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NZQA
NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Scholarship 2010
Biology

9.30 am Friday 26 November 2010
Time allowed: Three hours
Total marks: 24

QUESTION BOOKLET

There are THREE questions in this booklet. Answer ALL questions.

Write your answers in the Answer Booklet 93101A.

Start your answer to each question on a new page. Carefully number each question.

Check that this booklet has pages 2–7 in the correct order and that none of these pages is blank.

YOU MAY KEEP THIS BOOKLET AT THE END OF THE EXAMINATION.

You have three hours to complete this examination.

QUESTION ONE: PŌHUTUKAWA AND RĀTĀ (8 marks)

Pōhutukawa and rātā belong to the subgenus *Metrosideros.* The subgenus is made up of 26 different species found throughout the Pacific. Of these there are two species of pōhutukawa and three species of rātā found only in New Zealand.

Pōhutukawa species
M. excelsa (pōhutukawa)
M. kermadecensis (Kermadec Island pōhutukawa)

Rātā species
M. robusta (northern rātā)
M. umbellata (southern rātā)
M. bartletti (Bartlett's rātā)

The most common pōhutukawa species in New Zealand is the coastal pōhutukawa *M. excelsa* (Figure 1).

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Figure 1: *M. excelsa*

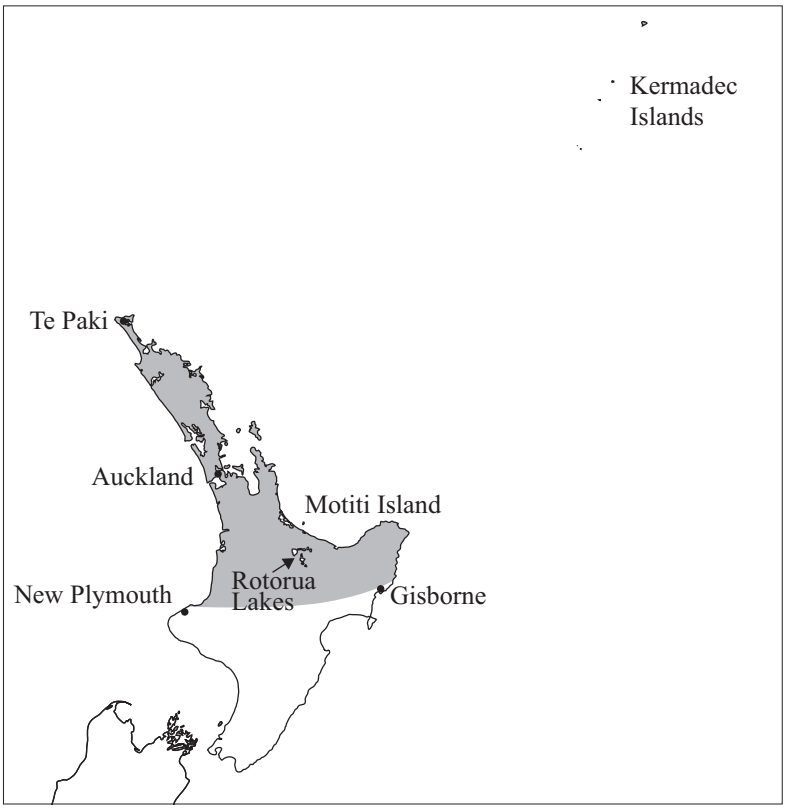


Figure 2

M. excelsa is widespread in coastal regions north of a line between New Plymouth and Gisborne (Figure 2). It produces bright red flowers from November to January (Figure 3). The nectar produced attracts a range of pollinators, including native bats, birds and insects.

At least two other varieties of *M. excelsa* are also known to exist.

- A pink-flowered tree (yet to be recognised as a subspecies) originating from the Rotorua Lakes area (Figure 4).
- A pale yellow-flowered tree *M. excelsa aurea*, which was found on Motiti Island in the Bay of Plenty in 1940 (Figure 5).

Both these varieties have now spread widely and are found in the same areas as *M. excelsa*.

Figure 3: Red-flowered variety
http://farm2.static.flickr.com/1191/1363457589_bc36a7f529.jpg?v=0

Figure 4: Pink-flowered variety.
http://farm1.static.flickr.com/113/258293601_2cde9d3a15.jpg

Figure 5: Yellow-flowered variety.
http://upload.wikimedia.org/wikipedia/commons/8/8c/YellowPohutukawa.jpg

The other pōhutukawa species found in New Zealand is *M. kermadecensis*, which was originally found only on the small Kermadec Islands 900 km north east of the North Island. (Figure 2). It is also a coastal forest tree with red flowers and, except for smaller leaves, is very similar in appearance to *M. excelsa*. It usually has some flowers all year round. *M. kermadecensis* is now common on mainland New Zealand since being first introduced by early Māori. It hybridises easily with *M. excelsa*.

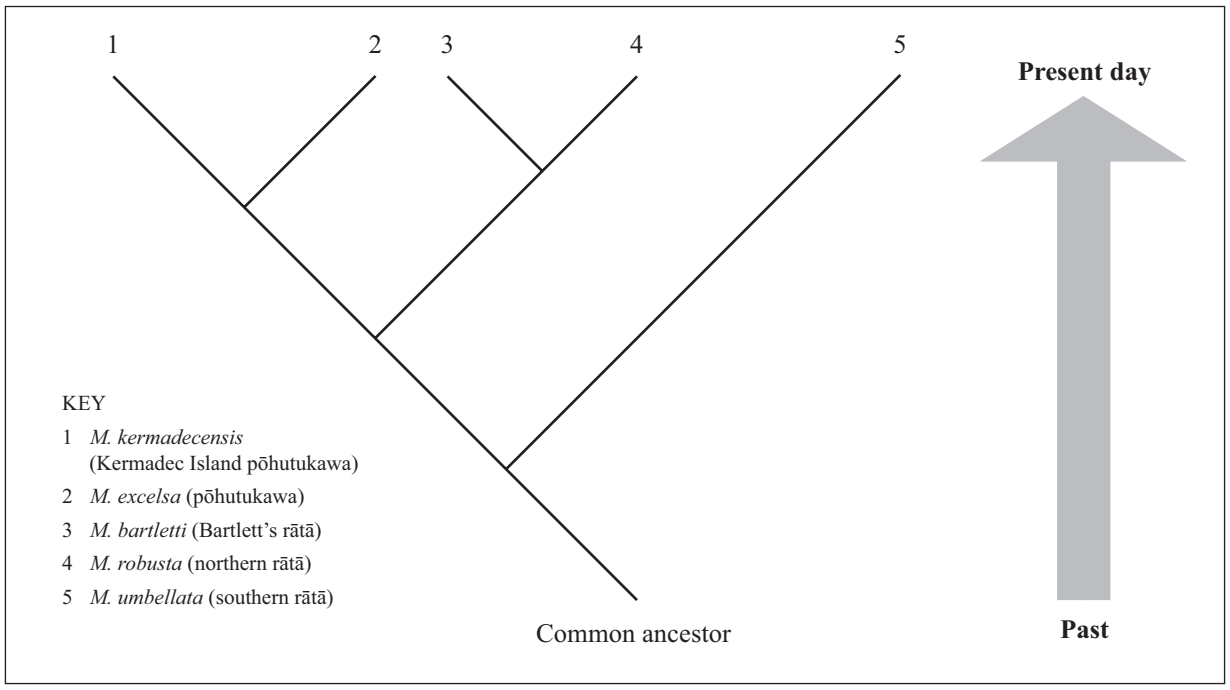
The other *Metrosideros* species found in New Zealand are three species of rātā (Figure 6).

- *M. robusta* (northern rātā) – Found in warm temperate forest at the top of the South Island and throughout the North Island. It has red flowers.
- *M. umbellata* (southern rātā) – Found in cool temperate to subarctic forests. It was common throughout New Zealand during the last ice age but it is now found mainly on the western side of the South Island. Some isolated plants are found in the North Island on a few elevated crests, where it is cool and damp. It has red flowers, but occasionally white, pale yellow and pink flowers have been seen.
- *M. bartletti* (Bartlett's rātā) – The rarest rātā, found only at Te Paki in the far north. It has white flowers.

Figure 6: Rātā tree.
http://farm3.static.flickr.com/2335/2289760402_311e552929_o.jpg

When growing conditions are less than ideal, for instance cooler inland conditions or on young lava, *M. excelsa* (pōhutukawa) is known to hybridise with *M. robusta* (northern rātā). The hybrids are usually found in a zone between the two parent species. Hybridisation has also occurred between *M. excelsa* and other rātā species.

Phylogenetic Tree for the subgenus *Metrosideros* in New Zealand



Discuss:

- the **processes** that may have led to the evolution of the **two species** of pōhutukawa found in New Zealand
- the **genetics** responsible for producing the **three different** coloured varieties of *M. excelsa* (red, pink, yellow)
- the possible **effects of hybridisation** on the **future evolution** of the subgenus *Metrosideros*.

QUESTION TWO: BROWN TROUT AND ATLANTIC SALMON IN NEW ZEALAND (8 marks)

Since the arrival of European settlers, many attempts have been made to introduce exotic fish species into New Zealand's rivers and lakes for sport and recreation. Two such species are the brown trout (*Salmo trutta*) and the Atlantic salmon (*Salmo salar*). Brown trout were introduced from the rivers and lakes of Europe, while the Atlantic salmon were introduced from the North Atlantic Ocean.

Figure 7: Brown trout, *Salmo trutta*. 1–5 kg, lifespan about 10 years.
http://pond.dnr.cornell.edu/nyfish/salmonidae/brown_trout.jpg

Figure 8: Atlantic salmon, *Salmo salar*. 10–20 kg, lifespan about 5 years
http://pond.dnr.cornell.edu/nyfish/Salmonidae/atlantic_salmon.jpg

Atlantic salmon are migratory fish, living most of their life cycle in the very cold waters of the sub-arctic North Atlantic ocean, but returning south to breed in the rivers of Europe.

Brown trout mainly inhabit fresh water; however they will readily enter, and feed in, coastal waters.

Adults of both species reproduce by spawning during autumn in clear, well-oxygenated river water, covering their fertilised ova in fine stones to reduce egg predation. Brown trout will also spawn on the shores of lakes where there are fine stones. Brown trout spawn annually and are more tolerant than Atlantic salmon of less favourable abiotic environmental factors. The majority (up to 95%) of Atlantic salmon spawn once and then die. Atlantic salmon are known to aggressively compete for prime breeding sites in the rivers.

The young of both species feed on the larval and adult stages of insects, and as they grow their diet widens to include any available fish, crustacea or small vertebrates. They in turn may be predated on by other fish and birds.

When about a year old, Atlantic salmon migrate to the sea where they spend the next three years feeding and growing. Their main food is squid, krill and fish which, in the Southern Hemisphere, are most abundant in the cold waters surrounding Antarctica. They then migrate back to the specific river where they were born, which will be one of the few rivers with suitable spawning sites. During this return migration, they do not feed and are sustained by their body tissues. After spawning, the adult Atlantic salmon die. Brown trout feed throughout their lives and do not migrate.

The introduction of brown trout has been very successful with many self-sustaining populations becoming established in coastal waters, estuaries, lakes and rivers from south of Auckland to the bottom of the South Island.

Despite numerous releases in a variety of river environments, Atlantic salmon have consistently failed to establish any viable populations and today are considered to be near extinction in New Zealand waters.

Discuss possible reasons why the Atlantic salmon has been unable to successfully establish in New Zealand, unlike the brown trout. In your answer consider the following:

- differences and similarities in **ecological niche** and **breeding patterns**
- the **migration behaviour** of Atlantic salmon **compared with** brown trout.

QUESTION THREE: MAMMOTHS (8 marks)

The ancestors of mammoths migrated out of Africa into Europe and Asia about 3.5 million years ago. Several specialised species evolved from the ancestral species. The woolly mammoth (*Mammuthus primigenius*) first appeared in Europe about 400 000 years ago. Woolly mammoths were adapted to cold environments and ranged from Great Britain, across northern Europe and Asia, to North America. They roamed over vast grasslands, eating a diet of grasses, broad-leafed herbs, and small shrubs.

Figure 9: Mammoth range.
Mueller, Tom, 'Ice Baby', *National Geographic* May 2009, p 44.

Between 14 000 and 16 000 years ago, mammoths disappeared from much of their range. This disappearance coincided with the end of the most recent ice age and the expansion of human populations into Europe and Asia. By about 10 000 years ago, mammoths had become extinct. Today, the earth is between ice ages. Temperatures in the regions in which mammoths once roamed are now a lot warmer. Strong winds blow frequently and there is little rain. Vegetation includes grasses, small shrubs, lichens, and mosses.

Adaptations mammoths (*Mammuthus sp.*) had for the very cold climate of the ice ages included:

- skin covered with two layers of hair – a dense undercoat then a top layer with hairs up to 1 m long
- small ears lined with hair (ears were about 30 cm in length; modern elephants have ears up to 180 cm in length which are not hairy)
- oil-secreting glands in the skin secreted insulating lipids onto the hair
- an insulating fat layer up to 8 cm thick under the skin
- immense tusks that could double as 'snow shovels' to forage for food.

Figure 10: Mammoth and Asian elephant.
Mueller, Tom, 'Ice Baby', *National Geographic* May 2009, p 55.

The closest living relatives of the mammoth are the African elephant (*Loxodonta africana*) and the Asian elephant (*Elephas maximus*). They live in hot environments, have under-developed hair, and live in herds of females and calves, while males are solitary. The African elephant is found throughout sub-Saharan Africa, while the Asian elephant is found throughout Asian countries, such as India and Thailand.

Adults of both species have no natural predators, but the African young may be preyed on by lions, leopards, hyenas and crocodiles, and the Asian young by tigers. Adults eat between 170 and 225 kg of vegetation a day and drink up to 200 L of water. Asian elephants are much smaller than African elephants. Mammoths were about the same height as Asian elephants, but heavier and stockier.

Figure 11: 'Ice baby' Lyuba.
Mueller, Tom, 'Ice Baby', *National Geographic* May 2009, cover.

Many dead mammoths have been found preserved in ice. The most recent and best-preserved is the ‘ice baby’ (named Lyuba) found in 2007.

DNA has been successfully extracted from the cells of these preserved specimens. Comparisons indicate that mammoths and present day African elephants have at least 98% of nuclear DNA in common.

Some scientists have suggested that modern biological techniques and processes could enable mammoths to walk the earth again.

Discuss how a modern biological technique could be used to bring mammoths back to life, and the implications of having mammoths living again. In your answer:

- **Explain** biological techniques that could be used to bring back the mammoth and produce a self-sustaining wild population. **Evaluate** the likely success of this process.
- **Analyse** the **evolutionary** and **ecological** implications of having a population of mammoths living on earth again and **justify** whether or not we should bring back the mammoth.

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