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NZQA
NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Scholarship 2009
Biology

9.30 am Friday 27 November 2009
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 (8 marks)

The lesser short-tailed bat, *Mystacina tuberculata*, and its distant relative, the long-tailed bat, *Chalinolobus tuberculata,* are the only two native land mammals found in New Zealand today.

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Lesser short-tailed bat, *Mystacina tuberculata*.
J. L. Kendrick, DOC

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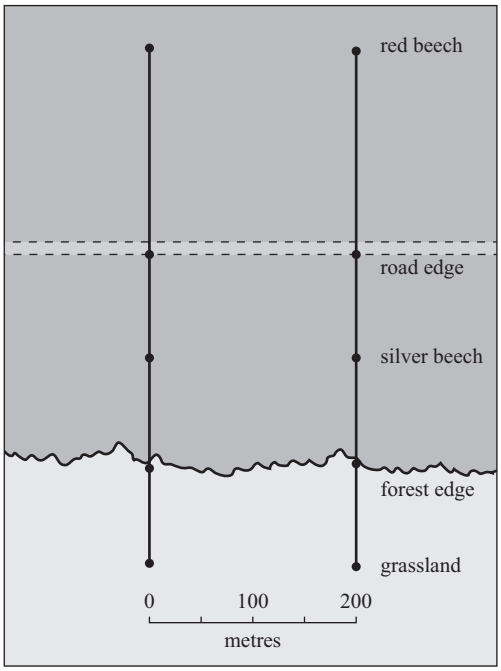
Long-tailed bat, *Chalinolobus tuberculata*.
J. L. Kendrick, DOC

The ancestor to the short-tailed bat arrived in New Zealand from forested areas in Queensland, Australia more than 35 million years ago, inhabiting densely forested regions throughout the country. These are unusual bats because although they are capable of rapid, darting flight, they, unlike their Australian ancestors, spend a lot of time on the forest floor searching for food. The ability to fold their wings and use them as legs, allows them to scurry along the ground. Their diet consists of insects and other small invertebrates, as well as pollen, fruits and nectar of flowering plants. They are the main natural pollinator of the ground-dwelling wood rose plant. The short-tailed bat has sometimes been described ecologically as doing the job of mice.

Figure 1(a): Transects set up over five different habitat types

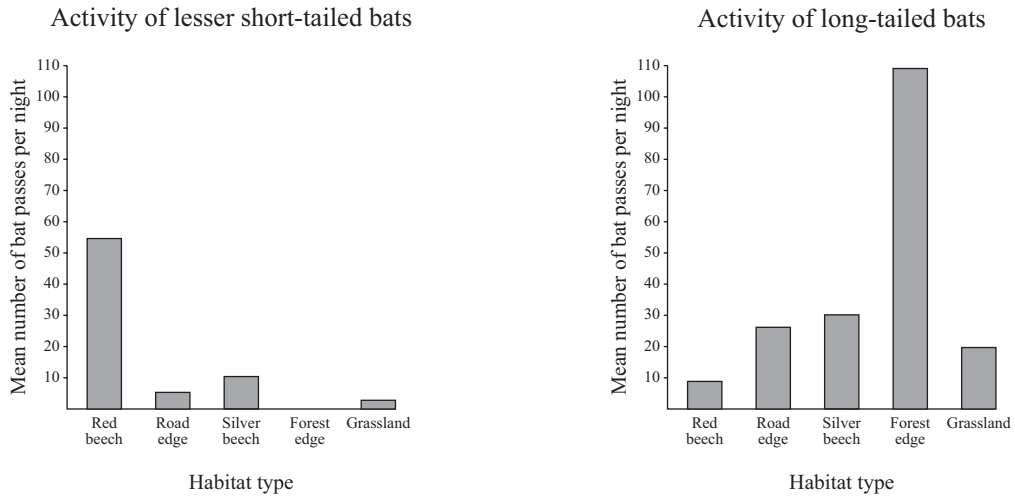


The long-tailed bat is a recent arrival, blown over from Australia about 1 million years ago. This bat exhibits more typical bat structure and behaviour. It is a high-flying aerial feeder on mosquitoes, moths and beetles.

Both species of bat have similar roost requirements, although short-tailed bat roosts tend to be closer to the ground than those of the long-tailed bat. Both are probably vulnerable to the same present day predators such as the native owl (morepork), the native falcon and recently introduced mammals.

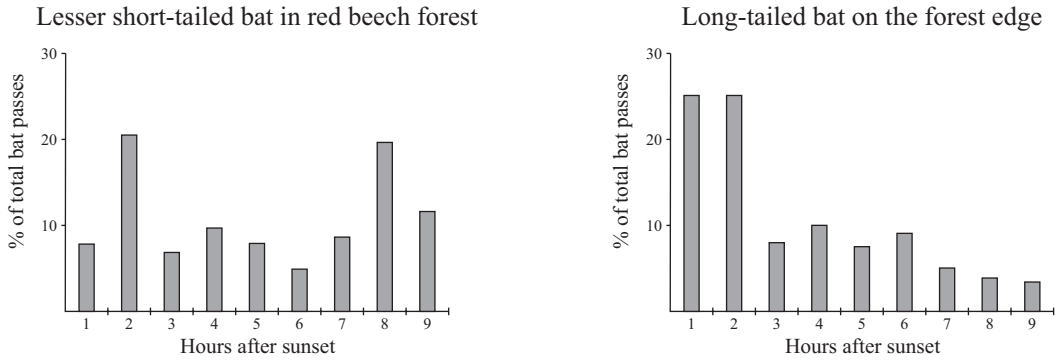
Scientists have studied the activity patterns of populations of the two bat species living in the same area. The collected data has been summarised in the following graphs and observations.

Figure 1(b): Habitat use by the two species of bat recorded as the number of "bat passes"* during the night



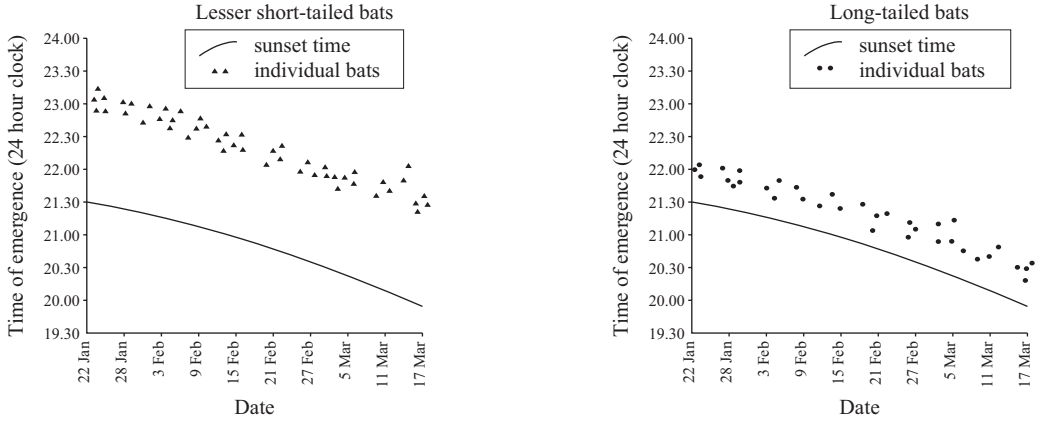
* "Bat Pass" is the recording of a bat as it flies past a microphone set up in the area.

Figure 2: Patterns of activity of the two species of bat throughout the night in their preferred habitat



Seasonal activity: observations of the two species of bat suggest that the long-tailed bats were much less active in the winter months than the short-tailed bats.

Figure 3: The activity of the two species of bat recorded as emergence times from their roosts during summer



Discuss:

- The evolutionary **processes** that have resulted in the present day niche of the **lesser short-tailed** bat in New Zealand.
- The **factors** that allow the **co-existence** of these two species of bat in New Zealand.

Support your answer using data from the resource material.

QUESTION TWO (8 marks)

Lactase non-persistence is an example of a genetic trait that has been influenced by cultural factors.

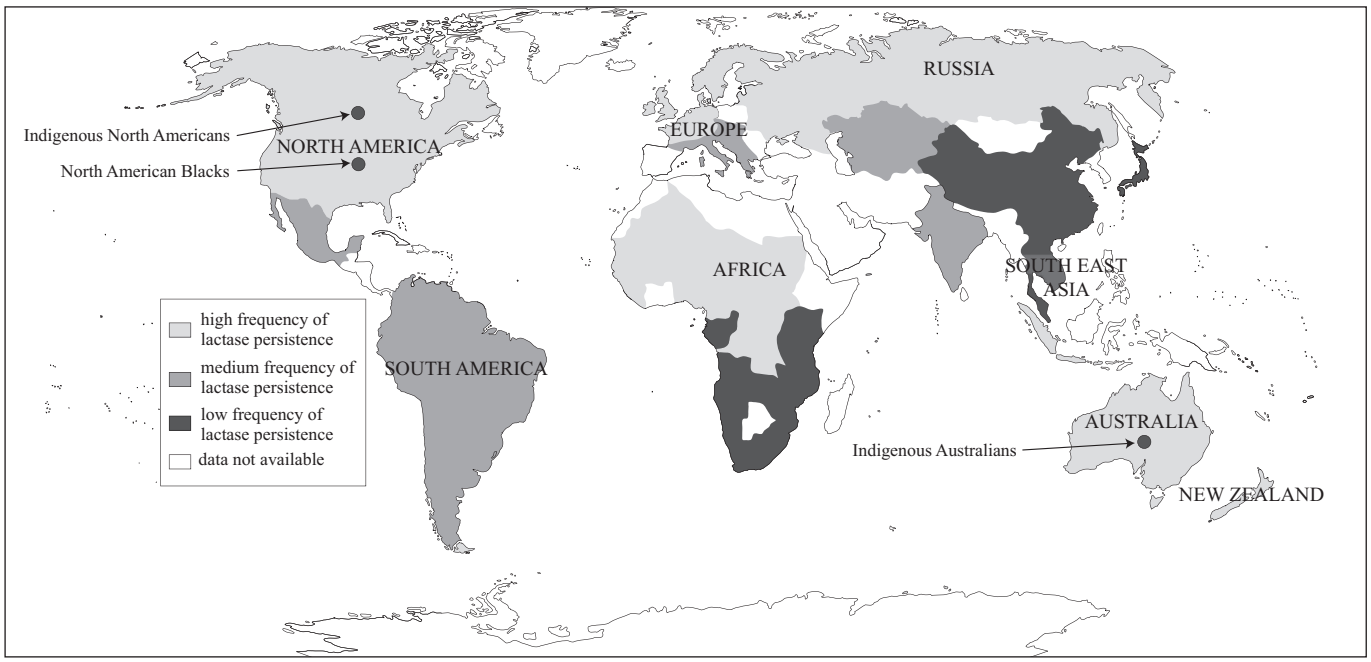
Domestication of animals by humans began approximately 10 000 years ago. Farming of cattle provides a reliable source of meat and milk. Milk is rich in nutrients and calories, and, through dairy farming, provides more calories than would be yielded if the cows were consumed as meat. Milk from domesticated cows has been a valuable food source in parts of Europe for 8 000 years as dairy farming became an established practice.

Lactose is a disaccharide sugar found in milk. The enzyme **lactase** catalyses the breakdown of lactose into glucose and galactose, which are absorbed into the blood from the small intestine. If undigested, the lactose molecule is too large to be absorbed into the blood. Instead, it continues into the large intestine, where it is fermented by bacteria.

Lactase production in humans is controlled by a gene located on chromosome 2. This gene is switched on in babies, so lactase is manufactured in the cells lining their small intestine. This enables the digestion of lactose in the milk consumed during infancy.

The production of lactase drops by approximately 90% during the first four years of life due to the switching off of the lactase gene. This switching off is environmentally induced by the weaning of the baby from the mother's milk. Globally, about 70% of all adults have inactive alleles and do not produce lactase, so they are unable to digest lactose. The switching off of the lactase gene results in **lactase non-persistence** in adults, which is the normal genetic condition.

At some stage in human evolution, a dominant mutation occurred that prevents the switching off of the lactase gene, allowing the production of lactase into adulthood. People with this mutant allele are able to digest lactose throughout their lives. This is known as **lactase persistence**. Evidence indicates that the mutation occurred independently in populations in northern Europe and parts of Africa before or at about the same time as cattle were domesticated.



Global distribution of lactase persistence

Discuss the presence and occurrence of lactase persistence in different regions of the world.

In your discussion consider:

- the **genetics** and **inheritance** of the lactase persistence allele in humans
- the role of **cultural** evolution in the **selection** of lactase persistence in only **certain** regions of the world
- the **reasons** for the **current frequency distribution** of lactase persistence.

QUESTION THREE (8 marks)

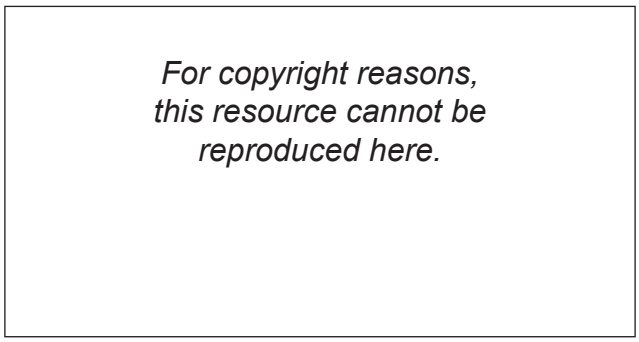
Banana is the common name for the plants and the fruit of the genus *Musa*. It is the fourth most important food crop in the world after rice, maize and wheat. Banana plants reproduce asexually by sprouts or suckers. The fruit of the modern day banana are seedless, but "wild" banana species produce seeds.

Many different species of banana exist today, all of which are descended from one or other of the "wild" Asian species:

Musa acuminata (AA: 2n = 22)

Musa balbisiana (BB: 2n = 22)

both of which can reproduce sexually and asexually.



Fruits of "wild" bananas have numerous large, hard seeds.
http://able2know.org/topic/122539-1

Today there are a number of different banana cultivars (cultivated varieties) within each different species.

Examples of modern day cultivars found in six different species of banana

Species Genome	Cultivars
AA	Sucrier
	Jari Buaya
AAA	Gros Michel
	Grande Naine
	Cavendish
BB	Abuhon
	Chuoi Hot Qua Lep
AB	Njalipoovan
ABB	Awak
	Pelipita
AABB	Kluai Ngoen

Cultivars of banana species showing variation in size and colours when ripe.
http://2.bp.blogspot.com/_R7fLdadnsbY/SMEVtz2Xo3I/AAAAAAAACIM/
6WHmwZG1nuE/s400/banana_varieties__mosquit_1.jpg

Export bananas are popular, partly because they are produced all year round and can be picked when unripe. Ripening of fruit is stimulated by ethylene gas, which is produced in, and released from, the cells of the fruit. When unripe bananas reach their destination, they are placed in special airtight rooms, which are then filled with ethylene gas to induce ripening.

Ripened Cavendish bananas in
a New Zealand grocery store.
http://warriorsofatlantis.com/when-bananas-ruled-the-world

Discuss:

- The **sequence of events and processes** that have resulted in the three different **species** of banana with the following genomes, arising from the original "wild" species of banana:

  AAA
  AB
  ABB

  Use annotated flow diagrams to support your answers.
- The **genetic processes** that could have occurred to produce the different **cultivars** of Gros Michel, Grande Naine and Cavendish within the **one** species of the AAA genome.
- The **factors** that need to be considered and the possible **sources of error** in the design of a **reliable and valid experiment** in a typical school laboratory to investigate the effect of ethylene concentration on the ripening rate of bananas.

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