PART IB ANIMAL BIOLOGY

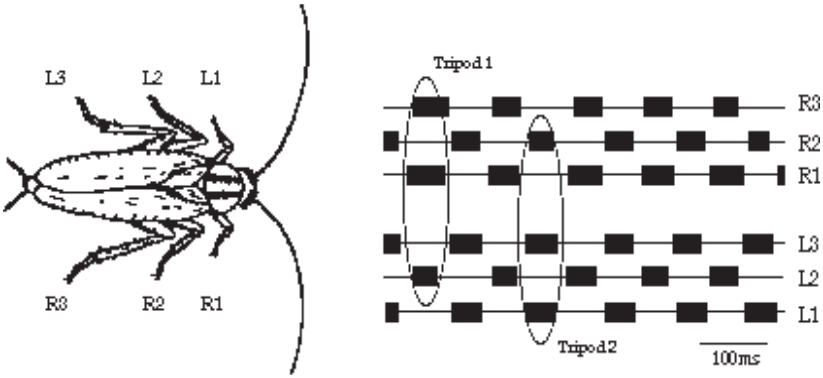
Part IB Animal Biology is characterised by diversity: that of animals themselves, and of the ways in which they are studied. The course comprises five half-term sections: *Behaviour and Ecology, Brains and Behaviour, Insect Biology, Vertebrate Evolutionary Biology* and *Evolutionary Principles.* These sections are described on the following pages.

Practical work, which is assessed continuously, consists of experiments, observation of specimens and dissections. Films, computer simulations, seminars and museum tours are used as appropriate. Students receive instruction in the written presentation of their practical work.

If you require more information, please contact Dr Berthold Hedwig in the Department of Zoology [telephone (3)36603, e-mail bh202@cam.ac.uk]. The current Animal Biology Course Handbook, containing lecture synopses etc., is available in the Elementary Laboratory, Department of Zoology.

Information about the many activities within the Department of Zoology may be found at its website:

http://www.zoo.cam.ac.uk



Walking pattern of a cockroach

Aims, objectives and learning outcomes of the course

Aims

- To show how the form, function and behaviour of animals become adapted to the environment through evolution.
- To elucidate general biological principles through the study of specialised or experimentally tractable systems.
- To prepare students for Part II courses that require knowledge of animal biology at the systems and organismal levels.
- To develop students' practical scientific skills.

Objectives

- To provide lectures in behavioural ecology, neuroethology, insect biology, vertebrate evolution and animal physiology. Students will be acquainted with current ideas by lecturers who are actively researching in these fields.
- To advise on supervisions on the lecture material, consolidating what has been learned and developing students' abilities to discuss critically the course material, verbally and in writing.
- To provide practical classes, illustrating topics discussed in the lectures, and cultivating experimental, observational and scientific writing skills.
- To monitor students' practical work by continuous assessment.
- To examine students in two theory papers at the end of the course.

Learning outcomes

At the end of the course, students should:-

- Be able to develop cogent and critical arguments based on the course material.
- Have an enhanced ability to perform, analyse and report on experiments in animal biology, and to interpret observations in terms of function and the effect of natural selection.
- Be able to integrate related topics from separate parts of the course.

With which other Part IB courses is Animal Biology compatible?

Animal Biology can usefully be combined with many other Part IB courses. It is a good companion course to **Plant Sciences**, and provides a 'whole animal' perspective complementary to those of **Cell and Developmental Biology**, and **Biochemistry and Molecular Biology**. Some examples (by no means exhaustive) of how Animal Biology can relate to other Part IB courses are as follows:-

- All sections of the course contain material relevant to **Ecology**.
- Topics in the *Behaviour and Ecology* and *Brains and Behaviour* sections are likely to be of particular interest to students also taking **Experimental Psychology**.
- Much of Animal Biology has an evolutionary theme. Parts of the *Vertebrate Evolutionary Biology* section relate well to topics in **Geological Sciences A**.
- The sections *Brains and Behaviour, Insect Biology* and *Evolutionary Principles* discuss material relevant to **Physiology**.
- *Behaviour and Ecology, Brains and Behaviour, Insect Biology* and *Vertebrate Evolutionary Biology* complement topics in **Neurobiology**.

Previous experience

Whilst it may be an advantage to have taken Part IA Evolution and Behaviour, it is not **necessary** to have taken this or any other particular first year course. Nor is it necessary to take particular accompanying courses in Part IB. Interested students who have no experience of biological courses in Part IA are advised to consult Dr Berthold Hedwig in the Department of Zoology [telephone (3)36603; e-mail bh202@cam.ac.uk].

Suggested background reading

Bateson, P. and Martin, P. (2001). *Design for a life: how biology and psychology shape human behavior*. Touchstone Books, London.

Boyd, C.A.R. and Noble, D. eds. (1993). *The logic of life*. Oxford University Press, Oxford.

Dawkins, R. (1999). *The extended phenotype*. Oxford University Press, Oxford.

Dawkins, R. (1990). *The selfish gene*. Oxford University Press, Oxford.

Eisner, T. (2003). *For love of insects*. Cambridge, MA: The Belknap Press of Harvard University Press.

Gould, S.J. (1994). *Eight little piggies*. Penguin, London.

Gould, S. J. (2000). *The lying stones of Marrakech: penultimate reflections on natural history*. Three Rivers Press. Note: All of Gould's books of essays are worth reading.

Jones, S. (2000). *Darwin's ghost: the Origin of Species updated*. Random House, London.

Mayr, E. and Diamond, J. (2002). *What evolution is.* Basic Books, New York.

Ridley, M. (1995). *The Red Queen: sex and the evolution of human nature.* Penguin, London.

Ridley, M. (2003). *Nature via Nurture*. HarperCollins, London.

Schmidt-Nielsen, K. (1970). *How animals work.* Cambridge University Press, Cambridge.

Some of the references used during the course

MICHAELMAS

Behaviour and Ecology

Alcock, J. (2005) *Animal Behaviour*, 8th Edition. Sinauer.

Krebs, J.R. & Davies, N.B. (1993) *An Introduction to Behavioural Ecology*, 3rd edition. Blackwell Scientific Publications.

Brains and Behaviour

Simmons, P.J. & Young, D. (1999) *Nerve Cells and Animal Behaviour*, 2nd edition. Cambridge University Press.

Delcomyn, F. (1998) *Foundations of Neurobiology*, Freeman.

Shepherd, G.M. (1998) *Neurobiology*, 4th edition. Oxford University Press.

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Insect Biology

Chapman, R. F. (1998) *The Insects: Structure and Function*, 4th edition, Cambridge University Press.

Gullan, P.J. & Cranston, P.S. (2000) *The Insects. An Outline of Entomology,* 2nd edition. Blackwell

Hölldobler, B. & Wilson, E.O. (1990). *The ants*. Cambridge, Mass.: Belknap Press.

Vertebrate Evolutionary Biology

Kardong, K.V. (1995) *Vertebrates. Comparative Anatomy, Function, Evolution*. William C. Brown.

Liem, K.F., Bemis, W., Walker, W.F. & Grande, L. (2001). *Functional Anatomy of the Vertebrates*. 3rd Edition Harcourt College Publishers. ISBN 0-03-022369-5. Colour figures can be downloaded from: http://www.bio.umass.edu/biology/bemis/FAOV_PPTS/FAOV3.htm

Pough, F.H., Heiser, J. B. & McFarland, W.N. (1995) *Vertebrate Life*, 4th edition. Prentice Hall International.

Ridley, M. (1996) *Evolution*, 2nd edition. Blackwell Scientific Publications.

EASTER

Evolutionary Principles

Withers, P.C. *Comparative Animal Physiology*.

Pough, F.H., Heiser, J. B. & McFarland, W.N. (1995) *Vertebrate Life*, 4th Edition. Prentice Hall International.

Little, C. (1990) *The Terrestrial Invasion*. Cambridge University Press.

ANIMAL BIOLOGY 2007/2008

Lectures: **Fri, Mon, Wed 11-12, Main LectureTheatre, Department of Zoology**

Practicals: **Wed 12-5 or Thu 12-5, Elementary Laboratory, Department of Zoology**

MICHAELMAS

Behaviour and Ecology

Lectures	
Prof Nick Davies	**Fri 5 - Wed 17 Oct**
Dr Rebecca Kilner	**Fri 19 Oct - Wed 31 Oct**
Practicals	**Wed 10 Oct - Thu 1 Nov**

Brains and Behaviour

Lectures	
Prof Simon Laughlin	**Fri 2 Nov - Wed 14 Nov**
Prof Malcolm Burrows	**Fri 16 Nov - Wed 28 Nov**
Practicals	**Wed 7 Nov - Thur 29 Nov**

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Insect Biology

Lectures	
Dr Walter Federle	**Fri 18 Jan - Wed 30 Jan**
Dr William Foster	**Fri 1 Feb - Wed 13 Feb**
Practicals	**Wed 23 Jan - Thu 14 Feb**

Vertebrate Evolutionary Biology

Lectures	
Prof Jenny Clack	**Fri 15 Feb - Wed 27 Feb**
Dr Robert Asher	**Fri 29 Feb - Wed 12 Mar**
Practicals	**Wed 20 Feb - Thu 13 Mar**

EASTER

Evolutionary Principles

Lectures	
Dr Rufus Johnstone	*** Wed 23 Apr - Mon 5 May**
Dr Nick Mundy	**Wed 7 May - Mon 19 May**
Practicals	**Wed 23 Apr - Thur 8 May**

**Note the early start this Term*

MICHAELMAS TERM

Behaviour and Ecology

Prof Nick Davies (e-mail n.b.davies@zoo.cam.ac.uk, tel. 34405)
Dr Rebecca Kilner (e-mail rmk1002@cam.ac.uk, tel. 31766)

Aims. To introduce the scientific study of animal behaviour, showing how predictions can be derived from evolutionary theory and tested by comparative studies and experiments. To encourage the ability to think critically about how well observations match theoretical predictions and to consider alternative hypotheses.

The first two lectures give an evolutionary perspective of how animal survival and reproductive strategies relate to their physical environment and an environment consisting of competitors and predators. Then follow ten lectures considering in detail the various problems individuals have concerning survival and reproduction: foraging, avoidance of predators and brood parasites, habitat selection, mate choice, parental care, development and co-operation and conflict in societies. Throughout the course the emphasis is on the links between ecology, behaviour and evolution. Ecological factors provide the stage on which behaviour is played and, during evolution, natural selection will favour those behavioural strategies which maximise an individual's chances of survival and its reproductive efficiency. In the last lecture we consider how an understanding of behaviour can contribute to animal welfare.

The practicals involve experiments to test some of the hypotheses discussed in the lectures so students will gain first-hand experience of collecting and analysing quantitative data on behaviour, of testing alternative predictions, and of writing concise reports to summarise conclusions.

Red deer stag roaring at the start of a fight with a rival (photograph Tim Clutton-Brock)

Brains and Behaviour

Prof Simon Laughlin (e-mail s.laughlin@zoo.cam.ac.uk, tel. 36608)
Prof Malcolm Burrows (e-mail m.burrows@zoo.cam.ac.uk, tel. 36601)

Aims. To describe the ways in which the brains of animals function, how they operate in the detection and processing of sensory information, how they organise responses to environmental change, how sensory and motor functions are integrated, and how nervous systems are involved in learning.

One of the most challenging problems of modern biology is to understand the organization of the brain, especially in the control of behaviour and learning. The course draws upon examples of the specialized behaviour of certain animals and explains how their neurones and brains function. The lectures are designed to develop an understanding of common principles of neural function that are shared by a wide range of animals. These principles include the roles played by sensory and motor systems in permitting the exploitation of different habitats and the development of different lifestyles, how nervous systems generate reliable patterns of behaviour, and the logical progression from the simple to the more complex. Specific topics include:

- an introduction to the cellular basis of neural processing
- capturing and interpreting pictures of the world with compound eyes
- how bats and owls hunt in the dark with sound
- information from odour
- electrical signalling in the murky world of electric fish
- simple mechanisms for generating motor patterns
- control of locomotion in different environments

The first practical investigates motor mechanisms in insects. The second practical is concerned with the electric discharges and electric sense found in certain families of fish. A seminar provides the opportunity to discuss the ethics of the use of animals in science.

LENT TERM

Insect Biology

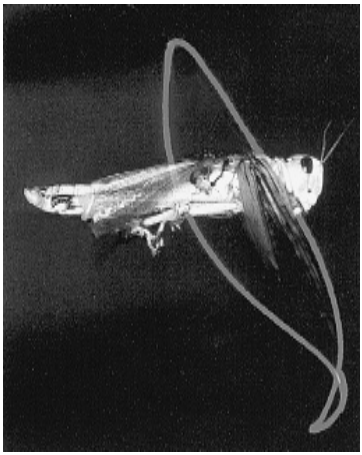
Dr William Foster (e-mail waf1@cam.ac.uk, tel. 36615)
Dr Walter Federle (e-mail wf222@cam.ac.uk, tel. 63435)

Aims. To provide an understanding of the biology of the most successful animals on Earth, the insects, in particular their physiology, locomotion, feeding biology, mating and reproductive behaviour, and the evolution of their social behaviour. To show how the study of insects contributes to our understanding of broad principles of physiology and evolutionary biology. To provide students with direct experience of handling, observing and studying living insects.

Insects are the most abundant and successful group of land animals. The course will seek to explain the secret of the insects' success by a detailed study of insect design and the adaptations of this design to an enormous diversity of life styles.

The lectures will cover insect cuticle, sense organs, respiration, water balance, locomotion, insect parasitoids, mating strategies, and the evolution of insect societies.

The practical classes will explore the physiology, structure, behaviour and classification of insects, and are supported by the wealth of insect material in the University Museum of Zoology.



Locust in flight.
The path of the tip of the forewing is traced by a light source on the wing

(Berthold Hedwig)

Vertebrate Evolutionary Biology

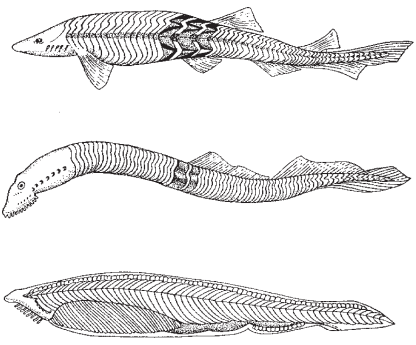
Prof Jenny Clack (e-mail j.a.clack@zoo.cam.ac.uk, tel. 36613)
Dr Robert Asher (e-mail r.asher@zoo.cam.ac.uk, tel. 36680)

Aims. To demonstrate that an integration of developmental and evolutionary studies enhances our understanding of vertebrate biology. To explore major evolutionary transitions and the adaptive radiations of living and extinct groups of vertebrates.

The first lecture will introduce the different groups of vertebrates, familiar and unfamiliar, and briefly outline their relationships. The second lecture will cover vertebrate embryology, and introduce some basic concepts of vertebrate structure. Some examples of 'primitive' vertebrates will be introduced in more detail. The third lecture will deal with vertebrate hard tissues, their structure, origin and distribution in the body and throughout the vertebrate family tree. The structure of the skull will be introduced. In the fourth lecture, the structure of the post-cranial skeleton - limbs, fins, vertebrae, will be studied, while the fifth looks at blood circulation and breathing. A lecture on sensory systems completes this part of the course and recaps the previous material.

In the second part of the course, the biology of amniotes is considered to illustrate how a common set of embryological features unifies a vertebrate group whose members otherwise appear to be quite diverse. Topics include amniote diversity, embryonic adaptations, the evolution of viviparity, heart and circulatory systems in relation to mode of life, locomotor systems and their design, feeding mechanisms and head structure, and hearing in amniotes.

The lectures in both halves of the course are backed-up by practical classes designed to teach the elements of vertebrate structure, function and diversity.



EASTER TERM

Evolutionary Principles

Dr Rufus Johnstone (e-mail r.a.johnstone@zoo.cam.ac.uk, tel. 36685)
Dr Nick Mundy (e-mail nim21@cam.ac.uk, tel. 36657)

Aims. This module will review the fundamental theories underlying evolutionary biology, and consider the methods available to interpret, understand and predict the pattern and process of evolution.

An understanding of evolutionary processes is of fundamental importance in Animal Biology. This module will investigate how organisms evolve at both phenotypic and genotypic levels, building up from models of evolution in populations to large-scale macroevolutionary patterns. We will examine the mechanisms of adaptation in populations involving single or multiple loci and how these can lead to predictions of future evolutionary change. The important topic of reproductive isolation among populations, and hence speciation, will also be considered. In the final series of lectures we will discuss the powerful methodology that has been developed to uncover phylogenetic relationships among organisms, and the patterns and processes of character evolution.

The practicals will provide an introduction to some commonly used methods to reconstruct phylogenies and investigate evolution in a comparative framework.

Scanning electron micrograph of cod gill lamillae vasculature

(Bob Boutilier)