

Evolution - A New Zealand Perspective

Teachers

This unit of work has been designed to support your class visit for the 'Evolution – A New Zealand Perspective' programme at the National Aquarium of New Zealand. Students will participate in a range of level specific interactive activities.

The primary focus of this programme is the Living World Strand of the Science Curriculum, however when planning your unit of work links can be made to other essential learning areas. Similarly, different essential skills can be emphasised depending on the needs of your students.

It is recommended that these materials be reproduced in their entirety for each of your students. It is hoped that students will be able to use this resource for preparatory work prior to their visit to the National Aquarium, as a workbook during their visit and as reference material after their visit.

Programme Overview

Why should you learn about evolution at the aquarium?

Evolutionary processes generally occur over thousands or even millions of years and therefore it is hard to grasp the concepts, processes and outcomes of evolution without real examples. In the aquarium there are many examples of evolutionary outcomes (e.g. kiwi and gecko) and from these the students may obtain a clearer understanding of the evolutionary processes involved.

Essential Learning Area: Science

Strand: Living World

Achievement Aim 3: investigate and understand how organisms grow, reproduce, and change over generations.

Level: 8

Achievement Objective: investigate and describe the diversity of scientific thought on the origins of New Zealand fauna.

Scientific Skills and Attitudes

- Focusing and Planning
- Information Gathering
- Processing and Interpreting
- Reporting

The 'Evolution – A New Zealand Perspective programme at the National Aquarium of New Zealand lays the foundations for developing the above investigative skills and attitudes.

Specific Learning Outcomes

- To learn some evolutionary terminology and definitions
- To understand the main processes of evolution and to give examples of evolution processes that have acted on the New Zealand fauna.

Natural selection and survival of the fittest

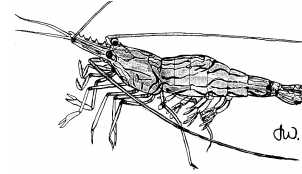
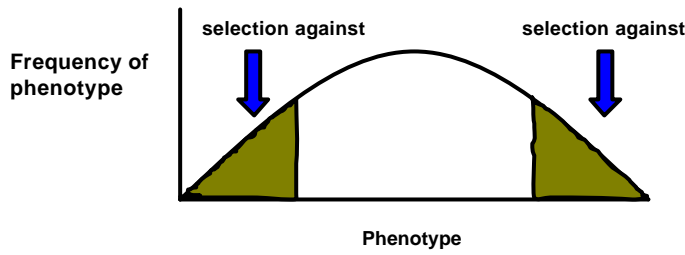
Darwin and Wallace in the 19th century both came up with the idea to explain the question of *why* there are so many different weird and wonderful animals in the world and how do organisms change? During Darwin and Wallace's many voyages around the world they observed that there was **variation** in offspring and eventually suggested that **environmental forces** acted upon the offspring and those which were adapted in some way to cope with the environment survived and the other offspring died. Thus over many years the fittest offspring would pass on to generations the phenotype that was the best for surviving in that environment, in other words **survival of the fittest**. This process was termed by Darwin as **natural selection**.

Selection Forces

Environmental forces when acting on offspring phenotypes can be termed **selection forces**. Selection forces can be **abiotic** (e.g. climate or limited resources) or **biotic** (e.g. predators or competition) and in combination can act on offspring phenotypes in different ways, giving different types of natural selection. Each group of offspring will have a range of phenotypes and the range can be interpreted as a normal distribution or bell-shaped curve. Selection forces act on different parts of the bell-shaped curve.

Types of natural selection

Stabilising selection:

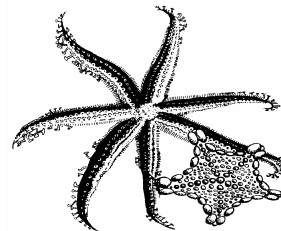
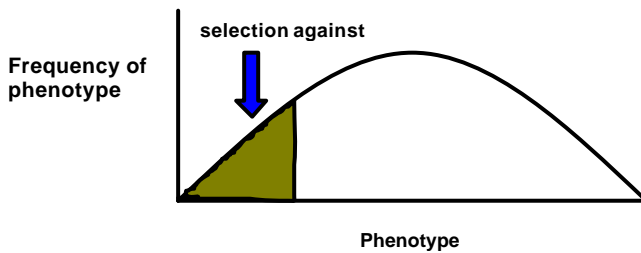


Stabilising selection is where selection forces act against the **extreme phenotypes** (e.g. the largest and smallest offspring)

Suggest what forces would be acting on the large shrimp phenotype.

Suggest what forces would be acting on a small shrimp, particularly with larger shrimp around.

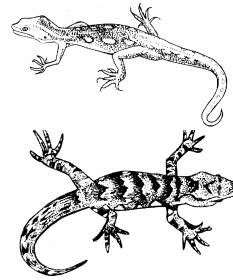
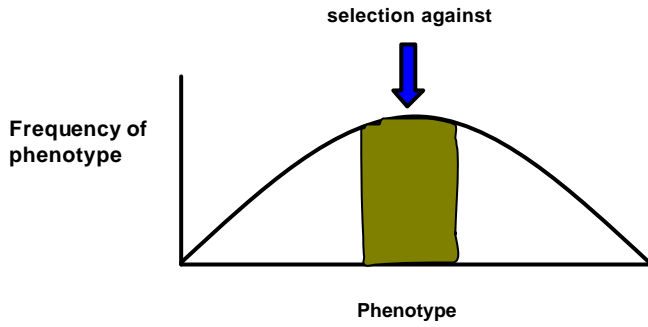
Directional selection:



Directional selection is where selection forces act against the **one of extreme phenotypes** (e.g. either largest or smallest offspring)

Suggest what forces would be acting on a small spiny starfish, with small spines compared to a large spiny starfish with large spines.

Disruptive selection:



Disruptive selection is where selection forces act against the **average phenotype** and favours the extreme phenotypes (e.g. either largest or smallest offspring)

From the NZ Gecko display, suggest why there are green and brown geckos but no mixed coloured geckos? What selection forces are likely to be acting in this situation?

What is the eventual outcome of disruptive selection? Hint: are the geckos the same species?

What is a species?

A species is one or more groups (populations) of individuals which can interbreed within the group and are reproductively isolated from all other organisms.

Looking around the aquarium, can we tell what fish are different species? How?

Scientific naming

Scientific naming enables us to identify a species (e.g. a fish) and allows people all over the world to know which fish you are talking about. All organisms are given a universal name, which is termed a **scientific name**. Scientific names are made up of two parts: **Genus** and **species**.

Sharkus maxima



Genus

Species

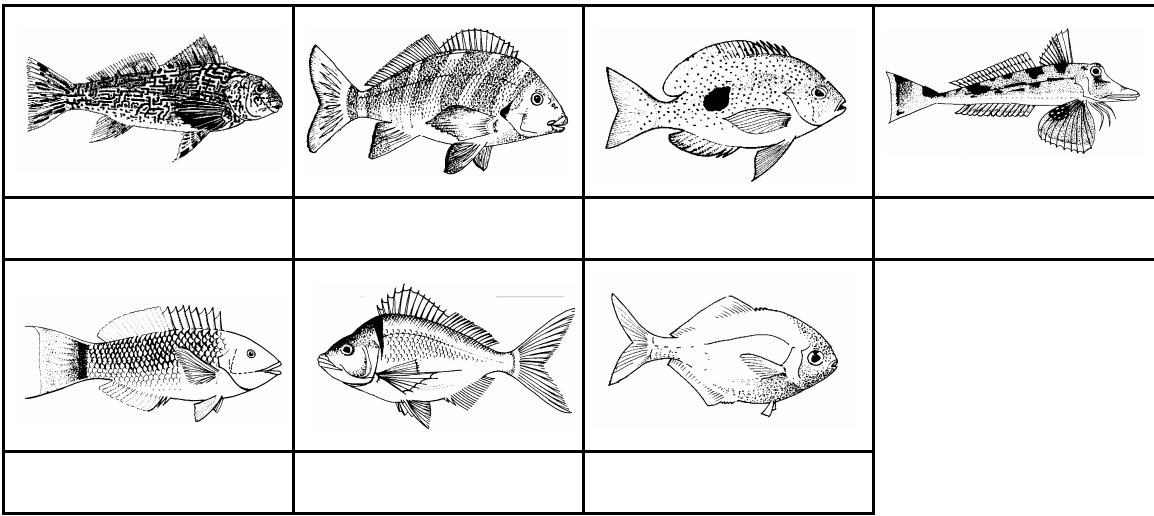
The scientific name can give you an indication of the classification of the organism and sometimes what the organism is like. The Genus indicates the group of organisms the organism belongs to, in this case the shark genus and the species name indicates the species type and sometimes what the species key characteristic is, in this case a LARGE shark species.

Organisms also normally have common names too. Why don't scientists just use common names e.g. Lemon fish??

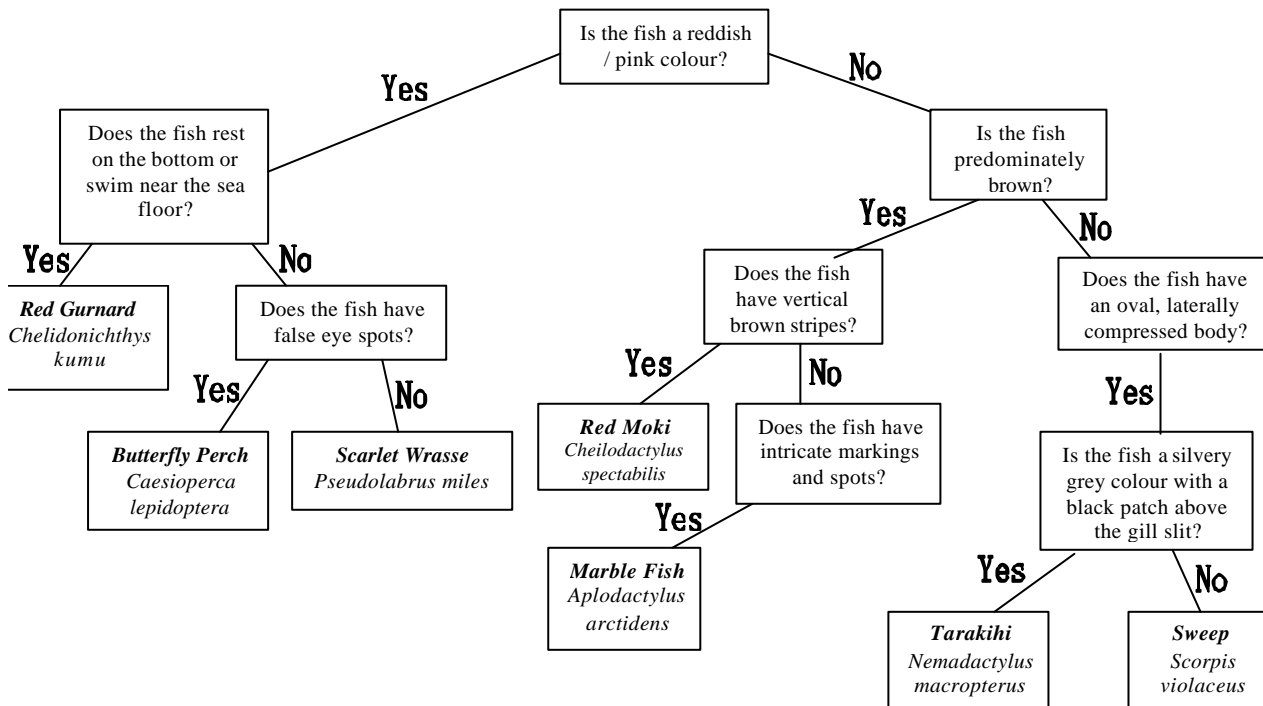
Classification and identification

Sometimes fish can look similar at a glance but they are different species. Looking more carefully for 'key' characteristics we can find which fish are different species. To help guide you to look for distinguishing characteristics a key is used. This helps you separate out fish species which look similar but are not the same!!

Stand in front of the Pania Reef tank and locate the seven fish pictured. Use the key to discover the names of the fish. Enter the name of the fish in the space below the picture.



Fish Identification Key



How are species formed?

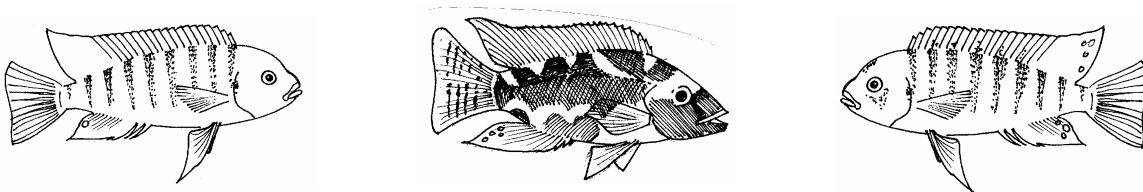
Species are derived by the process of natural selection and the term **speciation** describes the splitting of one species into two or the transformation of one species into a new species over time.

Types of speciation

Allopatric speciation:

Allopatric speciation occurs when populations of a species become separated geographically and eventually over time these populations become new species.

Allopatric describes species or populations whose geographical boundary does not contact each other .



The Cichlid fishes within the aquarium are an example where allopatric speciation has occurred. Describe the processes of allopatric speciation in this case and identify the geographical barrier. Is the geographical barrier permanent? Will this affect the process of speciation?

Sympatric speciation:

Sympatric speciation occurs when speciation occurs even though species occupy the same geographic range. **Sympatric** describes species or populations whose geographical range overlaps. Sympatric speciation can occur when populations of a species spend increasingly more time in different habitats within the same geographical range (i.e.

habitat isolation) or if different populations of a species respond differently to environmental cues for reproduction (**sexual isolation**).

The different species of New Zealand geckos may have derived from sympatric speciation. Suggest why habitat isolation might be the mechanism of speciation for these geckos. Hint: does the colour of the geckos suggest the habitat in which they occupy.

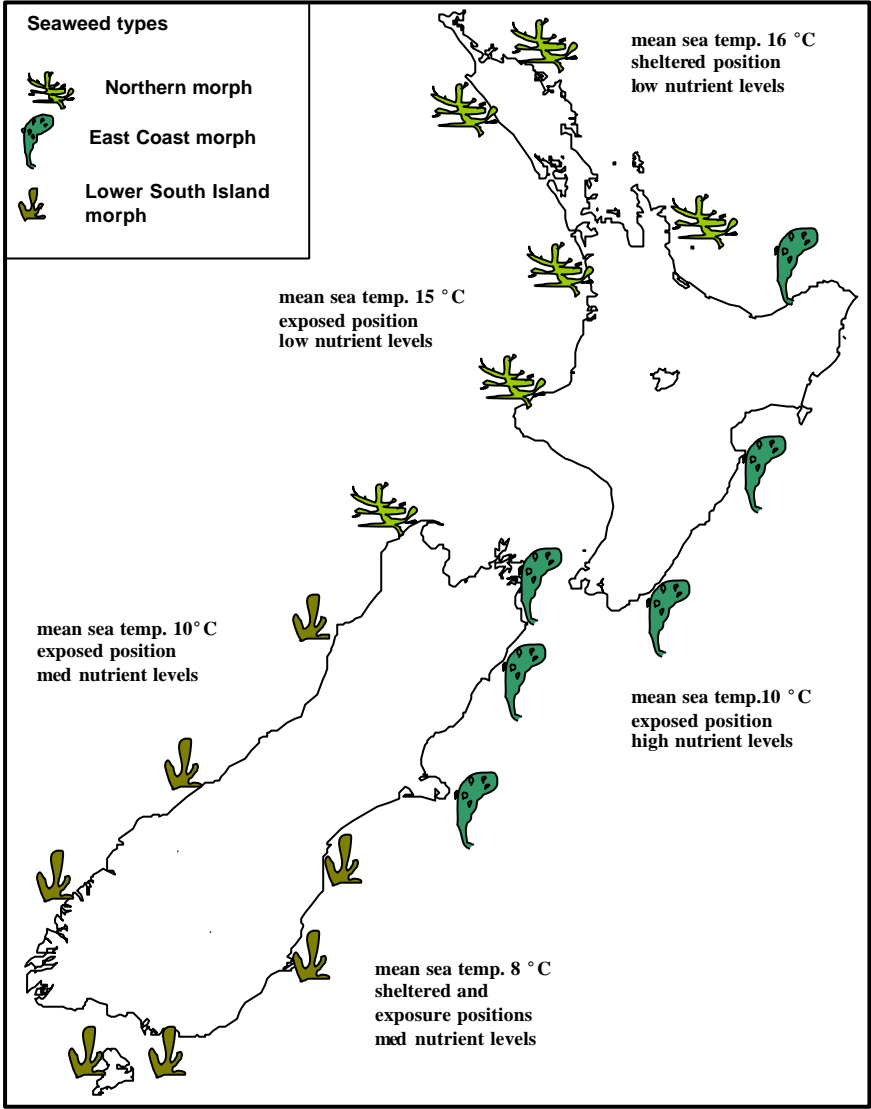
Different species of sea urchin live in the same marine environment/habitat. Suggest why sexual isolation is likely to have been the mechanism of speciation within sea urchin species. What environmental cues do you think the sea urchins will respond to for reproduction?

Clines:

A cline is where there are morphological changes within populations of a species along an environmental gradient, such as the mountains to the sea.

A scientist at University of Otago is studying seaweed, the genus *Pachymenia*. She is interested to know whether the genus *Pachymenia* has three separate species or whether the genus *Pachymenia* contains only one species that shows a variety of morphologies, in other words a **cline**.

Using the scientists research data of the seaweed's morphological differences and environmental data taken from around the coastline of New Zealand, work out what is the morphological gradient from North to South and what environmental factors are likely to influence the seaweed morphology.



Evidence of evolution

Evidence of evolution can be seen in many different organisms. Some morphological features can look very similar but have evolved from completely different ancestors that have been subjected to similar selection forces. For example a penguin flipper and a fish fin look similar and perform the same function (i.e. to help propel the penguin or fish through the water). These features are termed **Analogous** and are the result of **convergent evolution**. Other morphological features look very different and have different functions but have evolved from the same ancestor. These features are termed **Homologous** and are the result of **divergent evolution**.

How many examples of homologous and analogous features of animals within the aquarium can you find?

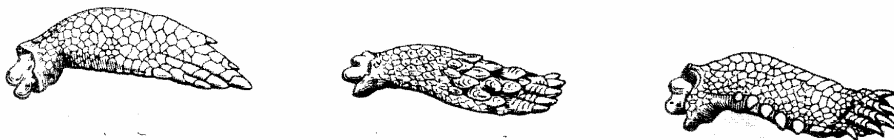
Other evidence of evolution shows the loss of morphological features or functions due to the reduced selection pressure on that morphological feature. For example, the appendix and tail-bone in humans and lizards without legs.

The aquarium has two fascinating examples of animals that have lost of morphological features; the kiwi and the blind-cave fish. Explain one morphological feature that the kiwi has lost, and two morphological features that the blind-cave fish has lost and suggest why these features were lost.

Adaptive radiation

Adaptive radiation is the process that describes the rapid evolution of one (or a few) species into many different species, which occupy different habitats. For example, marsupials of Australia and finches of the Galapagos Islands (Darwin's finches).

Go 'behind the scenes' and see an example of adaptive radiation in the turtles, terrapins and tortoises.



References used:

Strickberger, M.W. (1990) *Evolution*. Jones and Bartlett Publishers, London

Allaby, M (Ed.) (1998) *A Dictionary of Plant Sciences*. Oxford University Press, Oxford U.K.