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93101Q

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

New Zealand Scholarship
Biology, 2004

9.30 am Friday 26 November 2004

QUESTION BOOKLET

You should answer ALL the questions in the separate Answer Booklet 93101A

Check that this booklet has pages 2–7 in the correct order.

YOU MAY KEEP THIS QUESTION BOOKLET AT THE END OF THE EXAMINATION.

Outcome description

The student will analyse biological situations in terms of ecological and evolutionary principles and demonstrate integration of biological knowledge and skills.

Scholarship Criteria

The student will:

- use biological knowledge and skills to analyse biological situations and integrate ideas into a coherent response.

Scholarship with Outstanding Performance Criteria

In addition to meeting the criteria for Scholarship, the student will:

- demonstrate perception and insight in the analysis and integration.

You are advised to spend 3 hours answering the questions in this booklet.
Allow about one hour per question.

For ease of reference, the actual questions in this booklet are indicated by a vertical line down the left-hand side.

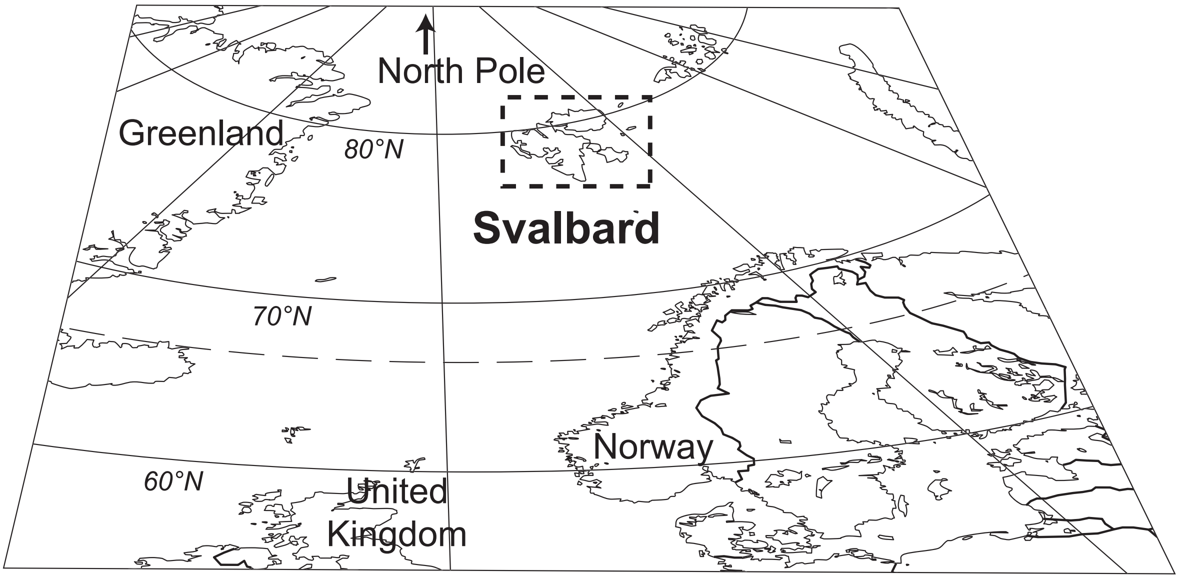
QUESTION ONE

In 2003 nearly 70 million hectares globally were planted in genetically modified crops. Of these, 73% were plants such as soybean, corn and cotton, which were modified to be herbicide tolerant and 18% were plants such as maize and cotton, which were modified to be insect resistant. A further 8% were crops with both herbicide tolerance and insect resistance. The remaining 1% were modified in other ways. (Annual Global Review of Commercialised Transgenic (GM) Crops. International Service for the Acquisition of Agri-Biotech Applications. http://www.isaaa.org/kc/CBTNews/press_release/briefs30/es_b30.pdf)

Compare and contrast the possible outcomes of releasing into the environment, plants genetically modified for herbicide tolerance with those of plants genetically modified for insect resistance. Your answer should include both the **ecological** and **evolutionary** outcomes of such releases, and evaluate the likelihood of these outcomes occurring.

QUESTION TWO

The Svalbard ptarmigan *(Lagopus mutus hyperboreus)* is a small herbivorous bird that lives permanently on the island chain of Svalbard. Svalbard is located in the Arctic Circle, approximately 700 km north of Norway at latitude 77–81°N. The Svalbard ptarmigan is the only bird that lives here all year; all other birds migrate to other locations during the winter months. It feeds on leaves, buds and berries from trees and shrubs on the islands.



Animals that live at this latitude are exposed to extreme conditions of weather and changes in photoperiod throughout the year. From mid-November to late January, the sun remains below the horizon, resulting in a continuous ‘polar night’. From mid-April until mid-August, the sun remains above the horizon, resulting in a continuous ‘polar day’.

Two research studies were carried out into the photoperiodic responses of the Svalbard ptarmigan. The results of these studies are presented over the page.

In the first study, ptarmigan chicks were raised outdoors at two latitudes (70°N and 79°N). Once they had become adults, the birds were housed individually in outdoor cages and had free access to food and water. Their feeding activities were monitored and actograms were constructed using the results. The actograms from the two different latitudes (70°N and 79°N) are shown in Figure 1.

Note: Each actogram has been duplicated and the two resulting actograms plotted side by side (double plotted).

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Figure 1. Examples of activity records from Svalbard ptarmigan at 79°N (left) and 70°N (right).
The time of year (month) is indicated on the vertical axis and the time of day (hour) on the horizontal axis.

Reierth, E. & Stokkan, K. (1998). Activity rhythm in High Arctic Svalbard ptarmigan (*Lagopus mutus hyperboreus*). *Canadian Journal of Zoology*, 76

In a second study, a group of birds was kept in individual cages in a light-controlled and temperature-controlled room in order to investigate the nature of the zeitgeber entraining activity. Prior to the study and during the first 30 days, the light regime was equal periods of light and dark (LD 12:12) and access to food was continuous. Once the experiments began, the birds were given either continuous access to food or periodic access to food under different light and dark cycles.

Figure 2 shows the feeding activity of one Svalbard ptarmigan in the study. Both actual feeding and food searching activity were recorded. The actogram has been double plotted. Figure 3 shows the different light–dark cycles and food regimes for each experiment.

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Figure 2. Feeding activity record from one Svalbard ptarmigan under differing conditions of light-dark cycles and access to food. The shaded boxes indicate periodic access to food and the open box indicates the time of food deprivation. Vertical lines indicate lights on (left line) and lights off (right line).

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Figure 3. The different light-dark cycles and food access conditions of each experiment. The shaded boxes indicate periodic access to food and the open box indicates the time of food deprivation. Vertical lines indicate lights on (left line) and lights off (right line).

Reierth, E. & Stokkan, K. (1998). Dual Entrainment by light and food in the Svalbard ptarmigan (*Lagopus mutus hyperboreus*). *Journal of Biological Rhythms*, 13 (5)

(b) Comment on the extent to which the results support the following hypothesis:
That two independent biological clocks entrain food-searching activity.

(c) Comment on the extent to which the results support the following hypothesis:
That the control of food-searching activity is more strongly entrained by access to food than by light-dark cycles.

(d) Considering both studies, discuss the significance of the responses shown by the ptarmigan to its survival in its natural habitat.

QUESTION THREE

While we can all recognise the basic shape of a bony fish (Figure 4), there is considerable variation in the morphology and behaviour of the bony fish belonging to class Osteichthyes.

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Figure 4. A typical bony fish. http://animaldiversity.ummz.umich.edu/site/resources/ryan_jonna/large_fish_diagram.jpg/view.html

Seahorses are so highly adapted to their special lifestyle that their shape and breeding habits seem most unlike those of a typical fish. They still have fins, gills and an internal swim bladder for buoyancy, but swim upright in the water and have a prehensile tail for grasping seaweed (Figure 5). When seahorses reproduce, the female deposits her eggs in the male's pouch for him to fertilise and take care of.

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Figure 5. Male and female seahorses. http://www.saseahorse.com/about_seahorses.htm

Flatfish such as flounder and sole are found in shallow waters near the low tide mark of sheltered beaches. They share these rich feeding grounds with wading birds. Early on in their development flatfish start lying only on their left side. As they do so, both eyes migrate to the right or upper side (Figure 6). Their protective colouration helps them to blend into the sandy background.

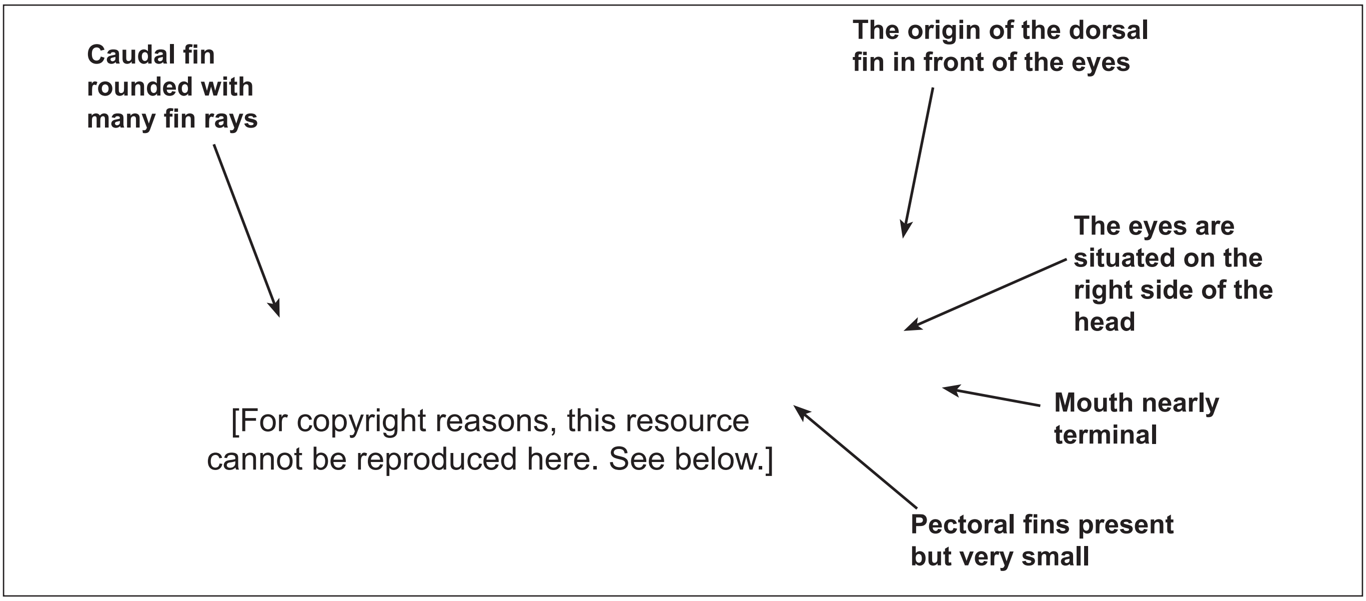

Figure 6. Picture of *Euryglossa harmandi*, a typical sole. http://www.mrcmekong.org/pdf/flatfish.pdf

Some species of Anglerfish are found several kilometres deep in the ocean under extreme conditions of constant darkness and high pressure. Figure 7 shows a typical anglerfish with some of the adaptations it has evolved to survive in these extreme conditions, including a bioluminescent lure and upward-pointing eyes. The bioluminescent lure attracts fish and other deep sea animals. In some species of anglerfish, the males are very small with very simplified body features and live as parasites on the females. Their sole purpose is to find a female and to deliver sperm to fertilise the eggs.

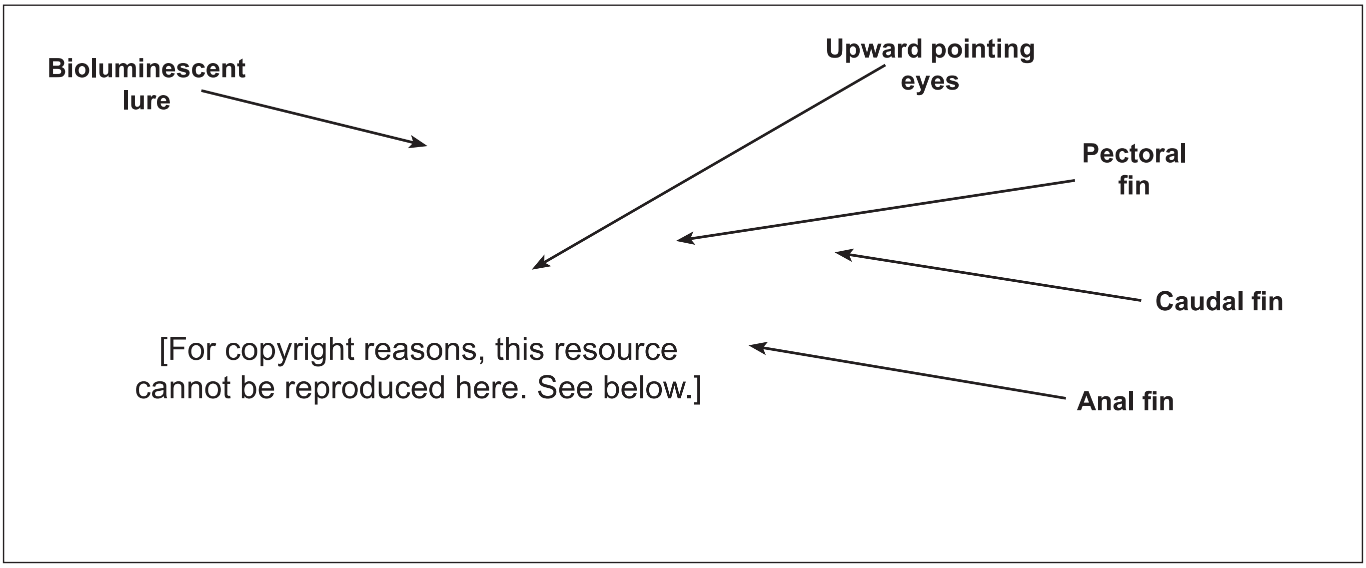

Figure 7. Picture of *Melanoctus johnsoni*, a deep sea anglerfish. http://www.mbayaq.org/efc/living_species/default.asp?hOri=0&hab=9&inhab=16z

The three examples shown represent just some of the diversity found in bony fish.

Use the diversity of the fish and/or any other named group(s) to discuss the following statement:

'Diversity is the end product of evolution.'