S

93101Q

931012

NZQA
NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Scholarship 2016
Biology

2.00 p.m. Thursday 17 November 2016
Time allowed: Three hours
Total marks: 24

QUESTION BOOKLET

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

Write your answers in Answer Booklet 93101A.

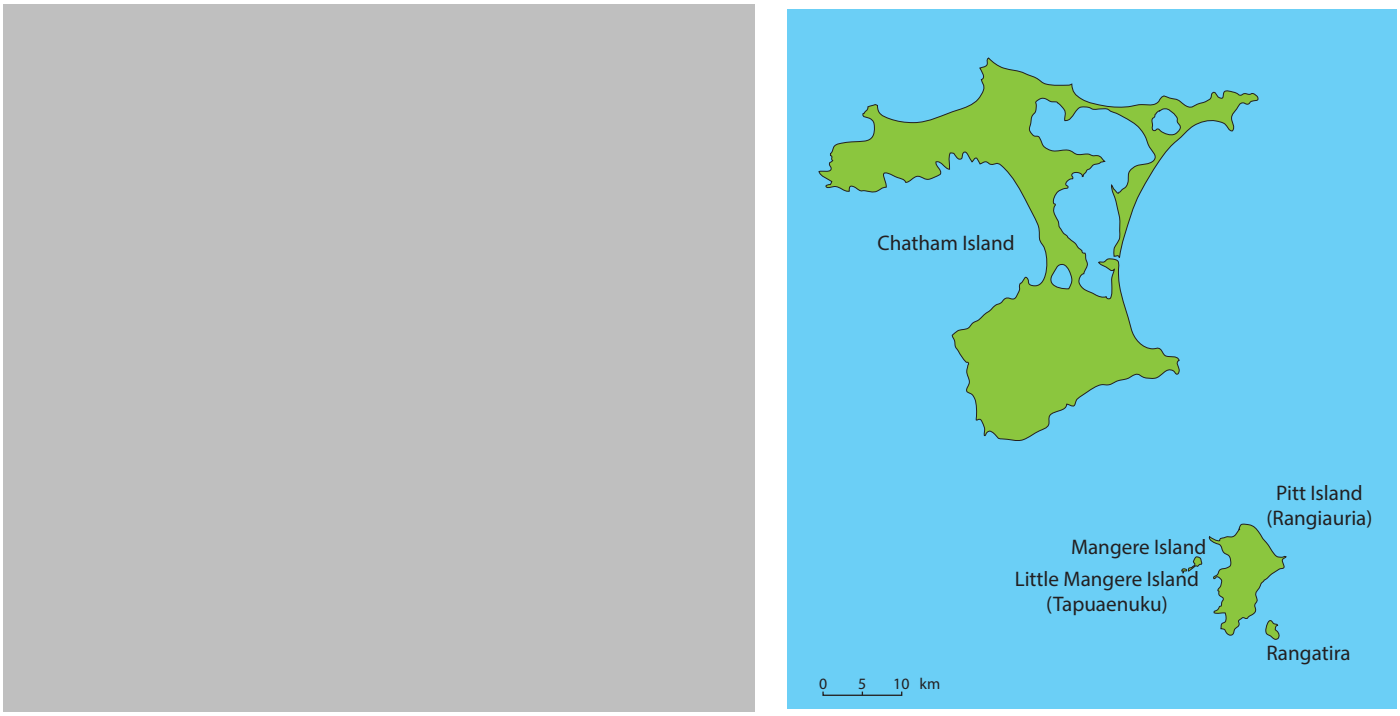
Start your answer to each question on a new page. Carefully number each question.

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.

QUESTION ONE: TOMTITS AND ROBINS

The Chatham Islands are a group of isolated islands 862 km east of Christchurch. The islands are very windswept, are pounded by seas, and experience low temperatures. European discovery of the Chatham Islands was in 1791 by the English ship HMS *Chatham*. European settlement dates from the early 1800s, with sealers and whalers based there, followed by farmers. The land is now predominantly used for farming.



http://www.ezilon.com/maps/oceania/new-zealand-road-maps.html

The tomtit and robin are two closely related native species (*Petroica sp.)* found in the forests of New Zealand. Robins are larger and longer legged than tomtits.

Tomtits are found throughout New Zealand on both the mainland and offshore islands including the Chathams. They utilise a variety of habitats from sea level to the subalpine zone, and can be found in all mature native forest types, as well as occasionally on shrubland and tussock grasslands. They feed on a wide range of small invertebrates, as well as fruit and vegetation. Tomtits search for prey at all levels in the forest on all vegetation surfaces as well as the ground.

When breeding, tomtits may rear up to three broods a year, with clutches consisting of 3 or 4 eggs. Nests are well concealed in thick vegetation or shallow cavities in trees.

Robins are found on mainland New Zealand and the Chatham Islands. They are found only in mature forests and favour a closed canopy with an open understory. Robins spend most of their time on the ground foraging for the invertebrates they eat. Nests are usually in tree cavities at an average height of 1.8 m above the ground. They rear a clutch of 1 – 4 eggs but will double clutch (lay eggs again) if the first clutch doesn't survive.

The Chatham Islands are home to two *Petroica* species found nowhere else in New Zealand – the Chatham Island tomtit (*Petroica macrocephala chathamensis*) and the black robin (*Petroica traversi*). Both birds used to be numerous and widespread throughout the Chatham Islands. However, the Chatham Island tomtit is now classified as nationally endangered, and the black robin as nationally critical (the highest category of extinction risk).

Chatham Island Tomtit

www.nzbirdsonline.org.nz/species/tomtit

Black Robin

www.nzbirdsonline.org.nz/species/black-robin

Today the tomtit population is about 1000 birds and is found only on Rangatira, Mangere Island and Pitt Island. It has become extinct on Chatham Island itself.

By the 1880s, the black robin was believed to be extinct. However, in 1938, 20 – 35 robins were found, confined to the predator-free island of Little Mangere. They had been unable to disperse from there to other islands due to their limited flight capacity compared to other robins. The decline in forest habitat on the island resulted in only 7 robins remaining by 1976. In an attempt to save the black robin, these birds were translocated to Mangere Island. However, by 1979 only 5 robins remained including just one female known as "Old Blue". When Old Blue mated and laid eggs, the researchers removed the eggs and placed them in the nests of warblers, which acted as surrogate parents. This was unsuccessful, and evidence suggests type of food rather than quantity of food was the most common cause of nesting mortality. Tomtits were then tried as surrogates, which was successful. As a result, Old Blue was able to lay up to 4 clutches in a season.

In 1984 it was observed that some black robin eggs were being laid perched precariously on the rim of the nest where they wouldn't be incubated. Researchers would nudge the eggs into the nest to ensure they would survive. Within six years, more than 50% of the females were laying rim eggs. Genetic analysis has discovered the rim-egg laying behaviour results from a dominant allele involved in egg-laying.

Human intervention stopped in 1998 when the population had grown to 200 birds. Since then, the black robin population has grown to be between only 250 and 300 birds, restricted to Mangere Island and Rangatira, where researchers had established a second population. Today, only 9% of females lay rim eggs.

A recent study on the black robins has found birds that:

- have deformed beaks
- are near naked (featherless)
- have chicks with poor bone development in their legs.

Question

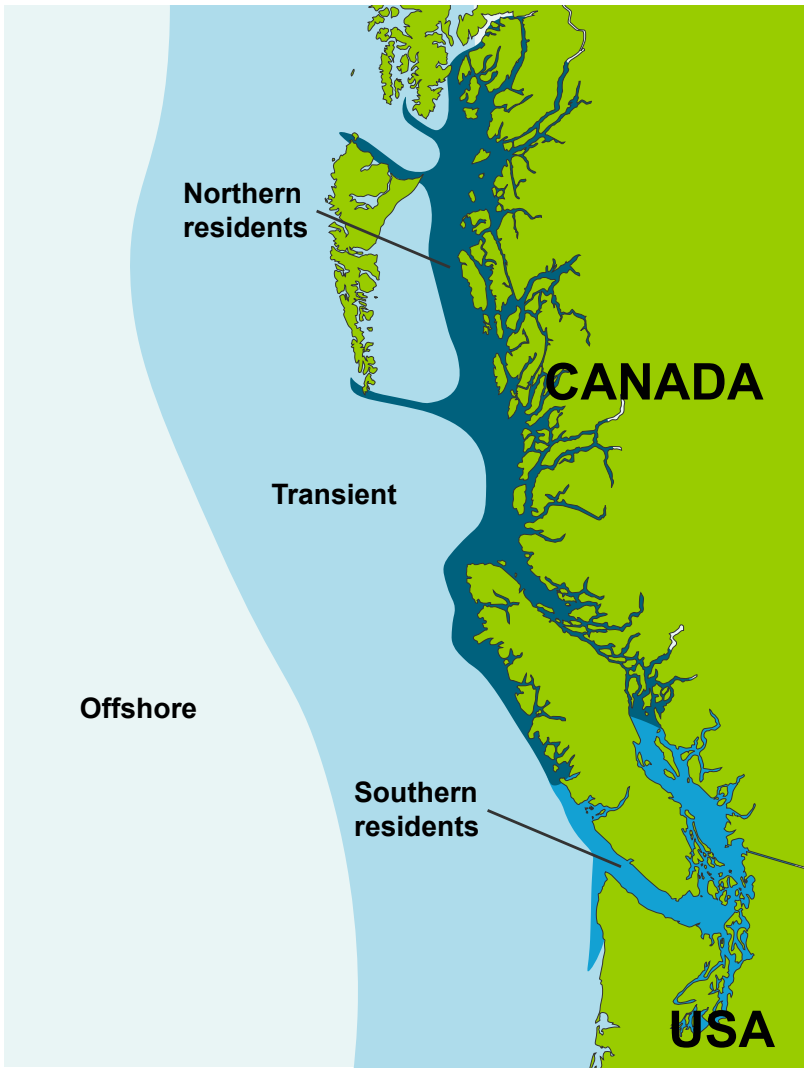
Analyse the information provided in the resource material and integrate it with your biological knowledge to discuss:

- the reasons why the black robin has a higher risk of extinction than the Chatham Island tomtit
- the impact of human intervention on the survival AND evolution of the black robin population.

QUESTION TWO: ORCA

Orca (*Orcinus orca*) are carnivorous marine mammals, the largest member of the dolphin family. Orcas live in social groups and have a matriarchal society. They do not have a definite breeding season, so can breed throughout the year. Males reach sexual maturity between 17 – 20 years and have a life expectancy of up to 60 years. Females reach sexual maturity at 14 years and have a life expectancy of up to 90 years. They typically do not have their first calf until 17 – 18 years and breed only every 4 – 8 years until menopause (similar to humans) is reached in their 40s.

Three distinct populations of orca are found in the seas off the Pacific coast of North America and have been the subject of research for over 30 years. The populations are known as the **resident orca**, the **transient orca** and the **offshore orca**. Resident orcas are divided into the **northern residents** and the **southern residents**.



Resident orca eating a chinook salmon.
www.http://wildwhales.org/killer-whale

The three populations of orca dsiplay significant differences in their range, diet, behaviour, and social systems.

Offshore orcas are wide ranging, preying on large fish including sharks. They occur in groups of 30 – 70, but at present nothing is known of their social structure. They have a distinct language, but little detail is known of their vocalisations.

Resident orcas hunt by echolocation, preying exclusively on fish, mainly on migratory salmon, with the Chinook salmon making up nearly 80% of their diet. They have a highly structured social organisation, with individuals travelling throughout their lives in matrilines, comprising a matriarch and all her

offspring; up to five generations have been known to be present. The matriarch is often a post-menopausal female who is more likely to lead the pod when food is in short supply. Matrilines may associate to form pods. Pods may associate to form clans of up to 30 individuals. Resident orcas are highly social and very vocal, sharing up to 17 different calls. Male orcas always mate with females from other matrilines.

During the research period, the northern and southern residents have never been found in the same area at the same time.

Transient orcas prey on other marine mammals such as seals, dolphins, and small whales, which they hunt by stealth as echolocation would be detected by their prey. They are found typically in groups of 2 – 6 individuals. They are not very vocal with only 4 – 6 different calls identified. Like the resident orca, they also have a matriline social structure, but the offspring are likely to leave the group when mature. Some males roam, joining temporarily with groups that have reproductive females.

The orca populations can be distinguished by the shape of their dorsal fins and the colour and shape of their saddle patch.

Offshore Orca	**Resident Orca**	**Transient Orca**
		
Dorsal fin is continuously rounded over the tip and lacks a sharp angle at rear corner. Saddle patch is either solid grey or open.	Dorsal fin has a rounded tip with a sharper angle at the rear corner. Saddle patch is open.	Dorsal fin is pointed. Saddle patch is large and uniformly grey.

www.orcanetwork.org/nathist/offshores.html

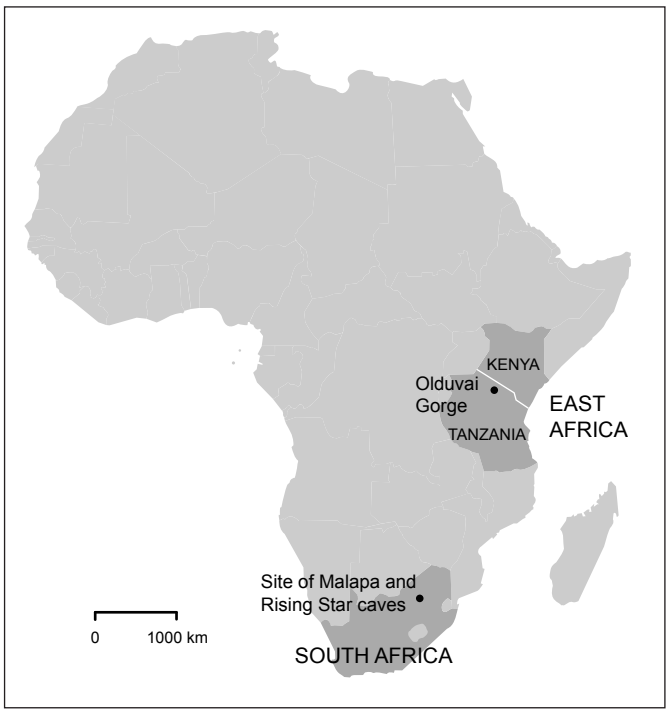
The three populations are not known to interbreed. mtDNA evidence suggests that the transient orca became reproductively isolated about 700 000 years ago, while the residents and offshore orca separated about 150 000 years ago. All of the orca populations are small, as a result of widespread whaling last century. The northern residents number about 200; southern residents about 90; transients about 250; and offshore orca about 250.

Question

Analyse the information provided in the resource material, and integrate it with your biological knowledge to:

- discuss the evolutionary AND ecological processes that may have resulted in the distinct ecological niches of the **resident** and **transient** orca
- analyse the data to discuss what may occur in the future evolution of the three populations of orca; include your justified opinion on this.

QUESTION THREE: *Homo naledi*



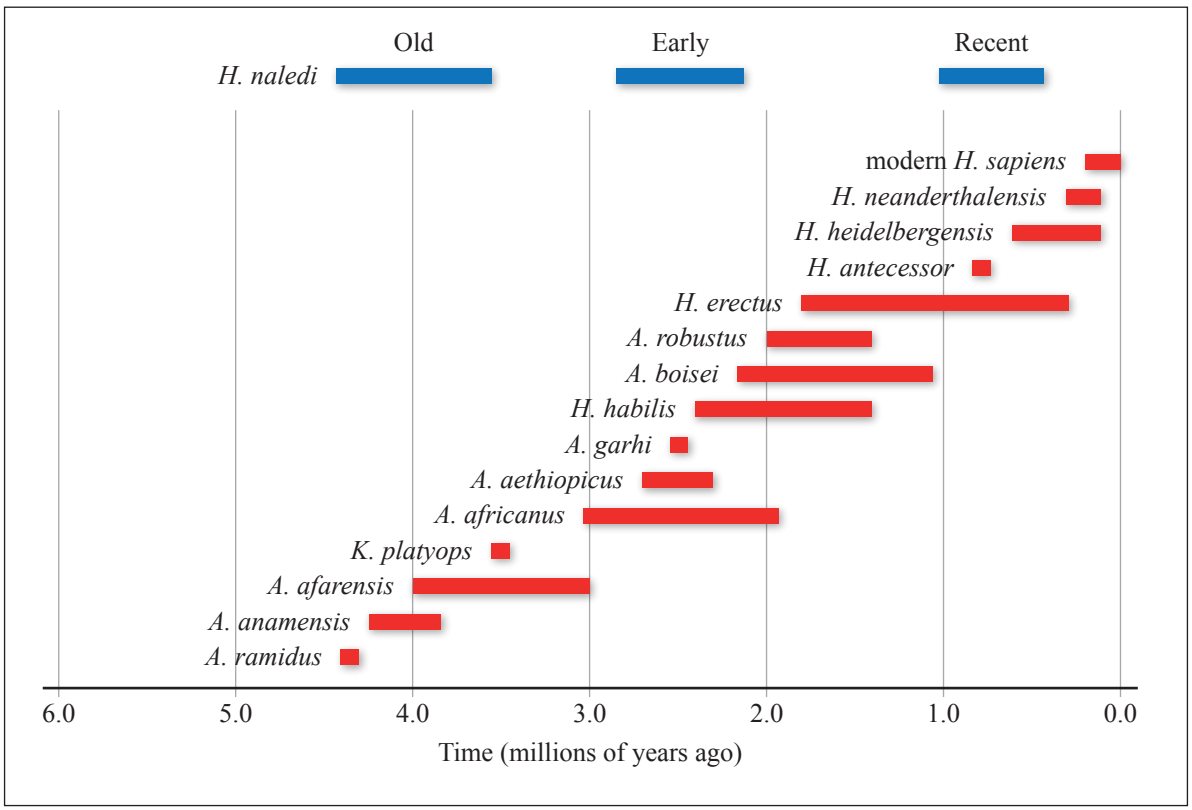
The first hominin fossils found in Africa were discovered in South Africa in the 1920s and named *Australopithecus africanus*. Subsequently almost all hominin fossils in Africa have been found in locations in East Africa, including all of the fossils belonging to the genus *Homo*. However, in 2008 hominin fossils were found in the Malapa cave in South Africa. Analysis of these fossils found they displayed a mosaic of primitive features and features characteristic of advanced humans; for example, both hands and feet displayed adaptations for tree climbing as well as adaptations associated with bipedalism. The hominin from Malapa was named *Australopithecus sediba* in 2010, and the fossils dated to about 2 mya.

In 2013, over 1500 hominin bones were found in a deep chamber of the Rising Star cave in South Africa. There were no marks on the bones, and nothing else was found with them – no rubble, no other animal bones. Researchers concluded that the bones were from bodies deliberately placed in the cave. As with *A. sediba*, analysis of the bones and reconstructed skeletons identified an interesting mosaic of both primitive features and those characteristic of modern humans. The species was named *Homo naledi.*

A composite skeleton reveals *H. naledi*'s overall body plan. Its shoulders, hips and torso are similar to earlier hominins, while its lower body shows more human-like adaptations. The skull and teeth show a mix of traits. They were around 150 cm tall.

http://news.nationalgeographic.com/2015/09/150910-human-evolution-change/

Unlike *A. sediba,* **it has not been possible to date these bones**. This means that it is difficult to decide where *H. naledi* is to be positioned in the hominin lineage. The time line below indicates the possible positioning of *H. naledi* dependent on whether the fossils have origins that are: Recent (< 1 mya); Early (2 – 3 mya); or Old (> 3 mya).



Adapted from: http://darwiniana.org/wisetime.gif

The first stone tools found were linked with *H. habilis* – brain size 610 cm^3 – and dated to about 2 mya. In recent years, researchers have found evidence of stone tool use with earlier hominins including:

- *A. garhi* (2.6 mya, brain size 450 cm^3) – simple tools have been found alongside fossil remains.
- *A. africanus* (2.8 – 2.0 mya, brain size 420 – 500 cm^3) – shape of soft bone tissue in the hand indicates stone tool use.
- *Australopithecus* or *Kenyanthropus platyops* (3.3 mya, brain size 430 cm^3) – stone tools at Lomekwi in Kenya.
- *A. afarensis* (3.4 mya, brain size 380 – 430 cm^3) – bones of animals found with these fossils have marks indicative of tool use.

No stone tools have been found or associated with either *A. sediba* (brain size 420 cm^3) or *H. naledi* (brain size 450 – 550 cm^3).

Question

Analyse the **fossil and stone tool evidence together with their location** provided in the resource material, and integrate it with your biological knowledge to:

- give your justified opinion on whether *naledi* should be placed in the genus *Homo* or *Australopithecus*
- evaluate the possible positions (old, early, recent) of *H. naledi* in the hominin lineage, AND the implications of each position for the evolution of modern humans.