S

93101A

931011

SUPERVISOR'S USE ONLY

SCHOLARSHIP EXEMPLAR

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Tick this box if you have NOT written in this booklet

Scholarship 2022
Biology

Time allowed: Three hours
Total score: 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.

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

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

Question	Score
ONE	
TWO	
THREE	
TOTAL	

ASSESSOR'S USE ONLY

PLANNING

Penguins

Divergent evo from common ancestor - mutation
- selection pressures
- competition
- Open niches - loss of apexes.
- Camelids

Niches
- adapting to diff niches
- environments

Extinction
- Marine mammals - competition / predation

&

Allopatric speciation

PLANNING

BFF

~~Eng~~ Endangered !!

1 - Dependant on praire ~~dogs~~ dogs - 90%.
- decline in pop size due to habitat loss, collapse of hab, dsp

4 - Bottleneck effect - ~~1970s~~1981 130 pop
- genetic drift

2 - R - strategy
- low birth rate
- genetic failure

3 - Territorial
- specialised haters

5 Disease

Management.

1 - good job so far

4 - breeding of unrelated individuals

2 - introduction of wilk into pop

3 - intro of SB2 into pop

- Transgene

PLANNING

The habbit

Model 1: 2mya - habilis

- Brain size 1
- joints, shoulders & limbs X
- feet 2
- wrists 3

Model 2: H. erectus

- water crossing 1
- Brodmann 10 2
- Stone tools 3
- Fire 4

Opinion

- Island dwarfism
  - reduced energy for brain / features 1
- Culture 2

1- Penguins

Roughly 66 mya, the ancestral penguin lineage saw its beginning, when the common ancestor of ~~th~~ modern (and extinct) ~~be~~ penguins split from procellariiformes. This split took place as a result of the extinction of apex predators such as large sharks and marine reptiles close to the Cretaceous - Paleogene boundary. With the extinction of these previous apex ocean predators, the common ancestor of ~~t~~ penguins and Procellariiformes had ~~to~~ a wider variety of open niches available. In order to best exploit these open niches, divergent evolution can be said to take place, with ~~t~~ the common ancestor of the penguin evolving over time in a different direction to the ancestor of Procellarii formes in a type of disruptive selection. Within this, in order to best utelise the now open niche of predator in oceans, the penguin ancestor became adept ~~an~~ at oceanic movement. This gives rise to the loss of flying feathers, and other features related ~~for~~ to flying in favour of features such as flipper like wings, dense bones and specialised feathers.

Within this process of microevolution and eventually macro evolution to the distinct penguin genus recognisable today, an important idea is that of mutations. In this common ancestor 66 mya, accumulation of specific mutations beneficial to the underwater hunting would have gradually ~~made~~ given rise to the features of ~~ben~~ penguins seen today. Within this, penguins which have slightly more dense bones are better able to prevent bone breakage and support the ~~friendly~~ large mass ~~of~~ of penguins required to stay warm in the cold climate they occupied. Similarly, the loss of aerial wings.

In favour of flipper like wings was likely a gradual process of directional selection, where penguins which had more ~~better~~ flipper like wings were better able to swim in the ocean. This meant that these penguin were better able to occupy the open niche left by the extinction of apex predators, acting as predators in the ocean, and therefore deriving more nutrients. With more nutrients/energy in their diet, these penguins would be better able to reproduce and rear offspring, with more energy to do so, meaning that, over time, the proportion of penguins with these flipper like wings and dense bones would increase. ~~On~~

On this note, another important feature to consider is the adaptations relating to thermoregulation. In early penguins, the penguins with more insulting soft feathers were better able to stay warm in the cold environment of antartica, meaning that these penguin were better able to survive and reproduce, making the trait more common. The same can be said about greater visual sensitivity and an ability to go long periods of time without eating where these features enable penguins to be more successful in their diving lifestyle, where being able to see clearly and go long times without food before ~~sustaining~~ getting food while hunting is of benefit to the survival and reproduction of penguins on a whole.

Thus then/ leads to the diversity of penguins, an idea which has two fundamental origins. ~~Firstly, in the presence of~~ Firstly, carrying capacity. At a particular point in time, the carrying

Capacity of antartica for the ancestral penguin species would have been reached, where the environment could not support any more penguin with current habitat and/or food resources. At this point, penguins with more specialised features would have been more successful in their survival. For example, Palaeeudyptes klekowskii would have arisen as a result of disruptive selection, where penguins which were slightly bigger than normal were better able to insulate themselves, while also being more successful in hunting big prey, meaning that, over time, Palaeeudyptes klekowskii attained a larger size. Similarly, smaller penguins such as the Little blue penguin were liable to arise, as these individuals, being smaller, were better able to sustain themselves from little food, resulting in a greater chance of survival compared to the normal sized penguin which expended more energy in movement / life functions such as rearing of offspring & reproduction. ☆ (pg 9) seen

The second part of this diversification is the migration of penguins into diverse habitats. With these penguins moving to locations such as Peru, New Zealand, South Africa and the galapagos islands, it means that new niches were able to be exploited. In turn, under the unique selection pressures of each environment, diverse species of penguin arose in a demonstration of divergent evolution. Within this, & places such as the galapagos and peru selected for smaller penguins such as the Pygoptes, with these smaller penguin having a ~~smaller~~ greater surface area for smaller ~~to body ratio~~ volume, ~~to~~ allowing for more effective heat loss and lower chance of hypothermia in these relatively hot environments.

However, a large amount of this diversity (50 species) have now gone extinct, with giant penguins such as Palaeeudyptes klekowskii and Icadyptes of Peru going extinct roughly 25 mya with the rise of marine mammals such as toothed whales and seals. Within this, due to the niche overlap between large penguins and these new marine mammals, in terms of temporal overlap, spatial overlap and diet overlap, only one group could continue to occupy the niche, with the other being outcompeted. In this case, it can be understood that large penguins were not able to outcompete these large mammals, instead losing food ~~out~~ to these mammals, eventually leading to the point where large penguins no longer had energy to sustain themselves & in survival and the rearing of offspring.

This is not to say, however, that diversity does not exist in ~~extant~~ extant penguins species. Roughly 22 mya, when Antartica seperated from Australia and South America and new island groups were formed, penguins were able to migrate to these new island groups. This then gives rise to divergent evolution, where unique selection pressures acting on penguin in these new & island populations ~~enabled penguins to~~ selected for unique traits. More specifically, for penguins in Peru or the galapagos, the warmer climate likely selected for a smaller body size compared to antartic penguins, with the warmer climate requiring penguins to have greater surface area for smaller volume in order to not overheat. This change mirrors that of moa after the ice age, where big footed moa became smaller in the warmer climate, as selection pressures from the environment meant

that mon which had greater surface area and less volume were better able to dissipate heat, allowing for more efficient functioning overall, and a greater ability to survive and reproduce. This, ~~alongside~~ eventually allows for ~~the~~ ~~a~~ the roughly 20 species of penguin seen in the Southern hemisphere. Within this, allopatric speciation and the effects of pre-zygotic reproductive isolating mechanisms are important to understand, as these factors likely ~~re~~ produced the diversity of species which are unable to reproduce for differences in communication and appearance.

Around the ~~a~~ ~~the~~ great auk, it can be understood that convergent evolution took place. Within this, the great auk, occupying a similar environment to penguins in the southern hemisphere ~~it~~ adapted to have similar phenotypic expression, with the use of wings for better mobility in the ocean and feathers which help in insulation.

This situation, therefore, mirrors that of ~~cichlids in North America~~ mides ~~et~~ cichlids in lakes apoyo and xiloa. Once the carrying capacity of these lakes was reached by the ancestral benthic form of the mides cichlid, divergent evolution took place, resulting in the limnetic form of mides cichlid. This limnetic form was better ~~able to~~ suited to the surface environment habitat, allowing it to ~~at~~ enter a niche full of new resources previously untapped into. ~~The~~ In the same way, evolution of larger and smaller penguins followed for utilisation of unutilised niches, benefitting the survival of species which are able to enter them through ~~greater~~ more resources and nutrient availability - Benefitting survival of these penguins.

2 - Black footed ferrets.

The role and interaction of factors contributing to black footed ferrets status as critically endangered.

As a species, the black footed ferret ~~(BBF~~ (BFF) is a highly specialised carnivore, completely dependent on praire dogs for sustenance. Within this, praire dogs make up 90% of the diet for BFFs, showing how dependent BFFs are on praire dogs. This then poses issues for ~~g~~ BFFs. With the praire and grassland habitats praire dogs reside in being highly fertile, it means that a large majority of this land is being utilised for agricultural use. With this agricultural use, 95% of the land of praire dogs has been lost, with remaining land being fragmented. Alongside this, activity from oil & gas extraction can cause the collapse of praire dog habitat. Ultimately, this means that the mortality rate of praire dogs is likely to ~~be diminished~~, increase, with less protection against harsh weather and predators, while the natality rate decreases due to a lack of ~~dens used by females~~ area for females to rear young. Exacerbating this further is the poisoning of praire dogs and the disease sylvatic plague introduced by flees; significantly increasing the ~~natality of~~ mortality of praire dogs. In turn, this ~~is~~ reduction in population size of praire dogs has detrimental implications for the survival of BFFs. With less praire dogs to consume, a number of BFFs will not have sufficient energy to rear young to maturity or reproduce. In turn, this means that the population size of BFFs decreases, making the species in its entirety ~~less~~ more susceptible to extinction events. ✓Δ (pg 14)

seen

critically

Further contributing to this endangered status is the R-strategy utilised by BFFs. With kits being moved to their own burrow shortly after weaning, it means that kits ~~are~~ ~~less~~ recieve less support from mothers in the development process. This reduces the overall natality of BFFs, with a greater susceptibility to the loss of kits due to predation. ~~As~~ Within this, with Females having low reproductive rates, it means that in conjunction with the higher chance of mortality, fewer offspring arise from each BFF, leading to a significantly smaller natality rate altogether. With a smaller natality rate BFFs are less able to recover from catastrophic events, ~~with~~ ultimately meaning a higher chance of extinction, and thus, explaining the critically endangered status of BFFs more. //

Tangential to this idea on natality is the territoriality of BFFs. With solitary BFFs ~~to~~ occupying a territory, it means that there is less carrying capacity for a given environment for BFFs. This then means that fewer BFFs can exist in a given environment, limiting population size and increasing chance of extinction. Linking to this idea is the ~~size~~ reduced prairie dog population size, where a reduction in the food available to BFFs means that the territory of each ~~BF~~ BFF has to be larger (as territory size depends on prey availability), further reducing the number of BFFs which can be supported in the given environment. //

These ideas of low natality and reduced population growth ability become especially prevalent ~~were~~ when considering the bottleneck event which occured in the ~~190~~ 1970s. With the population of

BFFs declining to just 130 individuals in 1981 and then declining further to just 18 individuals in 1986 due to disease outbreak, it ~~means that~~ the low natality would prevent significant population growth. At this point, the BFF were incredibly close to extinction. Furthermore, due to the decline in the number of individuals remaining in the species, it means that there would have been a reduction in genetic diversity, ~~but~~ with a large number of alleles no longer being carried by the species for individuals who previously carried the alleles passed away. This then leads to genetic drift, where the ~~random~~ natural mortality or failure to reproduce for a given BFF could significantly reduce genetic diversity. Indeed, as seen through ~~bottlenecks~~, this did occur, and the 55% loss in genetic diversity with ~~prairie dogs~~ BFFs now expressing reduced genetic diversity to those individuals in ~~the 1986~~ 1986. This gives rise to features such as a reduction in sperm quality, leading to reduced natality again, and a higher likelihood of extinction for the BFF.

Lastly, with reduced genetic diversity, the BFF ~~is no~~ as a species is more homogenous in resistance and vulnerability to disease, ~~as evidenced by~~ This means that infection ~~of~~ by Sylvatic plague or canine distemper could cause a significant reduction in population size, increasing likelihood of extinction for BFFs.

Options for the management of the black footed ferret.

At present, key strategies being used to reduce the vulnerability of the ~~BFF~~ BFF include a number of points. Through the use of

breeding programmes, and assisted reproduction of BFFs, it means that an increase in the number of individuals born, and thus an increase in the natality rate can be seen. This is critical, considering the low natality rate of BFFs when left in the wild. On this, the use of assisted reproduction partially mitigates the reduced sperm quality, allowing for greater reproductive success.

Through use of insecticides, ~~the~~ a large killer of prairie dogs can be lessened in its ability to kill prairie dogs. In doing so, researchers are able to increase the population size of prairie dogs to an extent allowing for more food for BFFs, and therefore, a greater population size/sustainability of BFF population.

Through vaccination against Sylvatic plague and CDV, it means that the mortality rate of prairie dogs ~~are~~ is liable to decrease, with these diseases ~~bein~~ having a ~~les~~ reduced ability to first infect ~~an~~ or second, harm the BFF lethally. With ~~greate~~ reduced mortality, BFFs are less likely to be endangered, with fewer harms to health. ~~mortality~~

~~With~~ Lastly, with greater conservation of grasslands, and prairie habitats, it means that more BFFs and prairie dogs can be supported/can thrive, reducing vulnerability of ~~p~~ BFFs to extinction, while also improving the long-term sustainability of the species.

Beyond these strategies, another key idea is the re-introduction of genetic material from dead BFFs. By breeding alive ~~prai~~ BFFs with clones of either wills or SB2, it means that researchers are able to re-introduce genetic material (novel alleles) into the ~~prairie~~ BFF

In doing so, ~~researchers~~ BFFs are able to have greater variation in phenotypic expression, reducing chances of mortality due to environmental changes such as an increasing global climate.

Transgenics ~~to~~ could also introduce diverse alleles ~~genetic material~~ into the current ~~prairie~~ BFF population. Within this, through insertion of ~~genes~~ alleles which improve immune system function, it means that BFFs can ~~better~~ be better immunised to the fatal impacts of Sylvatic plague or CDV. In turn, mortality for BFFs would ~~not~~ decrease, ~~as~~ increasing survival and therefore reducing vulnerability of BFFs to extinction, at least in the near future.

Lastly, another option which could be explored is the establishment of a new population in a geographically isolated location. If done so in ~~a~~ a way as is planned for the Californian Condor, it could mean reduced chance of species extinction due to disease (as ~~after~~ one population is isolated from the other) while a natural accumulation of genetic diversity takes place due to the differing selection pressures acting on each population.

(2) In addition to this, with fewer prairie dogs surviving & ~~and~~ reproducing, seen and a number of prairie dog burrows collapsing ~~under~~ as a result of oil and ~~fuel~~ natural gas exploration, there are fewer burrows for BFFs to be protected from predators in or raise young in, resulting in a higher mortality rate ~~and~~, lower natality rate and higher chance of extinction for ~~the BFFs~~ BFFs.

3- The Hobbit

Model A- H. habilis ancestry

Under model A, it is speculated that H. floresiensis arose as a descendent of H. habilis or a similar hominin which left Africa 2mya.

A key piece of information supporting this model is the brain size of H. floresiensis. As a species, H. floresiensis has a brain size averaging 380cc, akin to that of a chimpanzee. This comes to point at a more archaic ancestry for H. floresiensis, as, over time, it would be expected that the brain size of hominins tends to increase. This then points to an earlier hominin being the ancestor for H. floresiensis, such as H. habilis (614 cm³) with a more archaic ancestor having a cranial capacity (426cm³) closer to that of the average of 380cc seen in H. floresiensis.

Further contributing to this discussion is the archaic foot structure of H. floresiensis. In comparison to Modern humans, or even more modern hominins such as late H. erectus, H. floresiensis has large feet relative to its body. Additionally, with a flat foot arch, it means that H. floresiensis was unable to utilize the spring like motion of feet of Modern sapiens, leading to a less effective gait. Ultimately, this once again points to ancestory as from H. habilis or a related archaic hominin, with the feet of H. erectus (or other, more modern hominins) being more efficient in their gait.

With

The feet of H. floresiensis express similar, archaic features

Unlike modern humans, the wrists of H. floresiensis are quite simple, with little ability for precise motion and minute manipulation. This once again points to a more ancient ancestry for H. floresiensis, with these archaic features being remnants of features expressed by the H. habilis / other archaic hominin H. floresiensis evolved from.

(Pg 18) seen

Model B - H. erectus ancestry

The competing model for H. floresiensis ancestry is where H. erectus was the initial hominin from which H. floresiensis evolved, with this model beginning at a later date with a more complex ancestor for H. floresiensis.

The first key notion strengthening model B is the location of Flores. Being seperated ~~by~~ from mainland ~~east~~ Asia by at least 24 km of water at the lowest point, it means that complex waterfaring technology was required by the ancestors of H. floresiensis in order for these hominins to reach Flores. This begins to point to ancestry from H. erectus, with the significantly larger brain size of H. erectus compared to more archaic hominins ~~all~~ meaning that ideation and construction of the complex technology required to cross water is more feasable.

Linking to this is the presence of an enlarged Broadmann area 10. While expressing a relatively small cranial capacity, the presence of an enlarged broadmann area 10 points to a ~~at~~ the potential of inheritance of a more complex brain, with retention of this ~~compl~~ enlargement for the benefits relating to cognitive abilities such as hunting or tool making. This then points to ~~ancest~~

H. erectus ancestry, with these hominins having significantly more complex brain structures than ~~previous~~ more archaic hominins, with these hominins being the most likely to first possess and subsequently hand down ~~these~~ this enlarged Brodmann area 10. ||

This then leads to discussion around the tool and hunting culture of H. floresiensis. Unlike H. habilis or more archaic hominins, H. floresiensis actively hunted for food, likely killing the pygmy elephant Stegodon for its meat. This, in of itself, is evidence for H. erectus ancestry, with the complex social skills required to hunt effectively not being well developed prior to H. erectus. On this, the tools used by H. floresiensis, while smaller than those of H. erectus, appear to be fairly complex, expressing the bifacial, high time investment features of acheulian tools. ~~But~~ With H. erectus being the species which first utilised the ~~A~~acheulian tool culture, the use of the same tool culture by H. floresiensis is indicative of H. erectus ancestry. ||

~~The~~ Fire further strengthens this notion. prior to H. erectus, no hominin was able to have controlled use of fire, with some being able to use fire opportunistically at best. In this case, it can be seen that H. floresiensis ~~used~~ used fire in a controlled manner for cooking meat, similar to H. erectus. ||

Evaluation and Explanation ||

In all, it can be understood that the second model (Model B), with H. erectus ancestry makes more sense from an ~~evo~~ biological and cultural ~~pre~~ perspective. However, this then requires understanding of why H. floresiensis expresses the archaic features of a small brain

shorter stature and archaic feet / wrists common to older hominins or even the hominids.

A key aspect of this is the idea of Island dwarfism. Living solely on the island of flores, it is likely that fewer resources in terms of meat were available. Instead, the environment of H. floresiensis resembled that of hominids more, being heavily forested and tropical. In this forested, tropical environment, ~~redu~~ the presence of complex feet for effective bipedal locomotion was less necessary, with reduced grasslands to occupy / travel across. Instead, larger feet would have been selected for in this environment, making H. floresiensis more adept at climbing in this forested environment, allowing for better access to fruit and a better ability to travel. Similarly, with climbing being important for H. floresiensis travel, the complex wrists of H. erectus were lost over time in favour of more robust wrists better able to swing through trees / climb.

Lastly, with fewer nutrients in their environment, and a reduced need for complex brains beyond tool crafting, hunting and fire control, natural selection would have selected for smaller brains for H. floresiensis. In turn, with smaller brains, more energy of H. floresiensis could be devoted to survival and reproduction, meaning that these smaller brains evolved in H. floresiensis over time from the relatively more complex brains of H. erectus. (pg 19) See

(D) The last archaic feature expressed is the shorter stature of H. floresensis. Unlike modern hominins like H. erectus (165 cm)

(106cm)

H. floresiensis has a height closer to that of H. habilis (118cm). ~~This act~~ This points to a more archaic ancestry, with older hominins spending less energy in the development of a taller stature for more effective bipedal locomotion. //

Similarly, less ~~time~~ development of the height of H. floresiensis occurs, not giving an advantage in an environment where bipedal locomotion is less required. Instead energy can be saved and devoted to better rearing of offspring. //

soon

Annotated Biology Scholarship Exemplar Template

Subject	Biology Scholarship	***Standard***	93101	***Total score***	17

Q	***Score***	***Annotation***
1	6	This candidate gained 5 justified points and 2 description points overall. They comprehensively discussed the process of divergent evolution of the penguins with respect to the vacant niches available due to apex predator extinction. In addition, this candidate clearly explained selection for traits that increased reproductive success, considering the relevant niche selection pressures. A deeper understanding of convergent evolution and also of analogous and homologous structures, with evidence from the resource material, would have increased the overall grade.
2	3	There were 3 justified points and 1 description point given for this question. The bottleneck effect and subsequent lack of genetic diversity was clearly linked to allele frequency change due to genetic drift. Management of the black footed ferret vulnerable population was discussed with captive breeding linked to increased reproductive success, compared to ferrets breeding in the wild. In addition, the use of genetic tools, such as cloning, were linked to increasing genetic diversity and therefore adaptability of offspring to environmental change. This candidate did not name the interspecific relationship that exists between prairie dogs and black footed ferrets (predator/prey or exploitation) and, as a consequence, they did not access the points in this EP section. There was clear understanding of the relationship, but it lacked key details.
3	8	This question was comprehensively answered with 8 justified points and 2 description points being given. The biological features of *Homo floresiensis* were described and linked to archaic origin, with the exception given of the complexity of the brain (Brodmann's area 10) which more supported *Homo erectus* origin. Acknowledgement of the cultural features of advanced tools and construction of seacraft that support the model of origin from *Homo erectus* was given with links to brain complexity and prior knowledge of cultural advances of this hominin. The low energy, heavily forested environment of Flores was used as evidence to explain the unusual features of *Homo floresiensis,* such as climbing features to access food in the trees and selection for dwarfism. Overall, this was a concisely written answer with the model of *Homo erectus* origin was supported with evidence and justification.