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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 3 Biology 2024

91603 Demonstrate understanding of the responses of plants and animals to their external environment

Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of the responses of plants and animals to their external environment.	Demonstrate in-depth understanding of the responses of plants and animals to their external environment.	Demonstrate comprehensive understanding of the responses of plants and animals to their external environment.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–16 in the correct order and that none of these pages is blank.

Do not write in the margins (////). This area will be cut off when the booklet is marked.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Achievement

TOTAL 10

QUESTION ONE: Relationships in the forest

Kauri snails/pūpū-rangi (*Paryphanta spp.*) belong to the group of northern giant land snails, which evolved in New Zealand before the introduction of the nocturnal predator species: possums and hedgehogs. The snails live in areas of fertile soil, rich with earthworms, and may live to 20 years or more. The snails are most active at night. They usually spend the day under leaf litter or vegetation.

Faecal analysis shows their diet is mainly earthworms and some small snails, with the small snails' shells being a source of dietary calcium.

Snail mating occurs mostly between April and July, and appears to be triggered by climatic conditions, such as rainfall. The kauri snail lays about six eggs, three times a year. The eggs are protected by a hole dug by the snails or under leaf litter at the base of a tree.

Like the kauri snails, hedgehogs (*Erinaceus europaeus*) are also active at night; however, in cold areas they can hibernate for a few months per year if the ground temperature is below 11 degrees Celsius. Their diet includes kauri snails.

Nocturnal brushtail possums (*Trichosurus vulpecula*) also eat kauri snails and, from a position in trees, they can spot the large invertebrate as it slowly moves along.

Adult pūpū-rangi.

Pūpū-rangi shell.

A hedgehog eating a snail.

Brushtail possum.

Evaluate reasons for the coexistence and survival of these species in Northland.

In your answer, include discussion of:

- the relationships between the kauri snail and the possum, AND between the possum and hedgehog
- an advantage and a disadvantage of being active at night for the kauri snail
- how each of the behaviours of these animals support survival, such as frequency of egg laying three times a year for the kauri snail, hibernation for the hedgehog, and nocturnal behaviour for the possum.

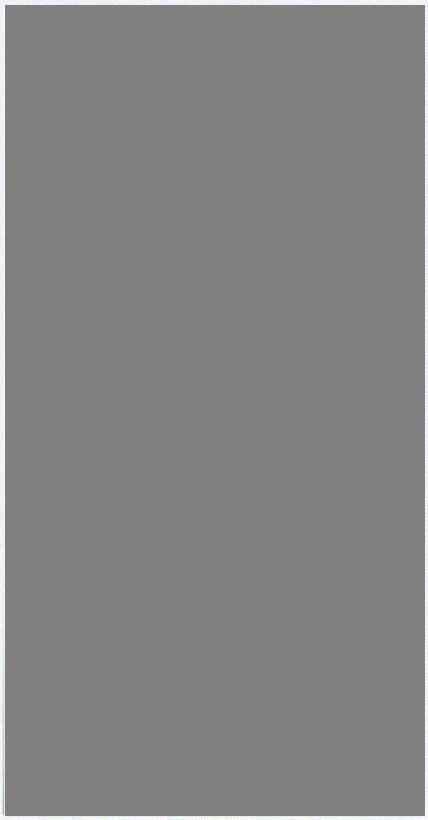
The relationship between the kauri snails and their predator species possum and Hedgehogs is an intraspecific relationship meaning they are not the same species. This is a prey / predator relationship because the possum and hedgehogs eat kauri snails. The relationship between the hedgehog and possum is competitive as they are both competing for resources (food) to ensure survival. A disadvantage for the kauri snail to be active at night is that its predator species, the possum and hedgehogs, are both also nocturnal, this ~~increases~~ decreases the snails ~~risk~~ chance of survival and is in result advantages for the predators. An advantage for the snail being active primarily at night is that snails are very sensitive to light, this is why during the day, the snails will hide under vegetation or leaf litter. During the night hours snails can use the darkness to their advantage and avoid desication. During the night the soil will be less dry making it easier to locate a food source in fertile and rich soil, and avoiding drying up in the sun as snails ~~a~~

display negative phototaxis and move away from light. This increases survival as they can easily move around avoiding light and can locate food. The kauri snails are R-strategist because they lay a large umount of eggs with very little to no care of offspring. Snails will lay 6 eggs around three times a year in a safe space but will not show any further support to the survival of that offspring. R-strategy is advantages for the snail, primarily because of the passing on of genes and contributing to the population of snails, promoting genetic diversity, all together positively contributing to the survival of the kauri snail species. The hibernation of ~~snails~~ hedgehogs to their species is advantageous because they are able to sleep through the colder climate times of the year where food sources are sparse increasing survival. The hedgehogs hibernating is also advantages for the possums because during this time they will not have to compete for food during a climate where food is already dwindling. This is also good for snails in conserving energy. Nocturnal behaviour for the ~~hedgehog~~ possum is advantages to the survival of the possum because its prey is primarily active at night and its level of energy will be higher in the dark compared to the heat, increasing survival.

QUESTION TWO: Bumblebees and kōwhai

The kōwhai (*Sophora spp.*) is a New Zealand native tree. The brightly coloured flowers bloom in late winter or early spring. Auxins are essential at each stage in the life cycle, including root development, growth, and flowering. Once the plant flowers, pollination occurs via animals such as the bumblebee (*Bombus terrestris*).

In New Zealand, the bumblebee forages for food during daylight hours, but is more active in the cooler times of the day. Bumblebees also live in the Arctic. During the Arctic summer, there is constant 24-hour daylight. An experiment was conducted in the Arctic to observe the foraging behaviour of a bumblebee colony under constant light conditions. Results for two bumblebees are shown in Figure 1 below.



A bumblebee foraging in kōwhai blossom.

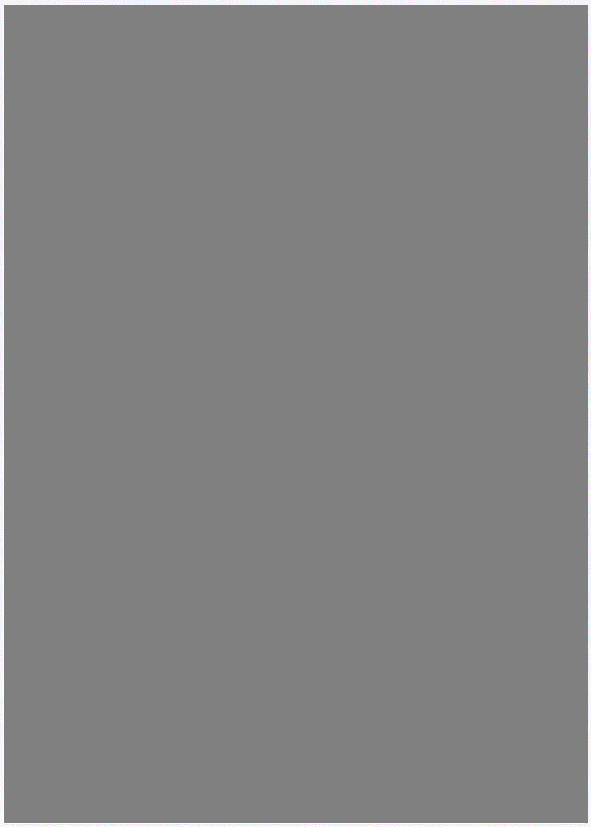


Figure 1: Double-plotted actograms showing foraging times of two individual worker bees from a colony under constant light conditions.

Discuss how the control of life processes through biological clocks results in kōwhai success.

In your answer, include discussion of:

- whether the kōwhai is a long-day plant or a short-day plant, including evidence
- the mechanism for the geotropic response of the kōwhai shoots
- the type of movement response of the bumblebee to the kōwhai nectar
- whether the New Zealand bumblebee and the kōwhai have biological clocks that are entrained to environmental factors.

Kōwhai are a short day plant because it flowers during late winter and sumener where the days are typically shorter. Auxin is a plant hormone that promotes cell elongation. When the kowhai grows upwards this is a display of negative geotropism, where it moves away and up from the soil. This is also when we can see Auxin implementing positive phototropism, as the auxin moves to the shaded side of the plant, promoting it to grow up and towards the light. During this time auxin will promote positive geotropism, this is where the roots grow down into the ground to absorb nutrients from the soil. The bumblebee display a positive chemotaxic response to the kowhai, this is a positive directional movement to a stimulus. The bumblee are ultimately drawn to the kowhai nectar to forage for food increasing survival for the bees and pollunating the kowhai flowers during daylight hours. The kowhai does display a biological clock entrained by environmental factors. this is displayed in its flowering time as it flowers at a specific time of year. The bumble bees also display that they follow a biological clock entrained by environmental factors. as they forage in daylight hours and are more active in the cooler parts of daylight hours. More specifically between est 6am and 8pm.

QUESTION THREE: Cooperative breeding

Australian chestnut-crowned babblers (*Pomatostomus ruficeps*) are known for their social behaviour. They live in groups of up to approximately 25 individuals and participate in activities such as dust bathing, preening, and feeding. Together, they look for food, including insects, spiders, small amphibians, crustaceans, and reptiles, as well as fruit and seeds from plants.

At night, they crowd together in one large, central nest and, when alarmed, they may huddle together under dense foliage or fly up into the under-canopy of trees and shrubs, chattering noisily.

Breeding usually occurs between July and November with a single, large clutch of eggs (i.e. many eggs) from all the breeding pairs.

The entire group helps to build the one nest, feed the incubating females, and defend the breeding territory. Reproduction without support is rarely attempted. Researchers confirm there are often about 4 breeding males but up to 12 non-breeding, helper-males. Kin selection appears to be important, as females will not support the care and development of young with which they have no genetic relationship.

Adult babbler.

A babbler with an insect it has caught.

Babblers are social in their behaviour.

A babbler coming off its nest.

Examine how social behaviour can lead to successful reproduction.

In your answer, include discussion of:

- the terms territory and kin selection, including definitions
- an advantage of a group being involved in finding food together and of preening each other
- why the larger number of helper-males supports the population, and why the non-related females do not support the care and development of the young.

The Austrailian chestnut crowned babblers are a social group which stay together in a claimed territory. A a territory is a place they actively defend and is where breeding, nesting, and the majority of their feeding will take place. with defense from predators. During reproduction the species are k-strategists, prioritising care ~~fore~~ for their offspring. This means that even though the may have less offspring, they will have increased chance of survival. Kin selection, where parental figures choose to have responsibility / care for is important for the females. Having breeding pairs aswell as helper males supports the population as it means less energy will be spent supporting the young and responsibility can instead be shared. This increases opportunity for food and care as well as resources and general survival for the species. Having shared care also means the birds will do activities like preening and foraging for food together. This is advantages as it increases area they can cover and decreases the amount of energy used, the animals can then put this energy towards further survival such as escaping predators, defending territory, and caring for young. This energy is also saved for at night when they display defense mechanisms by nuddling together and making noises. Because female Austrailian chestnut-crowned babblers have multiple ~~your~~ young they only provide care to

their own young they have passed their genes on to. This is to save energy for the mother as they have a maternal / paternal protective response and are supported by the male helpers. Increasing survival of their offspring. Females who have not bred that season will not show support to knew young as will look for a partner to breed with following season, where they will care for their own young, staying strong, healthy, and keeping energy to support reproduction.

Achievement

Subject: Biology

Standard: 91603

Total score: 10

Q	Grade score	Marker commentary
One	A4	This response demonstrates understanding of a range of descriptive terms and the advantages and disadvantages, as well as the synchronicity of the possum with the activity of its prey.
Two	A3	The candidate has identified the plant as a short-day plant and describes the basic action of auxin and the advantage of positive chemotaxis.
Three	A3	This response demonstrates understanding of territory and the advantage of holding one, as well as the advantage of social behaviour in these birds.