EXEMPLAR

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NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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 E		

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.

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

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

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.

candidate names and describes

Coevolution. One species developing adaptations as a result of selection pressures caused by another species' adaptations.

A

anything biologically correct is acceptable

(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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variation within the species

~~The~~ those nectar bats ~~that had~~ ~~had~~ had longer tongues long enough to reach the nectar in the long flowers have better reproductive success those bats have better access to resources and so can produce more offspring that hold their genes for long tongues. The food plant has developed an extremely long flower to deter other organisms from feeding on its nectar. This is an example of coevolution. Those plants with longer flowers have better reproductive success as other organisms cannot take their nectar. As a result, ~~but~~ those bats with longer tongues have better reproductive success as they are able to reach the nectar provided by the food plant.

pass trait on

advantage of long tongue

advantage to plant

M

candidate uses correct key words to define natural selection, and explains benefits to both the bat and the food plant

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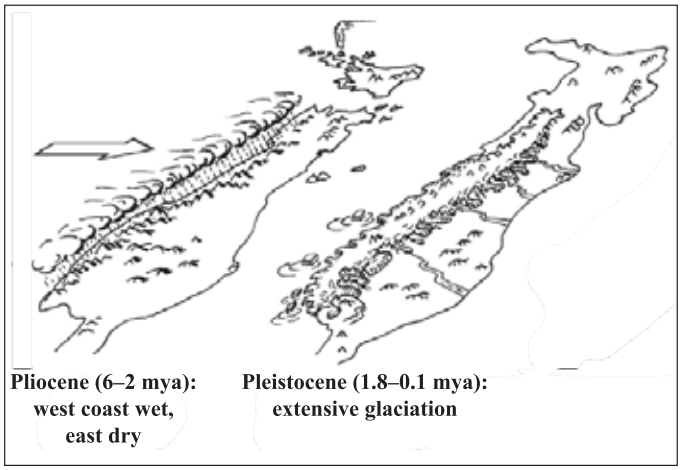
Phylogenetic tree for South Island cockroaches (*Celatoblatta* spp.)
W. Chin & N. Gemmell (2004) *Molecular Ecology* 13:1507–1518



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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.

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impact of geological change explained

Geological changes in the cockroaches environment have resulted in new niches becoming available, different selection pressures. During the 6 - 2mya (Pleiane) period, the cockroach population has been separated by geographical boundaries caused by uplift of the southern alps. This caused speciation of the cockroaches, resulting in the current distribution of the Celatoblatta species as they are geographically isolated. Because of this isolation, the gene pools have become isolated and the cockroaches have moved to fill many different available niches. Adaptive radiation has occured as multiple species have derived from a common ancestor through filling of different ecological niches. New niches has resulted in different selection pressures & new species developing.

adaptive radiation defined

resultant situation as seen today

E

(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 are sympatric, different but related species living in the same area. These populations may have arisen allopatrically, and then late moved the the same geographical area, or they may have each filled different microniches in the same area, developing different adaptive features until they became separate species

candidate is expected to understand that the two populations are the same species

N

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.

recognises doubling of chromosome

These different Libertia species have evolved through instant speciation, or Polyploidy through ~~destroy~~ many multiple chromosome sets

shared evidence – polyploidy or doubling of chromosomes may be found in parts (a) or (b)

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

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

2n two L. puchella species may have given rise to a daughter with 4n chromosome number by either non disjunction at meiosis for both parents forming a 4n gamete, or a doubling of chromosomes at a very early mitotic cell division, resulting in a 4n individual (L. paniculata) that is a different species.

how this happens

L. paniculata described

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. pergrinans may have arisen from autopolyploidy, ~~allopolyploidy~~, with 3 sets of chromosomes. May have come from L. peregrinans ~~hybrid born from two different species~~ (not from inland Nelson) where non disjunction at meiosis occured, forming a triploid individual. Half the no of chromosomes in other L. pergrinans = 57. 57 x 3 = 171. This is a triploid individual

M

a series of polyploidy events is recognised as being the origin of this species

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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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

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*".

Punctuated equilibrium is a rate of equilibrium in which there is long periods of evolutionary inactivity followed by short rapid bursts of evolutionary activity. The diagram supports this as from 20-2 mya there was little activity and a lot from 2 Mya. The data shows adaptive radiation as many species have evolved ~~to~~ from a common ancestor to fill many different niches.

both punctuated equilibrium AND adaptive radiation are defined, using evidence from the resource material

M

(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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sympatry defined

Sympatric speciation is when a new species develops in the same geographical area. When indigobird nestlings grow up they learn the host bird's songs. This is a barrier that acts as a pre zygotic isolating mechanism that helps to develop new species of indigobird. Those birds that were raised in the same species of Finch's nest are likely to choose others raised with that species as mates. This is because they recognise the song (a learned ability) as their own species. Those that mate hetero- will lay their eggs in the same Finch species that they were raised with. This results in isolation within the indigobird species as they have different behaviour + songs depending on their finch host species, and this separates the species' reproductively. The indigobird may behave differently, depending on the Finch species that they were raised with. This acts as another isolating (cont)

M

we are looking for a new species formed

song recognised as prezygotic reproductive isolating mechanism

E is earned when the candidate recognises that the laying of indigobird eggs in a new finch host nest will initiate a new species

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

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Question number

Iwife) mechanism that prevents the individuals from reproducing with those in a seperate species. Eventually these species will fill different niches, and may develop different morphological features. This will result in hybrid pre zygotic isolation. //