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SCHOLARSHIP EXEMPLAR

NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Scholarship 2015
Biology

9.30 a.m. Tuesday 10 November 2015
Time allowed: Three hours
Total marks: 24

ANSWER BOOKLET

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

Write your answers in this booklet.

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

Check that this booklet has pages 2–26 in the correct order. Pages 2–4 are blank and are to be used for planning. Pages 5–26 are lined pages for writing your answers.

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

PLANNING

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Question one: Moa a Goer?

* Evolutionary, ecological factors → extinction & inc. in rate of extinction, named examples.

→ habitat destruction
→ competition
→ food source
→ pollution
→ farming & infastructure
→ disease.
→ poisons, pesticides. etc.
→ hunting.

* moa DNA → restore How?, biological implications.

→ somatic cell nuclear transfer.
→ gene technology.
Restriction enzymes, plasmids etc.
→ surrogate mothers.

→ impact on ecosystem/food chains.
→ protection/captive breeding./conservation.
→ monitor.
→ IVf for future generations/artificial insemination.
→ limited food source, predation
→ close to towns.

PLANNING

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Question two: Human dispersal

* Presence & distribution of rare EPAS1 in modern human populations.

→ interbreeding between pop. present.
→ rare EPAS1 ⇒ Tibetans & Han chinese.
→ mongolians & Nepalese sherpas.

→ Tibetans at 4000m altitude.
40% less O_2 87% rare EPAS1

9% Han chinese → lowland china.

Denisovans → Altai ⇒ extinct.

PLANNING

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Question three: Hawaiian Honeycreepers.

* Distribution & diversity (evolutionary processes)

→ Divergent evolution of common ancestor from Asia. 5 mya.

→ adaptive radiation of lather creeper species.

⇒ Islands Kauai → O'ahu → Maui → Hawaii.

⇒ allopatric speciation
→ new available niches.

8 → Maui
7 → Hawaii.
4 → O'ahu.
6 → Kaua'i.
Nihoa → Nihoa Island. (1)
Laysan → Layson Island (1)

phenotypic diversity → colour, size & shape beak.

56 species → 18 species present NOW
+1.

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Question one: Moa a Goer?

The decline in population numbers of species worldwide has resulted in the extinction of many species. This can be seen in the extinction rate of 0.1 species per year per million species increasing to 100 species per year per million species at the least. This has been primarily due to the negative impact that humans have had on the habitat of organisms such as the Moa. The fact that Moa were endemic to New Zealand meant that they were not found living in any part of the world other than New Zealand. This meant that the extinction of the Moa must have been caused by environmental and human-related events occuring in New Zealand. From the map we can see that much of New Zealand's forest has been replaced with towns and human farming. This suggests that habitat destruction has played a key role in the extinction of the Moa, because it means that the animals are not able to find a sufficient amount of food as they were dominant herbivores, which meant that they only ate plants. Also the loss of habitat would mean that there are fewer breeding sites and that the young were easily exposed to predators. The D. robustus

species being so tall at over 2m tall means that it can be easily spotted by hunters and poachers. The fact that the adults are so large may cause them to be killed as they are seen as a threat to the human population. This means fewer breeding opportunities leading to an increase in the rate of extinction. In addition, the growing human population about 600 years ago would have required more land for development leading to the destruction of these forests and shrublands. It is also possible that due to ~~human~~ pollution (caused by humans) and increased global warming that the species of Moa may have been affected due to climactic changes in modern times. Nowdays we are seeing many species in Africa, the amazon and polar regions being affected. Ecologically the declining population of species can be attributed to increased predation and competition for food resources. It is also possible that some forms of disease may have resulted in the death of a large population of Moa about 600 years ago. However it is very clear that humans and their growing population and infastructure have primarily resulted in the increase in rate of extinction of species in modern times. //

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E&J

EP

EO

/

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MC

Through transgenesis the transfer of Moa DNA may be able to restore the population into the Rimutaka Forest Park. Firstly, Moa DNA must be located perhaps within preserved samples of Moa tissue. Humans will have to locate somatic cells from the moa tissue and carry out somatic cell nuclear transfer. The DNA removed from the moa tissue is transferred using a gene gun or injected into an egg cell that has had its nucleus removed. This egg cell must come from an organism that is genetically similar to to Mantell's moa. P. geranoides DNA is placed into the egg because it is the species of moa that is about the size of a turkey and will not harm humans. The egg cell may be grown in a culture medium until it reaches the 6 to 8 cell stage where it can be placed in the uterus of a surrogate mother through embryo transfer. The DNA must come from a male and a female tissue of P. geranoides and both male and female moas must be born so that the population can be restored, The two moas are bred together to create offspring which will then be bred further to increase the population. When released into //

MC 1

MS

/

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the Rimutaka forest, they can be monitored and surveillance can be used to make sure they are protected. Artificial insemination and IVF techniques may be used to form more offspring. However, it is unlikely that a fertile offspring would be produced because the species became extinct 600 years ago, it is unlikely that the climatic and environmental conditions would be suitable for survival. In addition there will be a lot of inbreeding depression as all future offspring would have been produced from one of each parent. This means that there is limited genetic variation so if environmental conditions change, the moa will once again be at risk of extinction. Also the introduction of Moa will have strong biological implications on the ecosystem which are negative. Because they are dominant herbivores they will eat the food source of other herbivores which may put the competing species at risk of extinction. Furthermore, the Forest being so close to human towns such as wellington and Lower Hutt suggests that they are very likely going to be affected by human infastructure and pollution. As such, it is unlikely that the Moa will recover from

(1EJ2)

IE

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extinction not only due to genetic insecurity but also due to ecological and environmental consequences.

EP ✓ 1EJ2 ✓
EO ✓ MSJ1 ✓
MSJ ✓
ETJ ✓

45+2

Seen

please turn over.

5 ✓

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PM

Question two: Human dispersal.

When humans (H. sapiens) evolved from H. erectus and moved out of Africa, they spread in different directions across the world. Through a genetic mutation by chance happening randomly, the normal variant of the EPAS1 gene was replaced with the rare version of the EPAS1 gene. The Humans that moved to Asian regions would have also come from Africa. In Africa where the Altitude was not very high, there would have been no selective advantage of having the rare form of the allele. When the first group of H. Sapiens moved to the Tibetan plateau, the people that moved very quickly over a short relative space of time would have had increased thickness of the blood because many would have the normal variant of the gene. This meant that they would have problems such as hypertension and heart attacks and would have died. Also the fact that they had difficulty in conceiving meant that fewer offspring would be born with the normal variant of the gene. This means the frequency of this allele would be reduced in the gene pool. The people with the rare form of the allele would have died from not getting enough ~~Haemoglobin~~ oxygen

PS2

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PS1

LT

because at the higher altitudes there is much less oxygen per unit volume. The H. Sapiens that moved slowly to higher altitudes would have allowed time for the body to adjust to the changes in O_2 concentration. However this time, the individuals with the rare variant of the gene would have had a selective advantage and survive for a longer time till reproductive age and produce offspring. This means there is an increasing in the frequency of the rare form of the gene in the Tibetan population. Therefore they have 87% of the rare variant as opposed to individuals in other parts of the world. The fact that this gene (rare) is only found in high frequencies in Asian high altitudes but not at high altitudes in other parts of the world means that there must have been very few individuals with the random advantageous mutation and a large number must have moved in the Asia direction. In other areas those individuals may have died before their advantage is expressed. The Han Chinese having a significant 9% even at low land areas, suggests that the Tibetan population's offspring may have migrated to low land china and due to inbreeding in family marriges, the allele is still

2H

present even though it has no advantage in lowland china. This is similar to the Denisovans in the Altai Mountains. It is possible that the part of Tibetan population migrated north in search of new land to the Altai mountains but may have become extinct due to unfavourable living conditions. Because there was significant interbreeding between SE Asian Denisovans and modern oceania and Asian populations, the rare form of the gene would more present in higher ~~frequencies~~ frequencies. This is especially true for oceanic populations which had 3-6% from SE Asia. It is less likely that the rare EPAS1 gene would be present in Europeans because the interbreeding occurred mainly between Neanderthals. The Neanderthals moved straight into the European region after leaving Africa so it is unlikely that there was enough interbreeding with the Tibetan populations for there to be a significant frequency of the EPAS1 in the gene pool. Therefore it is estimated that in modern humans, the presence and distribution of rare EPAS1 is more likely to be prevelant in Oceanic and Asian populations!

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LG

RMJ

LG

/

ASSESSOR'S USE ONLY

LH ✓ LJ ✓
LT ✓ LE ✓
RMJ ✓
PSJ1 ✓
PSJ2 ✓

5J + 2✓

Q4 6

seen

please turn over.

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Question three: Hawaiian Honey Creepers

About Smya, the main island of Kauai was formed however from the map we can see that many smaller island were formed before as the islands are forming towards a south-easterly direction. The common ancestor of the common Rosefinch and the Poouli must have undergone divergent evolution after arriving From Asia. Because the islands were very isolated and were relatively newly formed, there were a variety of niches free for organisms to occupy. Due to the different selection pressures that the last common ancestor from Asia experienced, Allopatric speciation of the birds occurred. This different selection pressure could have been limited access to the same food source in Asia and different forms of competition and predation. The fact that the Honeycreepers are all very phenotypically diverse shows the diverse and vast ranges of niches that they occupy. From the phylogenetic tree we can see that as the number of islands increased, the number of the different species of Honeycreepers were rapidly larger. This suggests that adaptive

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radiation has occured because all the different islands had different niches that the birds could occupy. Due to the different selection pressures, the organisms that by chance had a mutation that would give them selective advantage were able to survive to reproductive age and pass on their alleles to their offspring. From the extinction of the Akialoa and the reduced number of species with very small and very large beaks we can see that stabilising selection has occured. This is because many species have medium sized beaks however the presence of these very large and small beak sizes shows that those birds still possess the selective advantage in their environment. The fact that the Nihoa and Laysan finches are only present on their respective islands suggests that they are very well adapted to their environment and are not suited for survival on other islands. The Iiwi and Apapane birds are found on all four of the major islands which suggests that they are well adapted for survival in all conditions. The fact that the Hawaiian honeycreepers are endemic to only these isolated islands suggests that these niches are very specific and only present

in this region. The distance to other mainlands is very far so it is unlikely that many of the birds will survive the journey and the selection pressures will be so different that the finches will undergo allopatric speciation once again and become a different species.
The initial common ancestor that arrived from Asia can be described using the founder effect because it only carried part of the gene pool of all the other birds in Asia and through adaptive radiation became many different species of finches. We can also see sympatric speciation occuring between finches living in the same island. On the island of Maui the liwi has a colour and beak that is vastly different from the Maui Parrotbill which suggests that factor other than the land barrier is creating this diversity. This may be related to the feed habits and breeding habits of the organisms. The fact that the number of species dramatically decreased from 56 to only 18 suggests that many of the niches may have been occupied by different organisms and there must have been competition leading to

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(DAJ)

DF

DS

the survival of the fittest. Thus over time natural selection has caused the most fit individuals to become more present in the population of finches. It can be predicted that over time may of these species will be replaced with more fit species as the environmental conditions change and the diversity of Honeycreepers on the Hawaii islands will only become more phenotypically diverse.

(DAJ) DF
DLJ DS
DMJ ~~DAJ~~ SP
DNJ
~~4J 2d.~~ SP 3J+3

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