar, their DNA sequences differ significantly, as in the previous exercise (by 4 bases out of 18, or 22%). The genetic data strongly support the hypothesis that these two specimens belong to different species. Students can discuss reasons why the morphology of these two specimens might be so similar, even if they are different species. (The butterflies on this page are known as skippers. Skipper species are notoriously hard to identify because they look so similar to each other. Characteristics of wing veins, scales and genitalia are needed to identify species). **Specimen A is an Orange Dart *(Suniana sunias)*, and Specimen B is an Orange Palmdart *(Cephrenes augiades)*.**

Butterfly Pair 4

A

B

A	G	T	A	C	A	A	C	A	T	C	C	A	A	A	G	T	T	C
B	G	T	A	C	A	A	C	A	T	C	C	A	A	A	G	T	T	C

These two specimens have different colouration, although their wing shapes and body shapes are similar, and their DNA sequences are identical. In this case the DNA evidence strongly supports the hypothesis that these two specimens belong to the same species. Why do they have such different colouration? The top photograph shows a male Orchard Swallowtail, the bottom a female Orchard Swallowtail. This sexual dimorphism is just one example of how appearances can be misleading when trying to identify organisms, and shows how DNA can help by providing a separate line of evidence. **These two specimens are both Orchard Swallowtails *(Papilio aegeus)*.**

Classifying Butterflies

Student Activity

Use your knowledge of classification to hypothesise which pairs of butterflies are likely to belong to the same species, based on their appearance (morphology). Make sure you provide reasons for your thinking.

Butterfly Pair 1

A

B

Butterfly Pair 2

A

B

Butterfly Pair 3

A

B

Butterfly Pair 4

A

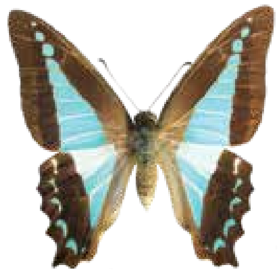
B

Identifying species based on morphology alone can be problematic. This is because separate species can appear visually indistinguishable from each other, while organisms within a single species can exhibit colour pattern or size differences between the sexes (sexual dimorphism). To resolve this problem, scientists use DNA sequences to identify new species. The comparison of DNA sequences from different organisms, and measurement of the number of changes (mutations) between them, also allows scientists to determine if species are closely or distantly related.

You will now examine DNA sequences for each butterfly pair. You will use this information to further support or refute your original hypothesise.

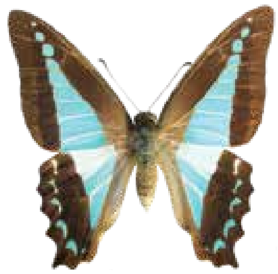
Butterfly Pair 1

A



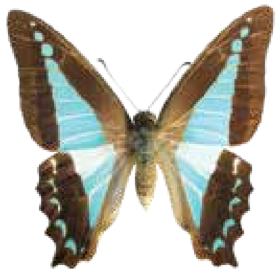
A	G	T	A	C	C	A	C	A	T	C	G	A	A	G	G	G	T	C
B	G	T	A	C	C	A	C	A	T	C	G	A	A	G	G	G	T	C

B



Butterfly Pair 2

A



A	G	T	A	C	C	A	C	A	T	C	G	A	A	G	G	G	T	C
B	G	T	A	C	G	A	C	A	C	C	G	A	A	A	G	T	T	C

B

Butterfly Pair 3

A

A	G	T	A	C	G	A	C	A	C	C	G	A	A	A	G	T	T	C
B	G	T	A	C	G	C	C	A	C	C	G	A	A	G	G	T	A	C

B

Butterfly Pair 4

A

A	G	T	A	C	A	A	C	A	T	C	C	A	A	A	G	T	T	C
B	G	T	A	C	A	A	C	A	T	C	C	A	A	A	G	T	T	C

B

Discuss your observations and findings below, based on your analysis of the DNA sequences for each butterfly pair. Explain if the information supports or refutes your original hypothesis.

ELABORATE - EVALUATE

DNA Sequencing: Skinks

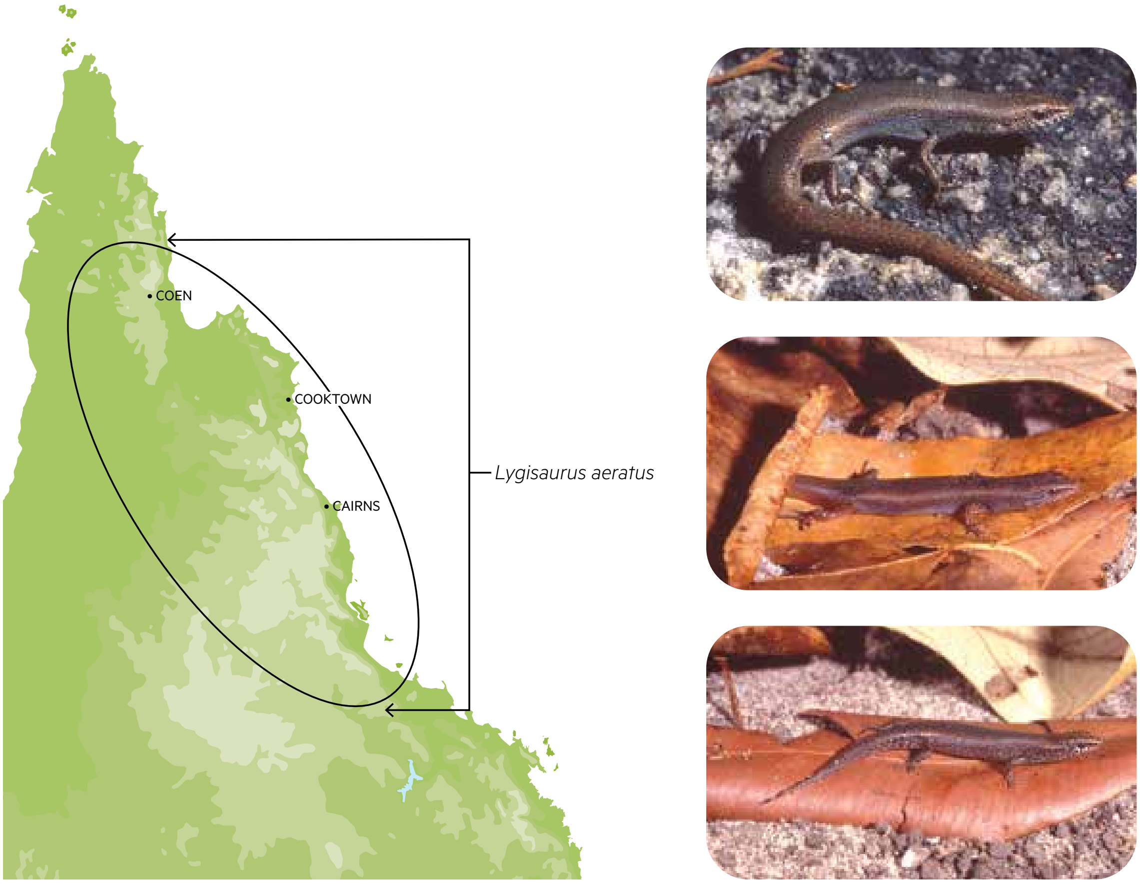
Teacher Resource

Determining whether individuals belong to the same or different species can be complicated. The boundaries between species are determined by assessing differences across a range of criteria, including morphological, genetic, behavioural and ecological characteristics. Each of these variables may provide conflicting results, and the degree of difference in characteristics which constitutes a species boundary is not always easy to quantify. “What is a species?” is a scientific question that does not have a single hard and fast answer; rather there are multiple operating concepts and definitions.

An example of this is the genus *Lygisaurus* (Litter Skinks). Skinks within this genus occur widely in northern and eastern Australia, and also in New Guinea. This genus currently comprises 30 species of skink and is known for its extreme morphological conservatism relative to many other lizard groups or genera.

Given this conservatism, it is unsurprising that recent studies on *Lygisaurus* members have revealed that cryptic speciation (when separate species are visually indistinguishable from each other) in this group is wide spread. One of these studies was done at Queensland Museum on the species *L. aeratus* (formerly *Carlia aerata*)[2]. Prior to the work of Queensland Museum scientists, *L. aeratus* was thought to have a wide distribution throughout north-eastern Queensland. Colour pattern differences had been observed among populations throughout the range, which previously had been thought to simply reflect colour differences between the sexes (sexual dimorphism).

[2] Couper, P. J., Worthington Wilmer, J., Roberts, L., Amey, A. P., and Zug, G. R. (2005). Skinks currently assigned to *Carlia aerata* (Scincidae: Lygosominae) of north-eastern Queensland: a preliminary study of cryptic diversity and two new species. Australian Journal of Zoology 53: 35-49.

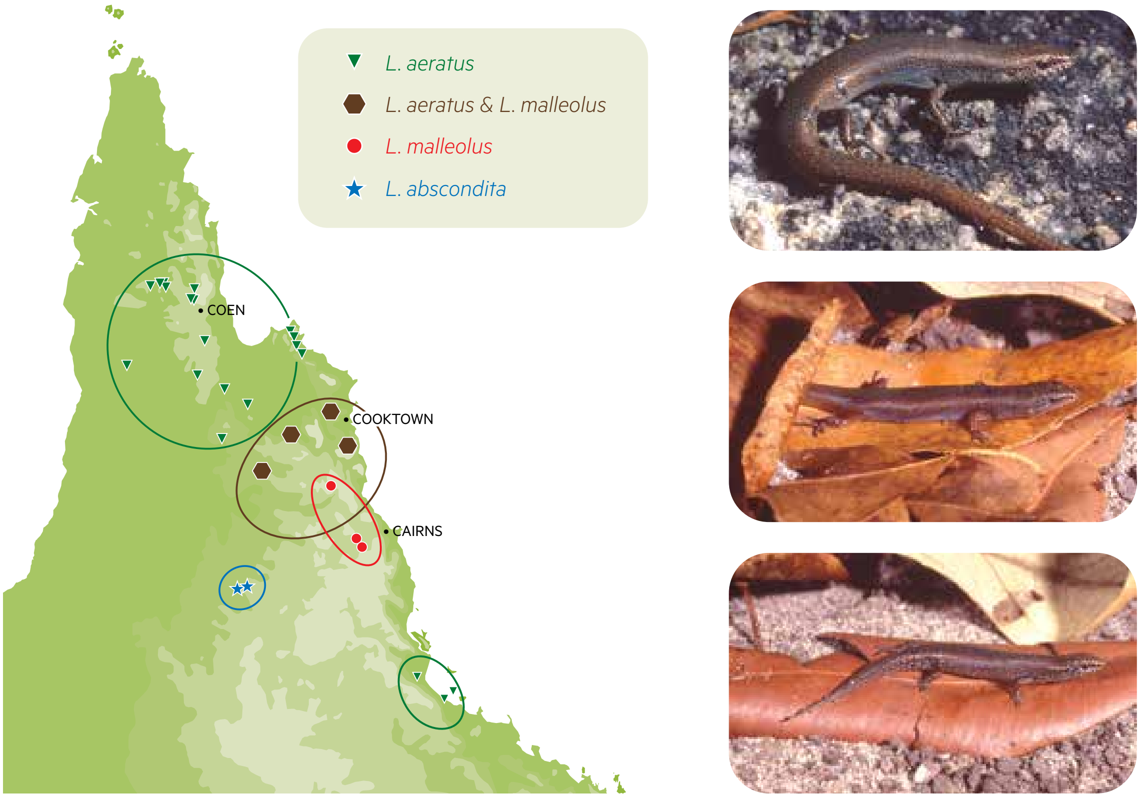


The distribution of *Lygisaurus aeratus* before 2005, based on available data. Images on the right show different *L. aeratus* specimens from across this range. Images: Gary Cranitch, QM, and Colin Dollery.

To investigate these colour pattern differences, Queensland Museum scientists collected tissue samples from *L. aeratus* skinks from many different locations in Queensland. These samples were processed and analysed by Queensland Museum geneticist Dr Jessica Worthington Wilmer. The DNA sequences extracted from the samples were then compared and used to construct a phylogenetic tree. The phylogenetic tree suggested that the colour pattern differences observed among the skinks actually represented three very distinct species, two of which were new to science.

Within this activity, students will use the findings from this research to complete a DNA sequencing activity. Students will use known sequences from three skinks to determine where five nidentified specimens belong in the phylogenetic tree, and consequently, how related these individuals are to each other.

Following the completion of this activity, students may consider and discuss the flow on effects of this discovery. These include instead of having a single species with a wide distribution, there are now multiple different species with very different range distributions. *L. aeratus* now is restricted to far north Queensland around the Coen and Cooktown areas. *L. malleolus* is restricted to between Cairns and Cooktown. The third, *L. abscondita*, is now known from only a single locality.



The updated distribution of the three species, based on data from Couper *et al.*, (2005). The brown hexagons represent sites where both *L. aeratus* and *L. malleolus* were found. Images: Gary Cranitch, QM, and Colin Dollery.

This study is one example of how taxonomic classifications and species names are not static. Instead they are constantly evolving as more sophisticated technology enables new and better resolution of data.

Curriculum Links (Version 8.4)

Science

YEAR 10

Science Understanding

Transmission of heritable characteristics from one generation to the next involves DNA and genes (ACSSU184)

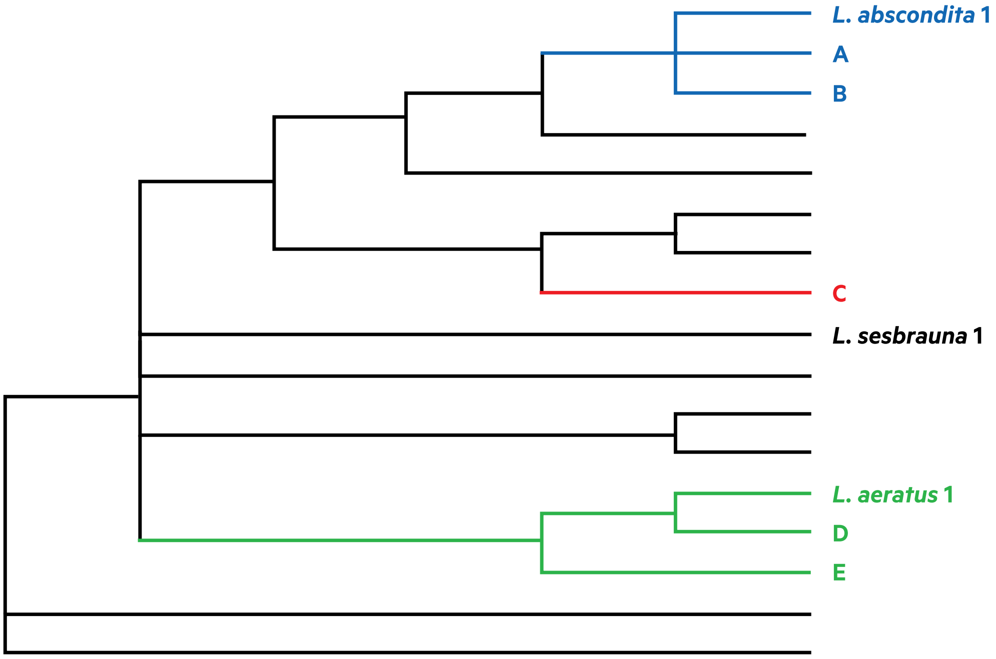
Science Inquiry Skills

Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS204)

Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS208)

DNA Sequencing: Skinks

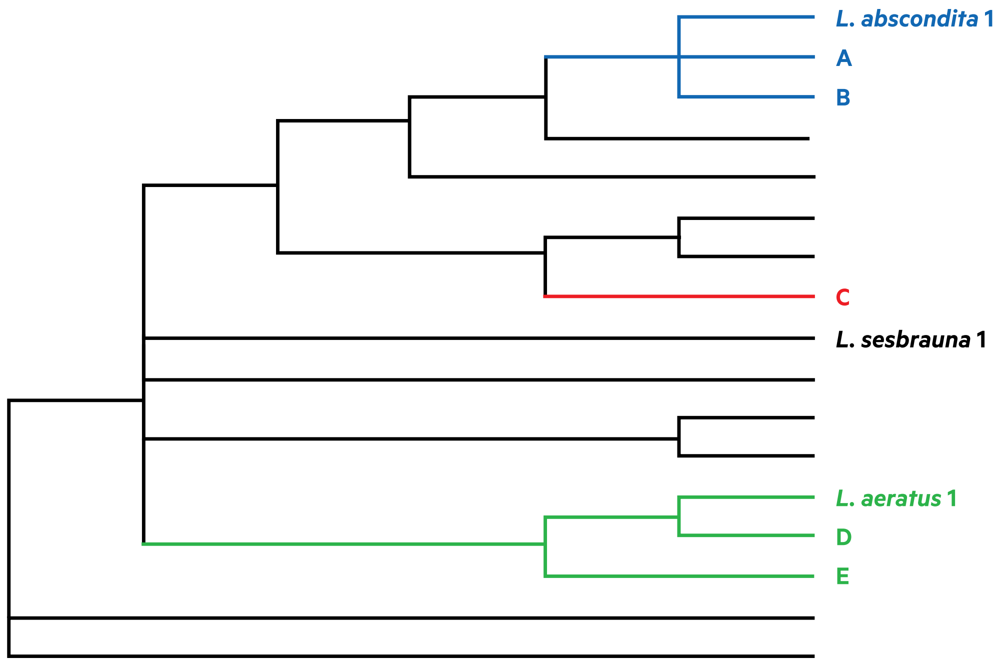
Teacher Resource: Answers



Answer Key		
A	Species 2	*L. abscondita* 2
B	Species 5	*L. abscondita* 3
C	Species 4	*L. malleolus*
D	Species 1	*L. aeratus* 2
E	Species 3	*L. aeratus* 3

DNA Sequencing: Skinks

Student Activity



DNA Sequences

Cut out the DNA sequences below. Place the DNA sequences of the three identified species beside their name in the above phylogenetic tree.

Determine where the unidentified species belong in the phylogenetic tree by comparing their DNA sequences to the DNA sequences of the three identified species.

L. abscondita 1	T C G G T G G C T A C G G C A T T A T C C G C A T C T C A C C A C T A C T A A A C C C A G C T T C A A T
L. sesbrauna 1	T T G G T G G C T A C G G C A T T A T C C G T A T T A C A C C A A T A C T T A A T C C A G C C T C A A T
L. aeratus 1	T C G G C G G C T A C G G C A T T A T C C G T A T T T C A C C T A T A C T A A A C C C A G C T T C A A C
Species 1	T C G G C G G C T G C G G C A T T A T C C G T A T T T C A C C T A T A C T A A A C C C A G C T T C A A C
Species 2	T C G G T G G T T A C G G C A T T A T C C G C A T C T C A C C A C T A C T A A A C C C A G C T T C A A T
Species 3	T C G G C G A C T A T A G C A T T A T C C G C A T T T C A C C T A T A C T A A A C C C A G C T T C A A C
Species 4	T T G G C G G C T A C G G C A T C A T C C G C A T T T C C C C G C T A C T A A A C C C A G C T T C A A T
Species 5	T C G G T G G C T A C G G C G T T A T C C G C A T C T C A C C A C T A C T A A A C C C A G C T T C A A T

Appendix 1: Additional Resources

Queensland Museum Learning Resources

Threatened Species
There are nearly 1000 threatened species in Queensland alone, and the extinction of these species has the potential to disrupt whole ecosystems. In this resource students examine a threatened Queensland animal, and create a Queensland Museum exhibit to explain why this species is threatened and what we can do to help protect it.

STEM Video: Organising Organisms
Explore how Dr Marissa McNamara uses classification in her work at Queensland Museum.

Queensland Museum Learning Programs

Biodiversity and Classification: School Program
Conducted onsite at Queensland Museum, South Brisbane (Year 7 – 12)

During this school program, Discovery Centre staff share real-life experience and knowledge in this overview of animal diversity and the Museum's collections. Students engage in discussions and observations while exploring real specimens to develop an understanding of biodiversity in the natural world.

Animal Classification: School Program
Conducted onsite at Queensland Museum, South Brisbane (Year 3- 6)

What could a possum have in common with a flying fox? Find out about this relationship and more as we explore the Animal kingdom using visuals, challenges and real specimens. Animal Classification sessions develop students' Science Inquiry Skills through recognising patterns and systems used in the classification process.

Apps

Queensland Museum Field Guide to Queensland Fauna
This app holds descriptions of over 560 species encompassing birds, fishes, frogs, lizards, snakes, mammals, turtles, freshwater, marine and terrestrial invertebrates, spiders and insects including butterflies. From animals found on Queensland's coral reefs, in rock-pools, in tropical rainforests, in deserts and in the suburbs, the habitats are hugely varied but only represent a tiny fraction of the true diversity of life in this large State. Our scientists will continue to add new species and refine this app over time.