EXEMPLAR

90717

907170

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

3

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	M	

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.

named

Co-evolution ~~because they have developed~~ where the evolution of one species influences the evolution of another.

described

A

(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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~~[illegible]~~

variation

The original bat population had tongues of varying length. Bats that had short tongues would not be able to exploit the flower as a food source and would either die or have to move to a ~~[illegible]~~ different niche. This would reduce the contribution they made to the next generation of bats and so the allele frequency for short tongued bats would decrease. That bats with longer tongues could utilise the food source and would thrive reproductively. This means that they would contribute more to future generations and the allele frequency for long tongues would increase. Eventually it would increase to a point where all bats that feed on this flower have long tongues.

passing trait on

A

- natural selection defined
- advantages for <u>bat</u> only given

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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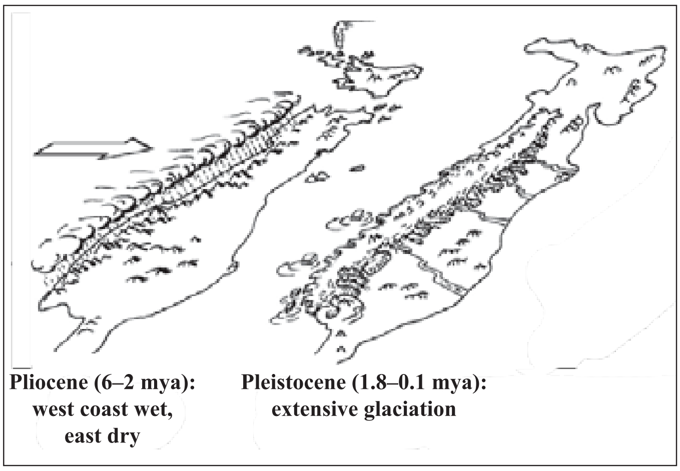
Phylogenetic tree for South Island cockroaches (*Celatoblatta* spp.)

W. Chin & N. Gemmell (2004) *Molecular Ecology* 13:1507–1518



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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.

on back

Assessor's use only

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 will display different adaptations/features because of the different selection pressures they have been subjected to. ~~This may~~ They may show the effects of a cline. Gene flow between these two populations will not occur as a result of specific isolation mechanisms. The difference in these two populations show that there is sufficient ~~vary~~ variation in selection pressures on Mt Taylor to warrant the need for separate species.

reduced gene flow

does not negate

imminent speciation implied

A

QUESTION TWO: PROCESSES OF EVOLUTION

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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.

Through polyploidy.

A

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

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

~~During meiosis non disjunction may have occurred in one of the~~ Most likely through amphiploidy i.e. the newly fertilised zygote failed to separate properly in mitosis. resulting in a tree with twice the diploid no. of chromosomes (4N)

"how" = amphiploidy defined

result = 4N

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.

Non disjunction in meiosis could have resulted in the L peregrinans being formed by a sperm or egg that contained a full set (2N) of chromosomes. This is supported by the table because if one gamete had half the no. of chromosome (57) while the other had the full no. of chromosomes (114) the zygote formed would have 171 chromosomes. The L peregrinans would then have to self fertilise.

M

candidate explains the series of events leading to 2N = 171

Note that Question Two continues on the next page.

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

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

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

The evolution shows adaptive radiation because it shows many ~~[illegible]~~ species of bird evolving from the same common ancestor. This is an exampl of punctuated equilibrium because there is a long period of stability followed by a quick evolutionary burst.

defined, but does not explain the data

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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.

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The population of indigo birds may have been geographically isolated through the formation of a land mass or some other geological change. The different populations would then have been subjected to different selection pressures, and because no gene flow could occur due to the geographic isolation new species would form. The geographic barrier may have then disappeared which would allow the new species of bird to occupy the same area once again. Alternatively some of the indigo birds may have had genes that made them rely on a different food source (habitat isolation) this eventually would have resulted in the formation of new species. The species are sympatric because they still occupy the same area. They are reproductively isolated because they are unable to recognize the different calls and so mating may not occur. This is a prezygotic isolating mechanism.

M

sympatry defined – role of song explained

Extra paper for continuation of answers if required.
Clearly number the question.

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Question number

1 c) The difference in climate between the west and east coast would have provided different niches for the cockroach to occupy. When the cockroach found these new niches it would have faced a no. of different selection pressures and would have evolved into different species accordingly. The prevailing winds from the west may have been a factor in distributing the cockroaches. This accounts for the adaptive radiation between 6-2 mya. When the glaciation occurred at 1.8 mya the climate would have changed drastically resulting in many new niches being formed. The cockroach would once again have radiated out to occupy these new niches and would have evolved under the selection pressures of each one. The high winds that would accompany an ice age may have helped to distribute the cockroaches. This shows why there is an evolutionary burst at ~~the~~ 1.8 mya

geological event