

MATRICULATION AND SECONDARY EDUCATION CERTIFICATE EXAMINATIONS BOARD
UNIVERSITY OF MALTA, MSIDA

MATRICULATION CERTIFICATE EXAMINATION
ADVANCED LEVEL
MAY 2006

SUBJECT:	BIOLOGY
PAPER NUMBER:	II
DATE:	16 th May 2006
TIME:	4.00 p.m. to 7.00 p.m.

Directions to Candidates

- *Answer ALL questions in Section A, any TWO questions from Section B and ONE question from Section C. Write all your answers in the separate booklet provided.*
 - *If more than two questions from Section B are attempted, only the first two answers shall be taken into consideration.*
 - *If more than one question from Section C is attempted, only the first answer shall be taken into consideration.*
 - *The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated.*
 - *You are reminded of the necessity for good English and orderly presentation in your answers.*
 - *In calculations you are advised to show all the steps in your working, giving your answer at each stage.*
 - *The use of electronic calculators is permitted.*
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SECTION A (Answer all questions in this section):

1. Read the extract below carefully and afterward, from the information given and from your knowledge of biology, answer the questions that follow. The numerals in the left-hand margin are line numbers.

INVASIVE SPECIES HARMS NATIVE HARDWOODS

CAMBRIDGE, Mass. -- An invasive weed that has spread across much of the U.S. harms native maples, ashes, and other hardwood trees by releasing chemicals into the soil. The tree-stifling alien, garlic mustard (*Alliaria petiolata*), first introduced into the U.S. in the 1860s, has since spread to Canada and 30 states in the East and Midwest, with recent sightings as far west as Oregon.

"While vanishing habitat caused by human activity is the number one threat to biodiversity, there is great concern over the impact of accidental and intentional dispersal of alien invasive species across the globe," says Kristina A. Stinson, a plant population biologist at the Harvard Forest. "In North America, thousands of non-native plants and animals have become established since European settlement and many more continue to be introduced. Some alien species cause little harm, while others can become very aggressive and radically transfigure their new habitat. The mechanisms for this phenomenon and its potential long term impacts remain poorly understood," Stinson adds, "but one possibility is that invasive species may disrupt fragile ecological relationships that evolved over millions of years."

The forest trees that are affected by the presence of garlic mustard are known to form mutually beneficial relationships with arbuscular mycorrhizal fungi (AMF). These fungi have long filaments that penetrate the roots of plants, forming an intricate interwoven network that effectively extends the plant's root system. When tree seedlings, which depend strongly on AMF, began to decline in the presence of garlic mustard, the researchers suspected that the invasive plant might thwart this relationship. To test this possibility, they collected soil from five forests in Ontario dominated by four species of native hardwoods. First, the researchers tested seedlings' ability to form mycorrhizal relationships in soil with a history of garlic mustard invasion. Three species -- sugar maple, red maple, and white ash -- had significantly less AMF root colonization and grew only about one-tenth as fast in the infested soil. Seedlings grown in sterilized, AMF-free soil taken from invaded and pest-free locations showed similar reductions. Other experiments showed that adding garlic mustard extracts to soil impaired AMF colonization and seedling growth, implying that the weed uses phytochemical poisons to disrupt native plants' mycorrhizal associations and therefore stunt their growth.

When the study was subsequently replicated with seedlings of 16 other native plants, only the hardwoods and other woody plants were harmed by the presence of garlic mustard whilst non-woody plants were unaffected.

Adapted from: Harvard University News Release; 25th April 2006

- 1.1 Garlic Mustard is referred to in the passage as an "invasive weed" (line 1). What is an invasive species?

[one mark]

- 1.2 "...there is great concern over the impact of accidental and intentional dispersal of alien invasive species across the globe," (lines 8-9). Why is such a process now a greater cause of concern than it may have been in the past?
[two marks]
- 1.3 What name is given to the ecological interaction between arbuscular mycorrhizal fungi and forest trees?
[one mark]
- 1.4 How may the interaction between arbuscular mycorrhizal fungi and forest trees benefit both these organisms?
[three marks]
- 1.5 The presence of Garlic Mustard ultimately leads to a reduction in numbers of forest trees. Does Garlic Mustard harm trees directly or does it harm them indirectly by affecting arbuscular mycorrhizal fungi? Support your conclusions by referring to the experimental results summarised in the passage (lines 24-33).
[four marks]
- 1.6 Why are non-woody species not harmed by the presence of Garlic Mustard (lines 35-37)?
[two marks]
- 1.7 Use your knowledge of ecological interactions and evolutionary processes to predict possible short-term effects (over a span of decades) and long-term effects (over a span of centuries or millennia) of competition between trees and Garlic Mustard on forest ecosystems in North America.
[four marks]
- 1.8 Garlic Mustard is not known to cause major ecological disruption in its native European forests. Suggest reasons that may explain this observation.
[three marks]

[Total: twenty marks]

2. The Striped Weakfish, *Cynoscion guatucupa* is a typical benthic (bottom-dwelling) inhabitant of estuaries and coastal regions, where it can be found throughout the year. The role of this fish species as a bio-indicator of organochlorine pesticides (OCP) was investigated in Bahía Blanca estuary in Argentina. Various fish tissues were analysed for OCP content over one reproductive cycle. The major OCP derivatives were endsulphate, pp'-DDE, chlordanes and gamma-HCH, all of which are lipid-soluble. The results obtained are represented graphically below.

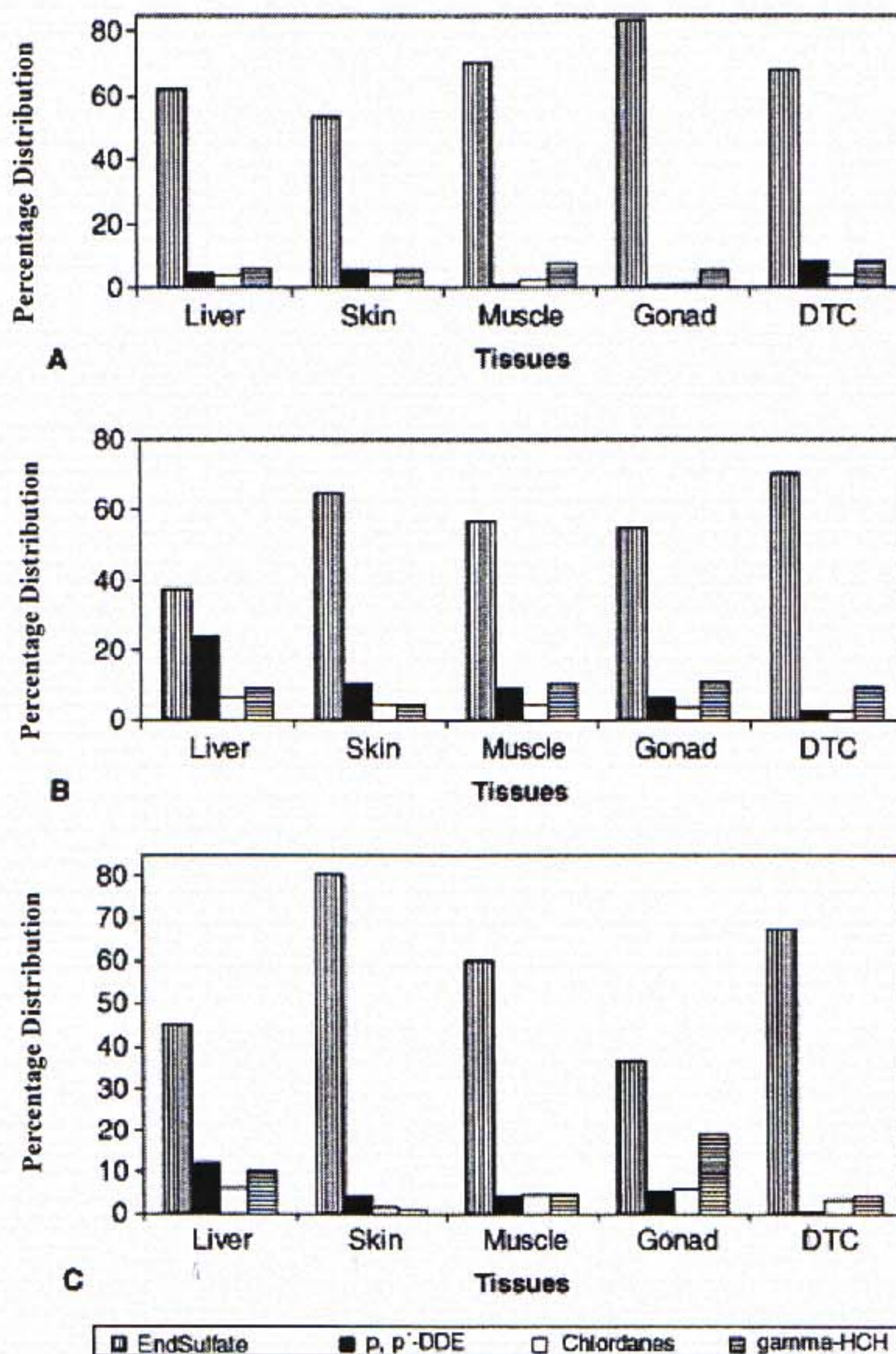


Figure 1: Distribution pattern of the major OCP compounds in *Cynoscion guatucupa* tissues from Bahía Blanca, estuary, Argentina. A: Juveniles, B: Male adults, C: Female adults. DTC stands for digestive tract content. The values on the y-axis represent percentage distribution in organs.

- 2.1 What is a bio-indicator? [two marks]
- 2.2 Comment on the distribution of OCPs in the tissues of juveniles. [three marks]
- 2.3 Comment on the accumulation of OCPs in juveniles relative to accumulation of OCPs in adults. [four marks]
- 2.4 Try to account for the lower level of some OCPs in females relative to that in males. [four marks]
- 2.5 Why is the use of bio-indicator species like *Cynoscion guatucupa* a better indication of pollution than chemical analysis of a sample of water? [three marks]
- 2.6 Why are fish generally not ideal bio-indicator species for a particular location? [two marks]
- 2.7 Which of the three, males, females or juveniles do you consider to be the best bio-indicator of OCP pollution? Justify your answer. [two marks]

[Total: twenty marks]

SECTION B

(Answer any **TWO** questions from this section; your answers should take the form of essays. Each question carries twenty marks).

3. Gymnosperms and angiosperms are classified as subdivisions of the same major group of plants. Describe the features which allow these two groups to be classified in the same major group and those which are used to place them in separate sub-groups.
4. Describe the role of respiratory pigments in oxygen transport in a mammal.
5. Give an overview of techniques of DNA analysis and profiling.
6. Briefly compare the advantages and disadvantages of internal and external skeletons and describe how mechanical support is achieved by different groups in the animal kingdom.

SECTION C

(Answer **ONE** question from this section).

7. Use your knowledge of biology to explain the following:

- 7.1 Avian Influenza Virus affects birds but does not usually affect other animals.
- 7.2 Antibiotics do not confer protection against Influenza.
- 7.3 The current trivalent influenza vaccine is recommended to people at high risk of exposure to the highly pathogenic H5N1 strain of Avian Influenza Virus even though it is relatively ineffective against this virus.
- 7.4 A possible Avian Influenza Virus pandemic is unlikely to affect all infected individuals.

[five marks each]

[Total: twenty marks]

8. Use your knowledge of biology to explain the following:

- 8.1 The mutant HbS allele for sickle cell anaemia is very common in African and Middle Eastern gene pools even though it causes the sickle-cell trait.
- 8.2 During a second pregnancy a rhesus-negative mother is given suppressant drugs in order to ensure she brings her pregnancy to term.
- 8.3 Despite great progress and advances in medical research, no drug able to effectively destroy the HIV virus has as yet been produced.
- 8.4 Depletion of the ozone layer may lead to accelerated rates of evolutionary change.

[five marks each]

[Total: twenty marks]