Assessment Schedule – 2018

Scholarship Biology (93101)

Evidence Statement

QUESTION ONE: FORBES' KĀKĀRIKI: Evidence Statement

Discusses the evolutionary and ecological processes that may have resulted in the hybrid that formed between the Forbes' kākāriki and Chatham Island red-crowned kākāriki cross, and the possible effects of these hybrids on the future evolution of Forbes' kākāriki (D).

Evidence	Justification
Existence of hybrids indicates no pre-zygotic reproductive isolating mechanism (RIM) in the hybrid zone.	Indicates Forbes' and Chatham Island red-crowned kākāriki are closely related species / diverged recently.
Existence of hybrids indicates no post-zygotic RIM.	Post-zygotic RIMs (in *Cyanoramphus*) develop slowly after divergence.
Forbes' kākāriki underwent population / demographic bottleneck.	Potential to affect fitness by genetic drift.
Prior to forest clearance, Forbes' and Chatham Island red-crowned kākāriki existed sympatrically with little hybridisation.	Prior to forest clearance, ecological barriers reduced opportunities for hybridisation. Prior to forest clearance, larger population size reduced competition for mates.
After forest clearance, Forbes' and Chatham Island red-crowned kākāriki existed sympatrically with increased hybridisation.	Forest clearance promoted opportunities for hybridisation because the two habitats became more similar.
	Forbes' and Chatham Island red-crowned kākāriki can, in principle, interact because of a lack of a geographic barrier.
	Forbes' kākāriki characterised as a forest specialist, in relation to the more generalist habits of the Chatham Island red-crowned kākāriki.
Loss of forest may have given the Chatham Island red-crowned kākāriki a competitive advantage, as they make more use of open habitats.	Competition for mates (by the more numerous Chatham Island red-crowned kākāriki) / limited mate choice (Forbes' kākāriki) / imbalance in numbers between species promoted opportunities for hybridisation.
Forbes' kākāriki may become extinct / population may decrease.	Due to genetic swamping / genetic pollution / introgressive hybridisation / genetic erosion. Due to being outcompeted by hybrid. Hybrid shows hybrid vigour / heterosis so has a competitive advantage. Due to lower immunity / disease resistance compared to hybrid. The introduction of genetic variation through hybridisation may increase the resilience of hybrid populations to environmental fluctuations and novel challenges.
Forbes' kākāriki population may increase.	Due to ongoing plantings making habitat more favourable for Forbes' kākāriki / reducing hybrid zone. Due to possible hybrid breakdown in F2.

Recommendations for the management of the Forbes' kākāriki to improve their vulnerable status are analysed (A).

Evidence	**Justification**
Allow some interbreeding.	Interbreeding could be used to restore genetic diversity / enrich depauperate (impoverished) gene pool of Forbes' kākāriki / increase in resilience to novel diseases may outweigh loss of genetic integrity. Interbreeding could introduce adaptive genetic variability into Forbes' kākāriki population. Interbreeding may increase immune response. Interbreeding may reduce potential for inbreeding within Forbes' kākāriki population. Hybrids' tendency to backcross with Chatham Island red-crowned kākāriki mean genetic integrity of Forbes' kākāriki less likely to be compromised by further hybridisation. Assortative mating / sexual selection (based on crown plumage colour) may be occurring when hybrids backcross with Chatham Island red-crowned kākāriki.
Continue / increase restorative plantings.	Habitat more favourable for Forbes' kākāriki / reduces hybrid zone / restored habitats will have a smaller interface between the two habitats, and opportunities for further hybridisation from parent species are reduced. Original habitat restoration allows parent species to have an adaptive advantage in each habitat so the hybrid population is outcompeted.
Cull hybrids (using the additional red feathers in the crown as identification) and Chatham Island red-crowned kākāriki from Mangere Island.	
	Do not cull hybrids as cryptic hybrids will have a selective advantage over hybrids showing other morphotypes / additional red feathers in the crown. Do not cull hybrids as it may only apply a selective pressure against alleles related to crown morphology and may have little effect on other loci.
Translocate hybrids and Chatham Island red-crowned kākāriki to another location.	Hybrids could be a valuable repository of novel alleles should Forbes' population require them in the future.
Set up an 'insurance' population of Forbes' kākāriki elsewhere in a suitable habitat.	Lowers the risk of extinction of Forbes' kākāriki in case of natural disaster / pest incursion on Mangere Island. Founder population should be sufficiently large to preserve genetic diversity. New location should have no other kākāriki species present to hybridise with.
Establish new population of Forbes' kākāriki in northern end of Chatham Island.	No Chatham Island red-crowned kākāriki present to hybridise with. Has suitable habitat (remnant forest) that could be enhanced with plantings. Would require predator-proof fence / pest elimination.
Conduct ongoing surveys of the relative proportion of hybrids.	
Sequence the genome of Forbes' kākāriki.	Use genome sequencing to identify cryptic hybrids and prevent these breeding with Forbes' kākāriki.

Judgement statement (the two areas are D and A)

8	Provides an in-depth response using information in the resource material and *Nature of Science* and *Living World* strands up to and including Level 8 in *The New Zealand Curriculum* to analyse and discuss the evolutionary and ecological processes that may have resulted in the Forbes' kākāriki × Chatham Island red-crowned kākāriki hybrid and the possible effects of the hybrid on the future evolution of Forbes' kākāriki. Informed judgements are used to analyse recommendations for the management of the Forbes' kākāriki to improve their vulnerable status in a fully integrated response. 8 Js or 7 Js and 2 descriptions. Must have 1 J in each area. Answer displays: • perception and insight • sophisticated integration and abstraction • independent reflection and extrapolation • convincing communication.
7	Provides an in-depth response using information in the resource material and *Nature of Science* and *Living World* strands up to and including Level 8 in *The New Zealand Curriculum* to analyse and discuss the evolutionary and ecological processes that may have resulted in the Forbes' kākāriki × Chatham Island red-crowned kākāriki hybrid and the possible effects of the hybrid on the future evolution of Forbes' kākāriki. Informed judgements are used to analyse recommendations for the management of the Forbes' kākāriki to improve their vulnerable status in a fully integrated response. 7 Js or 6 Js and 2 descriptions or 5 Js and 4 descriptions. Must have 1 J in each area. Answer displays aspects of: • perception and insight • sophisticated integration and abstraction • independent reflection and extrapolation • convincing communication.
6	Biological evidence is selected and organised into a discussion of the evolutionary and ecological processes that may have resulted in the Forbes' kākāriki × Chatham Island red-crowned kākāriki hybrid and the possible effects of the hybrid on the future evolution of Forbes' kākāriki. Well-reasoned judgements are used to analyse recommendations for the management of the Forbes' kākāriki to improve their vulnerable status. 6 Js or 5 Js and 2 descriptions or 4 Js and 4 descriptions. Must have 1 J in each area. Answer displays: • analysis and critical thinking • integration, synthesis and application of highly developed knowledge, skills and understanding • logical development, precision and clarity of ideas.
5	Biological evidence is selected and organised into a discussion of the evolutionary and ecological processes that may have resulted in the Forbes' kākāriki × Chatham Island red-crowned kākāriki hybrid and the possible effects of the hybrid on the future evolution of Forbes' kākāriki. Well-reasoned judgements are used to analyse recommendations for the management of the Forbes' kākāriki to improve their vulnerable status. 5 Js or 4 Js and 2 descriptions or 3 Js and 4 descriptions. Answer displays aspects of: • analysis and critical thinking • integration, synthesis and application of highly developed knowledge, skills and understanding • logical development, precision and clarity of ideas.
4	4 Js or 3 Js and 2 descriptions.
3	3 Js or 2 Js and 2 descriptions.
2	2 Js or 1 J and 2 descriptions.
1	1 J or 2 descriptions.

0	Lack of relevant evidence.

QUESTION TWO: MIDAS CICHLIDS: Evidence Statement

Discusses the evolutionary processes and patterns that have resulted in the diversity of the Midas cichlid species complex in Lakes Xiloá and Apoyo.

Evidence	**Justification**
Founder effect occurred separately in each crater lake with a single colonisation event.	Each of the crater lakes may have different, non-representative allele frequencies due to genetic drift and small initial population size / different source lakes (Managua and Nicaragua).
	The formation of crater lakes provided unoccupied niches as they did not exist prior to the eruptions.
	There would be different selection pressures in the new crater lakes compared to the source lakes.
Limnetic and benthic forms are a form of disruptive selection.	Limnetic body form selected for in the new niche of open water which does not exist in the source lakes as they are very shallow. Benthic form selected for as shallow shoreline habitat is present in new lakes.
Selection for different diets due to different habitat use (e.g. fish in open water vs snails in the shallows).	Streamlined body form selected for in limnetic species (*A.sagittae / A.zaliosus*) as this shape may provide a speed advantage to catch fish / Wider and deeper body form selected for in benthic species as streamlined form may not be required to catch snails.
Mutations produce variation in body form and behaviours.	Mutations selected for if they provide an advantage.
Divergence / adaptive radiation as each crater lake started with one colonising / founder species and now has multiple species in the same lake (at least 4 in Xiloá and at least 6 in Apoyo).	Radiation into new species reduced intraspecific competition for named resource(s) (e.g. food, breeding sites) between individuals in original population once carrying capacity is reached. There may be more species in Lake Apoyo because there has been more time for divergence. Unoccupied niches / ecological opportunity enabled adaptive radiation. Adaptive radiation common on islands, and Lakes Xiloá and Apoyo are the aquatic equivalent of islands. Release from competitors / predators in source lake provided the opportunity for utilisation of ecological niches / resources from which they were previously blocked.
Punctuated equilibrium as rapid evolution of new species in a short period of time (~10 000 years for Lake Apoyo and ~5400 years for Lake Xiloá).	
Sympatric speciation within the crater lake as there are no geographic barriers to prevent gene flow between the different populations.	Lack of gene flow between populations is due to different depth distribution of breeding pairs (with example from graph to support). Lack of gene flow between populations is due to different habitat usage between the species (e.g. *A. xiloaensis* using rocky areas, *A. saggitae* using rocks / weeds and sand, and *A. amarillo* using weeds) which could result in less contact between species. Lack of gene flow may be due to sexual selection as colouration / patterning / body shape differs between species.

RIMs exist between species within a lake and these are likely to be prezygotic.	Likely prezygotic due to unsuccessful interspecific breeding, despite pairings occurring, possibly due to differences in courtship behaviours. Likely prezygotic due to resource partitioning / ecological RIM as differences in diets, breeding depths and habitat use may mean they don't overlap enough in their distribution. Likely prezygotic as insufficient time for postzygotic mechanisms to be involved. Ecological speciation can occur relatively quickly.
Allopatric speciation occurs between crater lakes as they are isolated and fish are unable to move between them.	Movement between lakes is rare event – only one colonisation event for each of the two crater lakes in 5400 / 10 000 years.
Convergent / parallel evolution for limnetic form in Lakes Xiloá and Apoyo.	Benthic form likely ancestor in both lakes as source lakes both shallow. Both new deep crater lakes would have imposed similar 'open-water' selection pressures, resulting in a limnetic form being selected for. New open-water habitat in crater lakes (due to their much greater depth than the source lakes) provides a similar unoccupied niche in both Lake Apoyo and Lake Xiloá. Genetic evidence shows limnetic species are more closely related to benthic ones in their own lake rather than each other.

Judgement statement

8	Provides an in-depth response using information in the resource material and *Nature of Science* and *Living World* strands up to and including Level 8 in *The New Zealand Curriculum* to analyse and discuss the evolutionary processes and patterns that have resulted in the diversity of the Midas cichlid species complex in Lakes Xiloá and Apoyo. 8 Js or 7 Js and 2 descriptions. Answer displays: • perception and insight • sophisticated integration and abstraction • independent reflection and extrapolation • convincing communication.
7	Provides an in-depth response using information in the resource material and *Nature of Science* and *Living World* strands up to and including Level 8 in *The New Zealand Curriculum* to analyse and discuss the evolutionary processes and patterns that have resulted in the diversity of the Midas cichlid species complex in Lakes Xiloá and Apoyo. 7 Js or 6 Js and 2 descriptions or 5 Js and 4 descriptions. Answer displays aspects of: • perception and insight • sophisticated integration and abstraction • independent reflection and extrapolation • convincing communication.
6	Biological evidence is selected and organised into a discussion of the evolutionary processes and patterns that have resulted in the diversity of the Midas cichlid species complex in Lakes Xiloá and Apoyo. 6 Js or 5 Js and 2 descriptions or 4 Js and 4 descriptions. Answer displays: • analysis and critical thinking • integration, synthesis and application of highly developed knowledge, skills and understanding • logical development, precision and clarity of ideas.

5	Biological evidence is selected and organised into a discussion of the evolutionary processes and patterns that have resulted in the diversity of the Midas cichlid species complex in Lakes Xiloá and Apoyo. 5 Js or 4 Js and 2 descriptions or 3 Js and 4 descriptions. Answer displays aspects of: • analysis and critical thinking • integration, synthesis and application of highly developed knowledge, skills and understanding • logical development, precision and clarity of ideas.
4	4 Js or 3 Js and 2 descriptions.
3	3 Js or 2 Js and 2 descriptions.
2	2 Js or 1 J and 2 descriptions.
1	1 J or 2 descriptions.
0	Lack of relevant evidence.

QUESTION THREE: JEBEL IRHOUD FOSSILS: Evidence Statement

Species the Jebel Irhoud fossils might represent is justified (S).

Evidence	**Justification**
Jebel Irhoud fossils could be archaic / early *H. sapiens.*	Flattened face similar to *H. sapiens*. Putative early Neanderthal (with whom *H. sapiens* shared a common ancestor) also showed same pattern of skull development: archaic skull was elongated but with modern facial features. Levallois technology also associated with *H. sapiens*. *H. sapiens* also controlled fire. Lineage split indicated by Ballito Bay boy genome analysis supports earlier origin of *H. sapiens*. Endocranial volume within *H. sapiens* range. Delicate cheek bones / non-flaring zygomatic arch similar to *H. sapiens*.
Jebel Irhoud fossils could be *H. heidelbergensis / H. antecessor /* archaic *Homo* lineage.	Modern humans have more globular braincase / elongated brain case compared to modern humans. More prominent / robust brow ridge / supraorbital torus compared to modern humans.
Jebel Irhoud fossils could be *H. neanderthalensis*.	Jebel Irhoud fossil had elongated brain case similar to *H. neanderthalensis*. *H. neanderthalensis* endocranial volume similar to Jebel Irhoud endocranial volume. *H. neanderthalensis* used Levallois / Mousterian technology. *H. neanderthalensis* also controlled fire. *H. neanderthalensis* had a prominent brow-ridge / supraorbital torus like Jebel Irhoud fossil.
	No Acheulean tools indicate Jebel Irhoud population unlikely to be *H. erectus*.
	Unlikely to be *H. erectus* as Jebel Irhoud endocranial volume significantly larger.
Jebel Irhoud fossils could be *H. erectus*.	*H. erectus* also controlled fire.

Discusses the implications of the Jebel Irhoud finds (D).

Evidence	**Justification**
First *H. sapiens* fossils found in north / northwest Africa.	
	Further evidence for OoA / RAO model.
Jebel Irhoud skull shows a mixture of archaic and modern human features.	Modern facial morphology established early in history of *H. sapiens.* *H. sapiens* facial shape may not be derived, but primitive retentions from an ancestor. Brain case shape evolved later in history of *H. sapiens*. Brain volume plateaued ~ 315 000 years ago. Large brain volume occurred earlier than previously thought. Florisbad fossil may also be archaic *H. sapiens*. That Florisbad fossil may also be archaic *H. sapiens* is supported by its association with MSA artefacts.
Different species of hominin occupied Africa at the same time (*H. sapiens* / *H. heidelbergensis* / *H. naledi*).	Possibility of African archaic interbreeding / hybridisation between *H. sapiens* and more divergent hominins in Africa / admixture between *H. sapiens* and contemporaneous hominins in Africa.
Charcoal / burnt bones indicate Jebel Irhoud population controlled fire.	
Jebel Irhoud population hunted / cooked animals / used stone tools for butchery.	Percussion notches indicates marrow extraction. Damage on edge of some stone tools may indicate some used as a throwing spear / edge damage more likely on smaller (more delicate) flakes as they have finer edges.
Jebel Irhoud population intentionally sought out quality tool-making material and carried it with them.	Increased hunting efficiency.
Greening of Saharan desert may have allowed dispersal between northern Africa and sub-Saharan Africa.	Modern phenotypes evolved in several regions of Africa connected by gene flow. Enabled technology such as MSA tools to be shared. Jebel Irhoud population isolated from rest of Africa most of the time so may not have contributed to modern humans / coexistence of morphologically distinct populations. Similar fauna in east and north Africa indicate ecological corridor.

Comparison made to understanding of human origins prior to Jebel Irhoud fossil finds (C).

Evidence	**Justification**
Previous oldest *H. sapiens* fossils are ~195,000 years old / Jebel Irhoud fossils are ~120,000 years older than the previous oldest examples.	Omo I / Omo II found in Omo Kibish Ethiopia are ~195 000 years old. *H. sapiens* diverged from Neanderthals / Denisovans ~ 500,000 years ago so finding *H. sapiens* fossils older than 195,000 years old not unexpected.
Eastern Africa / Ethiopia not origin of *H. sapiens*.	*Homo* genus was evolving all over Africa / *H. sapiens* was emerging in multiple regions across Africa / Indicates multiregional (within Africa dispersal) origin of *H. sapiens* in Africa.

Judgement statement (the two areas are S, and, D and C)

8	Provides an in-depth response using information in the resource material and *Nature of Science* and *Living World* strands up to and including Level 8 in *The New Zealand Curriculum* to analyse and discuss the implications of the Jebel Irhoud findings and compare these to former understanding of human origins. Informed judgements are used to justify what species the Jebel Irhoud fossils might represent in a fully integrated response. 8 Js or 7 Js and 2 descriptions. Must have 1 J in each area. Answer displays: • perception and insight • sophisticated integration and abstraction • independent reflection and extrapolation • convincing communication.
7	Provides an in-depth response using information in the resource material and *Nature of Science* and *Living World* strands up to and including Level 8 in *The New Zealand Curriculum* to analyse and discuss the implications of the Jebel Irhoud findings and compare these to former understanding of human origins. Informed judgements are used to justify what species the Jebel Irhoud fossils might represent in a fully integrated response. 7 Js or 6 Js and 2 descriptions or 5 Js and 4 descriptions. Must have 1 J in each area. Answer displays aspects of: • perception and insight • sophisticated integration and abstraction • independent reflection and extrapolation • convincing communication.
6	Biological evidence is selected and organised into a discussion of the implications of the findings and these are compared to former understanding of human origins. Well-reasoned justified judgements are made on what species the Jebel Irhoud fossils might represent. 6 Js or 5 Js and 2 descriptions or 4 Js and 4 descriptions. Must have 1 J in each area. Answer displays: • analysis and critical thinking • integration, synthesis and application of highly developed knowledge, skills and understanding • logical development, precision and clarity of ideas.
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0	Lack of relevant evidence.

Cut Scores

Scholarship	Outstanding Scholarship
13 – 18	19 – 24