3

EXEMPLAR

90717

907170

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

For Supervisor's use only

Level 3 Biology, 2007

90717 Describe processes and patterns of evolution

Credits: Three
9.30 am Tuesday 27 November 2007

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 answer ALL the questions in this booklet.

If you need more space for any answer, use the page(s) provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–10 in the correct order and that none of these pages is blank.

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

For Assessor's use only	Achievement Criteria	
Achievement	**Achievement with Merit**	**Achievement with Excellence**
Describe processes and patterns of evolution. ✓	Describe processes and explain patterns of evolution. –	Describe processes and discuss patterns of evolution. –
Overall Level of Performance	A	

You are advised to spend 40 minutes answering the questions in this booklet.

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QUESTION ONE: PATTERNS OF EVOLUTION

Nectar bats feed on the nectar from flowers. One species of nectar bat, *Anoura fistulata*, can extend its tongue more than 80 mm (see below). This is more than twice the tongue length in other species of nectar bat.

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The nectar bat *Anoura fistulata*, extending its tongue.

After N. Muchala (2006) Nectar bat stows huge tongue in its ribcage *Nature* 444: 701–702

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Anoura fistulata feeding.

http://www.newscientist.com/data/images/ns/cms/dn10721/dn10721-2_742.jpg

(a) Name and describe the **pattern of evolution** shown by the relationship between this nectar bat and its food plant.

Mutualism. Both are benefited as the bat can feed and the flower gets its polin spread or it fertilised.

N

(b) Explain the role of **natural selection** in the evolution of the features shown by the bat and its food plant.

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Natural selection is the process in which the environmental pressures cause organisms to die due to lack of adaptation or tollerence to these factors. This bat species would have begun to adapt to the shape of the flowers when other food was harder to access or not available. Natural selection would have favoured these bats as they would have been healthier and spent less time and energy looking for food like bats with short tongues would have had to. Eventually the bats with long tongues would breed together and the species would grow. As this occured, natural selection would continue to get rid of the short tonge bats. The evolution of the long tonge bats would increase and, helped by natural selection, would domnate over those with small tongues.

A

selection for long-tongued bat

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There are many endemic species of cockroach (genus *Celatoblatta*) in the South Island (below), which have undergone adaptive radiation over the last 6 million years. During this time, the region was first warm and wet, and then heavily glaciated during the last ice age (see diagram bottom of this page).

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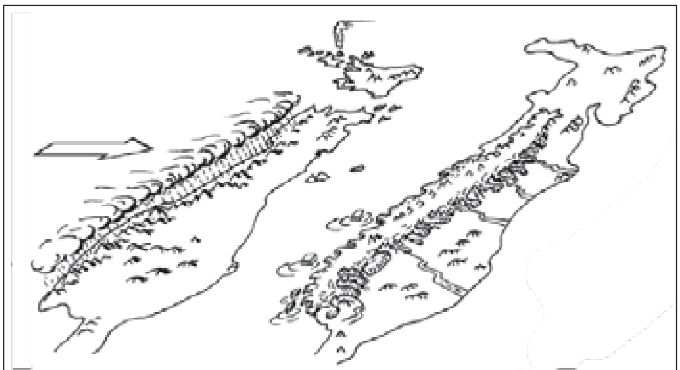
Phylogenetic tree for South Island cockroaches (*Celatoblatta* spp.)
W. Chin & N. Gemmell (2004) *Molecular Ecology* 13:1507–1518



Pliocene (6–2 mya): west coast wet, east dry

Pleistocene (1.8–0.1 mya): extensive glaciation

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Locations of *Celatoblatta* species in the South Island
adapted from W. Chin & N. Gemmell (2004) *Molecular Ecology* 13:1507–1518

(c) Discuss how **geological history** has affected the adaptive radiation and distribution of *Celatoblatta* species in the South Island.

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Adaptive radiation is a form of divergent evolution where many species form from one common ancestor. This has occured with the cockroach. 6-2 million years ago, many species evolved in Mckenzie and the Eastern South island. These cockroaches would have been subjected to different environmental pressures due to climatic and geographical factors, the east being very dry and Mckenzie in mountains and slightly wetter. The glaciation brought about new species to the south in the central area. These new environmental pressures and geological isolation would have affected the adaptive radiation and increased evolution to form more new species adapted to different, colder conditions.

adaptive radiation defined

impact of geological change explains speciation

M

(d) The phylogenetic tree suggests that there are two distinct populations of *C. montana* on Mt Taylor (in the Central region).

Explain the significance of these two populations.

These two populations evolved during the ice age or glaciation period. Because they were up on Mt Taylor, they would have experienced much different and colder selection pressures and would have been isolated from other species by the mountain.

no significance explained

N

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QUESTION TWO: PROCESSES OF EVOLUTION

Plants in the genus *Libertia* are found throughout New Zealand, Australia, and South America. The table below shows the chromosome numbers for several of these species.

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en.wikipedia.org/wiki/Libertia

Chromosome number for different *Libertia* species.

Location	*Libertia* species	Diploid chromosome number
New Zealand	*L. puchella*	38
	L. grandiflora	114
	L. peregrinans (except from inland Nelson)	114
	L. peregrinans (inland Nelson)	171
	Artificial hybrids between *ixioides* and *grandiflora*	171
	L. ixioides	228
Australia	*L. puchella* (Tasmania)	38
	L. paniculata	76
South America	*L. caerulescens*	38
	L. formosa (Chile)	76

D. J. Blanchon, B. G. Murray, & J. E. Braggins (2000) Chromosome numbers in the genus *Libertia* (Iridaceae). *NZ J. Bot.* 38: 245–250

(a) Use the information from the table to describe how these different *Libertia* species have evolved.

These species have evolved rapidly by (pollyploidy) a form of sympatric speciation.

A

The diploid number of chromosomes in ancestral *Libertia* is 38.

"how" polyploidy happens is explained

(b) Explain how *L. paniculata* (2n = 76) could have evolved from *L. puchella*.

The L. paniculata could have been a product of auto-pollyploidy where two plants of the same species did not carry out meiosis correctly ~~and~~ (non-disjunction occured) and a sterile hybrid formed. if this hybrid then self fertilised then the L. paniculata could have bread and evolved into a new species

M

L. peregrinans, from **inland Nelson**, has a different chromosome number, and is different in appearance, from other populations of this species.

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(c) Explain how this inland Nelson population could have evolved, AND give evidence from the table on the opposite page to support your answer.

L. pereginans could have evolved from others of its species that were not in inland Nelson. This could occur as a result of allopatric speciation where inland nelson was subjected to different environmental pressures and geographical isolation, forming a new species.

N

Note that Question Two continues on the next page.

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African indigobirds lay their eggs in the nests of various species of finch. Indigobirds are very selective in host choice. There are many species of finch in the area, but each indigobird species has a particular finch host. Indigobird nestlings are reared with the host young and learn their songs. Adult male indigobirds mimic the song of their host species. Adult females use these songs to choose breeding partners and also to choose the nests in which the females lay their eggs.

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Taxonomic relationships of indigobirds and their estrilid finch hosts.

Sorenson *et al.* (2003) Speciation by host switch in brood parasitic indigobirds. *Nature* **424**: 928–931

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ww.bu.edu/research/ graphics/spotlight/bird.jpg

(d) Explain how the data in the above diagram support the statement that "*indigobird evolution shows adaptive radiation and punctuated equilibrium*".

The indigobird evolution shows punctuated equilibrium because it occurs over a period of time where there are periods of no change ~~and~~ and periods of rapid change, as shown above. It also supports adaptive radiation because many (11) species have evolved to suit different environmental factors or different host birds species, and all came from one common ancestor.

no reference to data

A

(e) Indigobird speciation appears to be sympatric.

Discuss how new indigobird species could evolve. You should include the role of song and other isolating mechanisms in your answer.

Sympatric speiation occurs when species not isolated by any geographical boundaries evolve into two or more new species. This has occured in the indigobird due to behavioural and ecological factors. Each indigobird species in the area (same area) has a particular finch species to which it uses as a host to lay eggs. They use mating songs to choose which host to use and when the young are born they learn the host song. This suggests that when they are adult they only choose a finch species to which song they were subjected to as young and therefore keep one species of indigo for each finch species. Isolation could also continue by mating songs used by adult indigobirds (one which was learnt as young) and the females may only choose to mate with those birds who have the same song. Again this would further isolate the indigobird species from each other.

Assessor's use only

sympatry defined

role of song explained

new species formed

M