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SCHOLARSHIP EXEMPLAR



NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

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

Scholarship 2016 Biology

2.00 p.m. Thursday 17 November 2016

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.

Question	Mark
ONE	
TWO	
THREE	
TOTAL	/24

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S Exemplar

Throughout their response the candidate has considered the biological information in the different contexts to present a well reasoned response. Relevant biological concepts are organised into a coherent answer which address the question asked. Q1 The candidate has provided justified judgements for two of the 3 areas asked for in the question and would have lifted their grade if they had addressed the impact of human intervention on the survival of the black robin population. (answer lacked breadth) Q2 The candidate has addressed all aspects of the question but needed to explain more biological concepts in the context asked to lift their grade. (answer lacked depth). Q3 The candidate has addressed the question asked but again needed to explain more biological concepts in the context asked to lift their grade. (answer lacked depth).

Q1.) The Black Robin has a higher risk of extinction than the Chatham Island Tomtit, this can be attributed to a wide range of factors that the robins have been subject to, including increased predation due to their ecological niche, their egg laying behaviors and their inability to survive in a wide range of habitats.

The Black robin occupies a very particular ecological niche in which it resides in mature forests only with preference of a closed canopy and open understory, additionally robins forage only for food on the ground level searching for invertebrates when compared with the Chatham Island Tomtit the ecological niches that the robin can survive in are very limited, whereas the Tomtit is able to utilise habitats from sea level to the subalpine zone and are found in both mature native forest and some shrub/tussock grassland. The Tomtits have a larger range of diet feeding upon invertebrates, fruit & vegetation from all levels of the forest. This wider ecological niche gives the Tomtit selective advantage as it reduces the number of natural selection pressures acting against the Tomtit, whilst the more narrow ecological niche of the Robin increases the number of natural selection pressures acting against it.

Robins being only able to survive in mature forests puts them at a disadvantage compared to the Tomtit, this is because in the event of declines in suitable forest habitat the robins experience heavy natural selection pressures against them, reducing their survivability whereas the Tomtits who are able to occupy a range of habitats gain selective advantage as in the event of decline in forest habitat they are more likely to survive as they have the ability

to adapt to various habitats, thus reducing the natural selection pressures acting upon this species. Additionally robins source their food only from invertebrates on the ground level, whilst tomits source invertebrates, fruits and vegetation from all levels of the forest. This results in the robins being more susceptible to predation particularly from the small mammals such as rats, possums, cats and dogs that would have been brought to the chatham islands by english ships between 1791 - 1800 due to the nature of the nz natural environment at the time lacking land mammal predators there would have been a devastating effect on the robin population due to predation from the introduced mammals. this is because the robins were not adapted to survive the introduced predators and as they feed upon the ground the ~~set~~ introduced selection pressure from these new mammals would have acted more heavily upon the robin populations than the tomtit populations. The nesting ~~habits~~^{behavior} of the Robin compared to the tomtit also have a vast contribution in the disparity of extinction risk between the two species. Robins display double clutching behavior whereby they lay one clutch of 1-4 eggs and if the first clutch does not survive they will lay another, in addition to this the robins also exhibit a genetically controlled behavior whereby they lay eggs upon the edge of the nest where they are unable to be incubated, this in conjunction with laying only one clutch per season and double clutching effects the survivability of the robins as the unincubated eggs will not survive and therefore that pair of mating robin will not successfully

reproduce, thus has a negative effect upon isolated robin populations as it means that young are not being produced at a rate in which population stability or expansion can occur. However in the case that some of the edge laying females chicks do survive to hatch this behavior as it is genetically controlled will be passed down to offspring and as this behavior provides selective disadvantage the overall fitness of the population will reduce as these genes are passed down.

Whilst the fantails rear three broods of up to 3-4 eggs each season this behavior gives the fantails selective advantage as the increased number of clutches increases the ~~percentage~~ chance that a percentage of the clutches hatched will survive onto adulthood. The differences in the ecological niches and in particular the mating behaviors of the two birds result in the robins being critically endangered as they are less well adapted to survive in a range of environments and conditions than the fantails are.

Human intervention has impacted significantly upon the survival and evolution of the Black Robin populations. In 1938 the black robin which had been believed to be extinct since the 1880's was found in a small population of 20-35 robins on predator free, isolated Little Mngere Island. However a decline in forest habitats on the island lead to an even longer reduction in population size to 7 individuals by 1976 as a result of the selection pressures put on the robins due to change in their ecological niche which the robin was unable to successfully.

Adapt to. in an attempt to save the black robin their small population was translocated to Mangere island, this lead to only 5 individuals surviving with only one female. this relocation of the robin is an example of a founder effect, where a small population is located to a new habitat causing the gene pool to have significantly less diversity in alleles. in particular as there was only one female and 4 males left the gene pool of the black robin was very small and therefore did not contain the wide range of alleles that a population of a species requires in order to be able to withstand selection pressures such as disease.

Although the act of human intervention resulted in the survival of the black robin population it had severe negative impact upon the evolution of the black robin. A recent study has shown that black robin populations contain birds with deformed beaks, Birds that are featherless and chicks that have poor bone development in their legs. all of these harmful traits are most likely attributed due to the severe inbreeding of ~~parental~~ individuals to form the new population after the founder effect occurred. These negative traits have become established in the population as a result of human influence and the very small gene pool from which they are from. as there ~~was~~ was only one breeding female in the current population founding population all produced individuals carry her DNA and as a result of this they carry any negative mutations she may have carried this results in the population all being very closely genetically related which has had negative impact upon the 'fitness' of the population. In

addition to this the intervention of humans in ensuring individual survival has altered the evolutionary pathway for the robin as individuals who would previously been naturally selected against were surviving and reproducing, passing their genes onto the latter generation. This has proved to be problematic as now that humans had intervened a type of artificial selection had occurred thus resulting in a population of robin that was not necessarily adapted to suit its ~~new~~ environment or in this case resulted in the continuation of alleles in the gene pool that contained harmful mutations such as deformed beaks, feathers and chicks with poorly developed leg bones being able to be passed on and increase the allele frequency of these harmful genes within the gene pool. Overall the influence of humans on the Robin population has resulted in the ~~survival of the species~~ Evidence of human influence effecting the fitness of the population can also be found in that when researchers rolled non-layed eggs back into nests to ensure their survival within 6 years half the population had inherited this negative behavior as this behavior is controlled by a dominant allele. However once the population had reacted to and the humans stopped intervening overall the population growth was little of 50-100 birds since 1998, however the action of natural selection pressures on non-laying eggs had increased the fitness of the population with the allele frequency of non-laying dropping to below 9%. overall the influence of humans on the

robin population lead to the survival of the species, however meant that natural selection did not occur, altering the evolutionary pathway of the species and increasing the frequency of alleles that were harmful in the population.

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Both evolutionary and ecological processes have resulted in the distinct ecological niches observed between resident and transient orca. Resident orcas live closer to land and have a highly structured social organisation lead by a matriarch. Their pods ~~contain~~^{usually} contain up to 30 individuals and they are highly vocal and hunt largely migratory salmon using echolocation. Whereas the transient orcas hunt by stealth as they hunt seals, dolphins and small whales that would detect echolocation. They are not very vocal and have pods of 2-6 individuals however they try to follow a matriarchal structure.

The two populations do not interbreed and mtDNA suggests that transient orcas became reproductively isolated around 700,000 years ago from the resident orcas, it is highly likely that originally these two types of orca occupied very similar ecological niches, however as Gause's exclusion principle states no two populations can occupy the same niche in the same area at the same time. It is highly likely that this is what initiated the evolutionary processes that lead to reproductive isolation and the two populations distinct ecological niches. When the populations were in competition for similar niches around 700,000 years ago they would have faced very similar selection pressures however as the two populations separated into different ecological niches each was subject to different natural selection pressures over time these selection pressures selected for those individuals who carried alleles suitable for survival.

and divergence started to occur between the two populations.

in the new niche, for example in the resident population individuals who were well adapted to use ecolocation to catch their fish prey would have been better able to catch food & survive and hence pass on their beneficial genes whilst those individuals who did not use ecolocation as well would not have been as likely to survive thus increasing the allele frequency of ecolocation in the population over time. Overtime the small changes to the populations would accumulate and eventually each resident or transient orca population was so well adapted to their own niche that reproductive isolation mechanisms were in place what prevented the two groups interbreeding its likely that these may have been behavioral isolation as the social and vocal behaviors within the two groups differed so greatly that even if the two populations meet it is unlikely they would mate. thus causing each to follow separate evolutionary paths.

Additionally pressure placed upon food stocks such as the Chinook Salmon that the resident orcas feed on may have lead to the formation of the distinct ecological niches between transient and resident populations. It is possible that at one point the population of orcas relying on the salmon stocks was too high so individuals within the group were not getting enough food. this could have lead to a small population of those individuals who were better at stealth hunting seals, dolphins etc to separate from the resident population to focus on this food source and as this source was not migratory like the salmon it forced the small orca population to become

transient to follow the food source they had begun to use. As a result of this their would have been different selection pressures acting upon the transient population than the resident, resulting in them filling a new niche differing to that of the resident population. For example the niche the transient orcas adopted lead to the formation of smaller social groups of 2-6 as supporting large groups of up to 30 was impractical in a transient lifestyle. These adaptations caused by selection pressures overtime lead to the two types of orca occupying totally different niches ~~ever~~ permanently even though 700,000 years ago the two populations were interbreeding and therefore most likely occupying the same niche.

The data provided states that the offshore, transient and resident orcas all occupy vastly different niches and that no ~~is~~ known interbreeding occurs, supported by mtDNA evidence that suggests transient populations became reproductively isolated 700,000 years ago whilst the resident and offshore became reproductively isolated more recently 150,000 years ago this evidence leads me to believe that in future each group will follow different evolutionary pathways and divergent evolution will occur as each species is naturally selected by different pressures in accordance to their differing ecological niches. I think it is also possible that the northern resident population and southern resident population may begin to diverge because as stated northern and southern residents have

never been found in the same area at the same time. therefore i would expect that in time the two populations may experience reproductive isolation mechanisms such as changes in behavior or geographical barriers that may result in the northern and southern populations experiencing different selection pressures & eventually evolving to suit two different niches. //

3.) ~~What do you think~~

naledi should be placed in the genus *Homo* in my opinion. This is because although the composite skeleton shows a mixture of *Homo* and *Australopithecine* features the more primitive features it shows are on a more minor scale. That the *Homo* features in cases such as the pelvis can be linked to not having to birth a larger head of offspring however the *Homo* features *naledi* does show are significant in supporting a more modern bipedal motion than would be expected from the genus *Australopithecus*. Such as the changes in leg bones to long and slender with strong muscle attachmentments, this suggests the genus *Homo* rather than *Australopithecus* because the long slender bones with strong muscle attachmentments suggest that the *Hominin* spent most if not all of its time walking upright as the muscle attachmentments that were found were not needed for those hominins who still climbed & hung from things regularly, additionally the long leg bones would have been a hindrance in climbing trees, suggesting the hominin was less apelike. Additionally the Humanesque skull although with a small brain case suggests a change in diet that would fit with the *Homo* genus. *Australopithecus Afarensis* existed on a mainly herbivorous diet consisting of largely vegetation and seeds & nuts due to the nature of the diet a large grinding force was required however *naledi*'s skull does not show the sloped face and large brow ridge that is expected in the type of diets of *Australopithecus* instead showing a skull that suggests a much more

omnivorous diet which leads me to believe that it is more likely that *naledi* should belong to the *Homo* genus than the *Australopithecus* genus.

I think it is unlikely that *H. naledi* should be in a position of recent hominin lineage this is because other hominins in this region of the lineage have vastly more human like features than *naledi*. for example *H. Neanderthalensis* had a much more humanistic skull with a cranial capacity of $1250\text{--}1550\text{ cm}^3$ and used more advanced manufacture tools and toward the end of their time upper paleolithic. Therefore I think it is unlikely *naledi* belongs in the lineage here as the remains still contain a mixture of primitive features including a smaller narrower pelvis and curved fingers. but additionally they are not associated with any stone tool culture so therefore it is unlikely that they even existed after *H. habilis* who was considered the first to use stone tools and is associated with older tool culture. I think it is also unlikely that *naledi* belongs in the early hominin tree line also, because again ~~the~~ *naledi* does not share many similarities with the other hominins in this period. additionally *naledi* has a *H. naledi* considerably smaller cranial capacity than *H. habilis* with *habilis's* capacity at 610 cm^3 whilst *naledi's* was $450\text{--}550\text{ cm}^3$ however it larger cranial capacity than *A. Garhi* at 450 cm^3 and as the cranial size of hominins trend up throughout the tree line with those hominins in the recent times having the largest cranial capacities whilst those earlier hominins having the smaller cranial capacities (*A. afarensis*)

3.4 mya and in the old homini lineage with $380-430\text{cm}^3$ capacity) I believe that *H. naledi* belongs in the early lineage before *H. habilis*. This is additionally supported by the mix of homo and Australopithecine features ~~to~~ and the evidence of the hand remains suggesting tool use due to human like palm wrists and thumbs suggesting tool use, although not stone tool use which supports the placement between 3.2 mya. This position is also supported by where the remains were found in the rising star cave with those remains of *A. sediba* which have been dated to 2 mya.

The possible positions of *H. naledi* in hominin lineage have implications for the evolution of modern humans. If the placement were to be in the old lineage it would highly likely mean that the evolution of *H. sapiens* would have occurred earlier. This is because the hominins had far more advanced structures, ~~and~~ tool use and behaviors than other hominins in the old lineage. This is particularly evident in the deliberate placement of the bones in the rising star caves as this suggests more thinking and forethought than would be expected in the old lineage. If *naledi* was placed in the early lineage I believe there would be few implications upon the evolution of humans as it is entirely possible that *H. naledi* was an undiocussed ancestor that helped to bridge the pathway from *A. africanus* to *H. sapiens*. When *naledi* is placed in

~~early~~ early lineage it follows the expected pathway that known hominins evolved after each other becoming more advanced until the migration out of Africa which lead to the evolution of the African *H. erectus* population into *H. sapiens*. However if *H. naledi* were to be placed into recent lineage this would effect the understanding of the evolution of humans because if *H. naledi* was present in Africa from 1 mya it is possible that *H. sapiens* may have in fact evolved from *H. naledi* and not from African *H. erectus* as we understand it with the out of Africa theory, or it could mean simply that there was other hominins that were in Africa at the same time as the out of Africa migration who happened to be geographically isolated in caves etc in South Africa and in fact played no part in the evolutionary pathway of *H. sapiens*. *H7*