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SCHOLARSHIP EXEMPLAR



Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Scholarship 2025 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 to all THREE questions in this booklet.

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

Check that this booklet has pages 2–27 in the correct order and that none of these pages is blank.

Do not write in the margins (// // //). This area will be cut off when the booklet is marked.

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

ecological consequences

PLANNING

- food chains disrupted → lizards
↳ stuff that other species don't eat → uncontrolled pop. grow.
- underdeveloped joey
- nurtured to full development in pouch

altruistic young
~~at risk~~

→ k-strategist

↳ large energy investment

↳ can have bad effects on mother esp. if food low

- decreased food for eagles + snakes → negatively impact their survival
↳ exploitation relationship → predation

- habitat destruction → also other species habitats too

- interspecific competition ↓ → European introduced cat, foxes, predators fill their niche → their pop. ↑
↳ prey on native Australian species

- genetic manipulation

- DNA ~~at~~ may not be from genetic cells

↳ would be more successful if have oocytes and sperm produced.

Question one

The thylacine, being a keystone species, would have had a large contribution to the ecosystem. However, due to various reasons, the species became extinct, leaving ~~devastating~~ negative consequences on the ecosystem.

The thylacine dug and lived in burrows. With their extinction, these burrows likely do not exist anymore / no more are made. The thylacine's burrows may have been used by other ^{species} ~~organisms~~ in the same habitat for ~~shelter~~ shelter for example, if they had a mutualistic relationship. ~~However~~, Thus the extinction of the thylacine would have negatively impacted these species, who would now be vulnerable to predation or extreme weather ~~eff~~ events ~~that~~ due to lack of safe ~~hab~~ burrow previously provided by the thylacines. This shows a knock-on effect, as the extinction of the thylacine species would have negatively impacted other species too.

Another example of a possible negative knock-on effect in the ecosystem would be the disruption of food chains. Thylacine hunted possums, lizzards and birds, and scavenged carcasses. ~~The extinction of the~~ The thylacine have a exploitation relationship with these animals, in particular, predation. The thylacine benefit in this relationship as they obtain food, while the ~~on~~ animals which are their prey, are harmed as killed and eaten. The extinction of the thylacine would have disrupted this relationship, as the prey species no longer have thylacine

predators. ~~The~~ This may result in an increase in the population numbers of prey species due to the reduction in predators. Their extinction, however, also may decrease the interspecific competition ^{for food} the thylacines had with the Tasmanian devils whose ~~shared~~ diets overlapped. The population numbers of the species which Tasmanian devil also preyed on may be less affected, ~~as~~ (small birds and mammals); ^{as Tasmanian devils will eat them} ~~however~~ but other species, such as lizards, that Tasmanian devils do not eat, will be more impacted as they may experience a ^{sudden} population growth ~~to~~ with very large numbers of organisms ^{surviving} ~~being born~~ ^{and increased survival} due to the lack of predators. The increase in lizard population size could consequently further disrupt the ecosystem negatively.

The similar diet of the Tasmanian ~~devil~~ devil to thylacine indicates possibly a similar ecological niche occupied by both. This ~~might~~ interspecific competition, particularly for food, could have led to thylacine eventually being outcompeted. This follows Gause's principle ^{competing for the same limited resources} which states that two species ^{in the same ecological niche} ~~occupying the same ecological niche~~ cannot coexist stably. The better adapted will outcompete and eliminate the other. This means the Tasmanian devil ^{in numbers} ~~threw~~ population would have increased, due to reduced interspecific competition when the thylacines became extinct. The plentiful food available for them would have led to faster population growth as less energy would need to be wasted in competing with ^{the} thylacines, and less Tasmanian devils would be injured or killed ^{or aggressive behaviour} in fights that may occur with thylacine for food. However, ~~if~~

The Tasmanian devil themselves are now listed as vulnerable / critically endangered on the IUCN red list. This is because, following thylacine extinction, there was a rise in devil facial tumour disease. Since this cancer was transmissible, it would have quickly spread among the Tasmanian devil populations, causing death. Thus, the numbers of Tasmanian devils drop significantly, which again, impacts the food chains as its prey ~~species~~, ~~would~~ particularly the ones ^{that had been} shared with the thylacine, would have decreased predation, as 2 predator species (thylacine and Tasmanian devil) have decreased in number.

The thylacine's ~~also~~ joey were also prey of wedge-tailed eagles and tiger snakes, so a predator-prey relationship is also seen here, with the thylacine being the harmed species in this case, and ~~for~~ the eagles and snakes benefitting. So, the thylacine's extinction would have also decreased food availability for these predators, increasing the intraspecific competition for food within the population of each species. This negatively impacts their survival.

The ~~predators~~ cats, foxes and predators of similar size to the thylacine, introduced by Europeans, would have furthered interspecific competition, and after the ~~thylacine's~~ thylacine's extinction, these species would have filled the ~~at~~ newly vacant niches left by the thylacine (adaptive radiation may occur). These predators' populations will increase in size, and may prey on ~~at~~ native Australian

species. The native species may not have encountered these new predators before, and the significant increase in their population sizes may result in decrease, or maybe even extinction, of native species such as birds, that the cats ~~are~~ and foxes prey on. This may ultimately reduce biodiversity.

~~The~~

Due to the keystone role of the thylacine as a species, scientists have been trying to de-extinct it. Genetic manipulation could be used to do this through cloning using preserved thylacine DNA sequences. The Australian Museum has attempted to do this in 1999, with no results. They tried using DNA from museum specimens but no viable embryo resulted. This could be due to ~~the~~ the DNA used being damaged or not well preserved.

The Tasmanian devil ~~is~~ and quoll were considered to be used as surrogates for this project, ~~probably~~ ^{likely} due to having a common ancestor with ^{the} thylacines. This ~~idea~~ idea, although not carried out, is not particularly viable ~~itself~~, because ~~the~~ Tasmanian devils and quolls are vulnerable / critically endangered themselves. ~~This means,~~ ~~it would be~~ Using them for surrogacy would ~~not~~ risk their health, ^{during birth and also the energy used in nurturing young} and could worsen their conservation status on the IUCN red list, ~~and~~ ^{with successful} the results of ~~the~~ surrogacy of the thylacine not being, ~~is~~ guaranteed, risking ~~the~~ other endangered species may end up being in vain, so is not a smart choice to make.

The Colossal Biosciences is a bioengineering company.

They have claimed that they will clone the ^{extinct} thylacine using a near-complete ~~gen~~ thylacine genome using preserved thylacine specimens. The gaps are said will be filled using the genome of the ~~fat~~ fat tailed dunnart, which is the closest living relative of the thylacine. Cloning using this method may be successful, as dunnart DNA will have high similarities to the thylacines due to their close relatedness, so a complete thylacine genome could be built. However, the survival of the cloned thylacine would prove a bigger challenge. This is because the joeys are born underdeveloped. The artificial young of the thylacine is especially vulnerable, being the size of a rice grain, and living. The thylacines were K-strategists as they had few offspring at once, and nurtured their young to ~~at~~ full development in a pouch. It would be difficult ~~to~~ for a joey to ~~develop~~ ^{reach} into an full development without a mother thylacine. If another marsupial, who also have pouches, was used, the joey may still be unlikely to survive, due to ~~the~~ nurturing young being a highly energy demanding investment, which other species may not be willing to do. They may also recognise the thylacine joey as not their own, so leave it to die. Therefore, the Colossal Biosciences project is unlikely to be successful.

Question two

The bar-tailed godwit ~~in~~ migrates ~~to~~ between Alaska and New Zealand yearly. ~~This~~ Migration is the regular mass movement of organisms of a species from one region to another. To successfully undertake such journey, the bar-tailed godwits would have had many adaptations to meet the ecological requirements.

~~It~~ To ensure that ~~they~~ in the bar-tailed godwit migrate at ~~the~~ the same time as each other, they would ~~have~~ need to have ~~feet~~ to know when to migrate. Otherwise, migration would be pointless, as they would not encounter breeding partners in Alaska, so successful reproduction would not occur (which was the purpose of migration). It would lead to wastage of energy and resources. ~~They~~ So, they may be triggered to migrate due to ^{an} internal biological clock that ~~interacts with the~~ is synchronised ^(or temperature but it is less reliable) with the environment, such as day length, so the birds know to begin migrating from ~~near~~ New Zealand in March, and back again in September.

Migration is a risky behaviour, as a lot of energy expenditure and risks, such as starvation, or getting lost along the way, is associated with it. Thus, for migration to ~~be~~ have occurred for a long time, shown by fossil evidence of ~~the~~ bar-tailed godwits, and stayed in the population, the ~~the~~ benefits of migration must outweigh the risks. This means migration ~~it~~ ~~has~~ gives the birds a strong selective advantage. The ~~muta~~ migrating alleles ~~is~~ likely

arose in the bar-tailed ~~god~~ godwit through a mutation. As the phenotypes ~~re~~ coded by the alleles proved beneficial, ~~they~~ the individuals with it would have been more 'fit' so selected for, as they were more likely to survive and reproduce. They passed on these migration alleles to their offspring, causing the allele frequencies to increase in the population. ~~The~~ selection pressure for this may be food availability, as Alaska has plentiful aquatic invertebrates and shellfish for the bar-tailed godwit to eat, providing them the nutrients and energy needed for successful reproduction. In ~~the~~ New Zealand, May/June is winter, so food may not be as readily available, so intraspecific competition for food would have been more intense in New Zealand in these months, so successful reproduction may be more difficult.

The ^{alleles that coded for} phenotypes that ~~were~~ had a selective advantage ^{proteins involved in} could be associated with coding for ^{physical} physical features. ~~The~~ The ^{physical} adaptations of the godwit include ~~the~~ having fat stores. This would be beneficial in the migration journey as it ensures the birds do not starve to death, and have a sufficient source ~~of~~ of energy to meet the demands of actively flying such distances (^{29000 km} over ~~11000 km~~). This is especially true for the leg from Alaska to New Zealand, which is the longest non-stop flight of any bird (11000 km). It takes nine days, but ~~the~~ this period of time would require high amounts of energy to ~~keep up~~ keep flying. ^{other} Their adaptations such as having highly efficient metabolism aid this too, as it means

substrates can be quickly respired/metabolised to provide ATP (energy) for the bar-tailed godwit when needed, allowing it to take on the journey with no stops. The dense muscle fibres coupled with the strong honeycomb bone structure allow strong ~~muscles~~ muscles to exist in the godwits, allowing them to fly continuously, and also prevents being significantly blown away in severe weather events. The ~~large~~ wing shape of the bird also is adapted to reduce drag when flying, so less ~~eneg~~ energy is required in flight.

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The migration to Alaska, from New Zealand, interestingly ~~is~~ spans over months (March - June). This is significantly longer than the nine day migration back the other way. This is because the pathway is not non-stop, involving staging sites to rest, ~~a~~ refuel and prepare ^{for} ~~the~~ ^{the} next stage of ^{the} journey. This adaptation is important, as the godwits are migrating to Alaska to breed. ~~This means~~ Reproducing is also an energy-demanding task, so the godwits cannot ~~is~~ spend all their energy on migrating, as it would leave the birds too tired to breed once in Alaska, ~~is~~ defeating the purpose of the migration.

~~Alaska~~ In addition to the abundant food supply in Alaska, the bar-tailed godwits breeding there may also be beneficial as it allows all breeding godwits to assemble in the same location. ~~This is~~ Since the birds are from different places, their breeding would increase

genetic diversity in their species compared to if they had remained in New Zealand. The godwits also do not breed until their third or fourth year, so do not all migrate. ^{Breeding only in third or fourth} ~~this~~ reduces the intraspecific competition for mates in ~~at~~ Alaska, contributing to greater reproductive success. ~~Ho~~ The non-breeding birds staying in New Zealand is beneficial too as they are not risking their health for an unnecessary ~~for~~ journey, and also do not compete with the breeding godwits in Alaska for food (reduces intraspecific competition for food).

The population of the bar-tailed godwits is unfortunately declining (nearly 2% annually). This is associated with habitat loss at stopover sites, particularly in the Yellow Sea region. ~~This~~ ~~the~~ migrating bar-tailed godwits from New Zealand to Alaska are thus negatively impacted, as their journey becomes riskier. They may not be able to safely ~~at~~ rest, and/or find sufficient food to refuel. ~~the~~ Consequently, the migrating birds may not get enough energy to successfully reach Alaska to breed. (changes in wind patterns due to ~~it~~ climate change could result in the godwit's losing their way during migration, if they use wind direction to navigate. They could also be blown off course. ~~Being lost would mean they do not breed~~ ^{Being lost would mean they do not} ~~and would mean~~ ~~mean~~ breed either, as ~~A~~ they do not arrive in Alaska. ~~the~~ Changes in temperature could also impact their endogenous mechanisms which tell them when to migrate, messing up the migratory cycle. Due to staging

sites habitat loss, new migratory routes may also need to be found. However, this is risky, as ~~the~~ it would involve travelling via new routes, ~~would~~ ^{which would} increase chances of death as much would be unknown. Thus, climate change decreases the likelihood of successful migration, further contributing to their population decline.

* ~~the~~ Additionally, the migration could also cause the 'survival of the fittest' by natural selection. Those that successfully make the migration journey will reproduce passing on their alleles to their offspring. They will essentially be the 'fittest' individuals of the population, so contributing to the species becoming more fit as they ~~a~~ contribute their advantageous alleles to the gene pool. The ~~a~~ bar-tailed godwit species will be more likely to survive as a result.

Question 3 three

Homo sapiens and chimpanzees both ~~can~~ are able to throw projectiles. Several adaptations has allowed Homo sapiens to utilise projectiles more than chimpanzees, including physical and genetic features.

The human arm is able to rotate more than the chimpanzee due to difference in shoulder orientation. ~~The~~ This allows the arm to be drawn further back before throwing a projectile, ~~to~~ which generates more potential energy that is later converted into kinetic energy, leading to a ~~more~~ stronger throw. The major line of action of the Pectoralis major in a human is horizontal^{and outwards}, while it is diagonally upwards in a chimpanzee, which means a human can put more muscle strength in their throws in contrast with the chimpanzee. This allows the projectile to be thrown a greater distance and a greater force. ^{some of} The DNA present in modern humans and ancient hominins may have also contributed. The ADPS gene variant in the modern human shows enhanced rotational range of motion in the shoulders. This allows humans to move their arm into the arm-cocking phase ~~in the~~ ^{before} ~~during~~ an overhand projectile throw, thereby increasing the success of the throw. The ACTN3 gene is responsible for fast twitch muscle fibres, which allows powerful, explosive movements, ~~which is~~ ~~a~~ more efficient than the chimpanzee. It means that humans have the ability to move faster in the acceleration phase of throwing, allowing the projectile to be

thrown with a greater force, so it travels further. These adaptations to allow better throw of projectiles may have allowed the hominins to target specific animals and hunt and kill them for food. This would have allowed a more ~~nutritious~~ ~~nutrient-rich~~ nutrient-rich diet, which would have contributed to better brain development. ~~These~~ ^{Other} adaptations, such as a low wide shoulders and long legs may have been selected for, for other functions, not throwing. Low, wide shoulders would have helped maintain balance for bipedal walking, and long legs makes bipedal walking a more energy efficient process as one ~~th~~ stride can cover more distances. In addition, a flexible wrist ~~help~~ helps with throwing, but is also a significant feature for precision grip, which hominins are known for.

The designs and manufacture of the projectiles show a trend of becoming increasingly specialized as time went on. ^{as eventually tools were created to throw the projectiles} This cultural evolution of tools reflects the biological evolution of hominins, particularly brain ~~the~~ size increase. The stone-tipped throwing spears was likely used by Homo ~~er~~ erectus, as the stone tip is tear dropped shape, that coincides with the ~~Ache~~ ^{so Homo erectus probably used projectiles.} tools commonly seen in the Acheulean tool culture. The poison on stone-tipped throwing spears and arrows suggests ~~a~~ creative thought in the hominin species that used it, ~~so~~ with a larger brain and developed frontal lobe. This points to Homo neanderthalensis and/or

Homo sapiens using this type of ^{It would have allowed better hunting} projectile? The Atlatls (spear throwers) and ~~the~~ bow and arrows appear to have been used by Homo. ~~sapiens~~ sapiens, as it reveals much higher level critical thinking and manipulation of materials. They used bone and wood, ^{with bone being a} ~~which is~~ materials that was used later on in ^{tool, cultural} ~~the~~ ^{evolution} ~~culture~~ (upper paleolithic). Projectiles would have proved very useful in hunting, and later fishing, further improving the hominin diets. This would have resulted in a positive ~~for~~ feed back, where development and refinement of tools would have led to better diets, which would allow development of larger brains, that were then used to make more sophisticated tools.

Scholarship

Subject: Biology

Standard: 93101

Total score: 17

Q	Score	Marker commentary
1	7	Comprehensive understanding about the ecological consequences of thylacine extinction on the ecosystem was demonstrated through discussion of the large impact of a keystone species and its role as a predator, prey and competitor to other species for food. In addition, the lack of burrows created for other species to inhabit and the effect of introduced species that filled the vacant niche left by thylacines was discussed in terms of the reduction in biodiversity in the ecosystem. An evaluation of the use of genetic manipulation to de-extinct the thylacine was made in this response. In particular, an acknowledgement of the need for DNA to be gathered from several specimens to construct a genome and the likelihood of Colossal Biosciences succeeding in their endeavour due to them possessing a near-complete genome at this time. Consideration was also given to the concern over possible marsupial surrogate use when they are endangered species themselves (according to the IUCN Red List) and conservation of these extant species is important.
2	5	The physical adaptations of the bar-tailed godwit / kuaka such as the dense muscle fibres, honeycomb bone composition, and wing structure were discussed in terms of efficiency and energy-saving features that support the long migratory non-stop flight from Alaska to New Zealand. Environmental factors that signal the time to begin migration such as photoperiod / day length and temperature change were identified. The importance of adequate food and resources for nesting / raising chicks in Alaska was discussed in addition to the impacts of climate change on the migration of the bar-tailed godwit / kuaka. Wind / weather and food availability changes were identified with an evaluation regarding the overall effect of climate change on successful migration and an annual population decline of 2%.
3	5	This response critically analysed the adaptations the scapula and pectoralis muscle of <i>Homo sapiens</i> for throwing projectiles farther for hunting and compared this to the chimpanzee. Acknowledgement was made that some of the adaptations that improve throwing ability, such as long legs, were selected

		for bipedalism initially. The trend for projectiles to become increasingly complex, enabling more successful hunting was identified and the positive feedback loop from improved diet to brain development and increased tool / projectile technology was detailed. Complex projectiles such as atlatls and bow and arrow, which show features from the sophisticated upper palaeolithic tool culture using many materials and complex construction, were correctly attributed to <i>Homo sapiens</i>.
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