2nd Year Tutorials: Ecotoxicology (No. 14)

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Aims: This series of six tutorials aims to provide a broad based introduction to the field of ecotoxicology. In particular, it aims to introduce students to aspects of pollution and of its effects upon individual organisms, populations and whole ecosystems. The emphasis is upon aquatic systems and includes a consideration of analytical rationales used in environmental monitoring and a brief introduction to instrumental analysis.

The tutorials are conducted on the basis that enough background information is made available to each student to avoid the need (or temptation) to access internet sources and uncritically reproduce the information found there.

The tutorials are conducted in five one hour sessions and one half hour session at approximately bi-weekly intervals during the Lent Term. The topics covered in each tutorial are as follows:

Plans

1. Toxicity testing and its uses. This tutorial explores toxicity testing, detailing standard methods, standard test organisms. This includes the importance of standardised test conditions and organisms and briefly explores the statistical interpretation of data. The student is introduced to terms such as LC_{50}; $EC_{50;}$ LD_{50} and the coupling of these with fixed test timings. The tutorial is conducted in the format of a broad-based but directed discussion with students encouraged to contribute through direct questioning. During this tutorial a number of resource materials are handed out for later reading and samples of these are enclosed as attachments 1-5A. At the conclusion of this tutorial tasks are allocated as a basis for the following tutorial.

2. The second tutorial is based around individual presentations on the manufacture, use and environmental impact of toxic trace metals. Students are instructed to use the information resources in the University Library to construct a profile in short note form and to present the information to the group as a whole. With this exercise, the depth and scope of the discussion is to large degree constrained by the number of tutees. The fewer tutees, the more in depth the discussion. Nonetheless, even with large numbers attending the tutorials this serves as a useful exercise in establishing whether tutees are familiar with the library information resources (and any limitations) and the degree of effort that they have made to research the subject. Output from this tutorial is in the form of short notes which are collected at the end. Specimens from 1998-99 are included. The group are also handed further research/review papers to serve as a basis for developing the discussions within the group: Attachments 6-9.

3. The third tutorial is based largely upon attachments 10-13 and deals broadly with the problems associated with persistent organic pollutants. In particular it addresses the issue of PCBs as a case study, but considers also the problems associated with the

PCDDs/PCDFs and the organochlorine pesticides. The global fractionation/distillation theory is dealt with in some depth particularly in relation to impacts upon the arctic regions. At the conclusion of the tutorial an essay is set with PCBs as the thematic and examples from 1998-99 are included. The essays are used as a basis for discussion in the following tutorial. Source material for these discussions is in the form of Attachments 14-16

4. Tutorial four is largely concerned with discussion of the produced essays, the depth of discussion being contingent upon group numbers. In 1998-99 there were only 2 tutees and it was possible to have a full discussion of the produced essays and to detail areas of potential improvement. In larger classes, the essays are returned marked and commented upon to each student and a discussion is held to identify areas of difficulty and resolve them. At this tutorial a further essay is set on the relevance or future of ecotoxicology in which the student is assigned the task of critically discussing and assembling the information covered in the tutorial as a whole. The balance of the tutorial is given over to a discussion of risk assessment and risk management as a basis for the formulation of policy and regulatory instruments which takes place outside of a strict scientific domain.

5. Tutorial five is largely concerned with a (necessarily) brief introduction to instrumental analysis techniques. Students are shown examples of machines used in instrumental analysis including ICP-AES and GC/GCMS and these are explained in simple terms together with details of the sample collection and preparation involved in analysis of each type.

6. Tutorial six is a short half hour session in which the final essay is returned to the members of the group and discussed.

Assessments

Assessment of the activities and output of members of the group is conducted on a continuing basis in relation to the quality and extent of their contribution to discussions in the tutorial. Records of attendance are kept and notes made of each students contribution. At the conclusion of the programme each student should have a good working knowledge of the basic elements involved in ecotoxicological studies and the basis upon which these are extrapolated to legislation via the process of risk assessment. Marks are recorded and returned to the course supervisor. Essays/written work are assessed upon the content in relation to the information provided to the students, upon the clarity with which this has been assembled and the care with which the assigned tasks have been carried out.

Attainments

Examples of student work, together with completed mark sheets are attached. It should be noted that examples of work do not bear marks and commentary. Marked original/copy

essays and notes were returned to the students. In 1998/99 group discussion formed the major element of feedback..

Evaluations

Student feedback forms are attached.

Development

An increased number of students enrolled for the course in 1999/2000 will involve only minor changes to the course content. The chief modification will be the incorporation of a visual presentation using slides to illustrate the practical difficulties involved in ecotoxicological studies. This modification will be emplaced since discussion with the students has indicated that those without field experience may have difficulties visualising the "real world" situations encountered

Resource Materials

The materials supplied are a mixture designed for specific essay orientated reading and more general articles designed to fuel discussions:

1.Johnston, PA; (1987) Acute toxicity of inorganic selenium to *Daphnia magna* (Straus) and the effect of sub-acute exposure upn growth and reproduction. Aquatic Toxicology 10: 335-352

Introduction to single species toxicity testing and subsequent data handling

2.Johnston, P; Stringer, R; Santillo, D; Howard, CV; (1998) Hazard Exposure and Ecological Risk Assessment. Chapter 9 In: Nath, B; *et al.* [eds] Environmental Management in Practice: Volume 1. Instruments for Environmental Management. Publ. Routledge, London.

Extends toxicity testing into uses in hazard and risk assessment. Discussion of extrapolation of results to whole ecosystems. Note self assessment questions at end of chapter.

3.Cairns, J: (1989) Applied Ecotoxicology and Methodology. Chapter 6: In Boudou, A; Ribeyre, F; [eds] Aqautic Ecotoxicology: Fundamental Concepts and Methodologies, Publ. CRC Press, Boca Raton.

Description and discussion of ecotoxicological methods and concepts for background inforamtion

4.Cairns, J; (1995) The Genesis of Ecotoxicology. Chapter 1 In: Cairns, J; Niederlehner, BR; [eds] Ecological Toxicity Testing: Scale, Complexity, and Relevance. Publ. Lewis Publishers, Boca Raton

Outline of the historical development of ecotoxicology as a scientific and regulatory discipline

5 (a) Cairns, J; (1984) Are single species toxicity tests alone adequate for estimating environmental hazard? Environmental Monitoring and Assessment 4: 259-273

5 (b) Cairns, J; (1986) The myth of the most sensitive species. BioScience 36 (10): 670-672

Two papers which serve as a basis for discussion around the issue of translation of toxicity test results to real ecosystems

6 . Nriagu, JO; Pacyna, JF; (1988) Quantitative assessment of world wide contamination of air, water and soils by trace metals. Nature 333: 134-139

Authoritative paper on mobilisation of metals into the global environment

7.Nriagu, JO; (1994) Mercury pollution from the past mining of gold and silver in the Americas. The Science of the Total Environment 149: 167-181

A historical perspective to illustrate that metal contamination problems can be traced back a long way. In this case to the mid 1500s

8.Nriagu, JO; (1990) The rise and fall of leaded gasoline. The Science of the Total Environment 92: 13-28

A more modern example which broaches the subject of science and policy

9. Nriagu, JO; (1990) Global metal pollution. Poisoning the Biosphere. Environment 32 (7): 7-11, 28-33.

A more accessible treatment of the materials and data contained in Attachment 6.

10.Tanabe, S; (1988) PCB problems in the future: foresight from current knowledge. Environmental Pollution 50: 5-28.

A broad overview of the PCB issue

11: Wania, F; Mackay, D; (1996) Tracking the distribution of persistent organic pollutants. Environmental Science and Technology 30 (9): 390A-396A.

An overview of the properties of persistent organic pollutants and their environmental behaviour grounded in the concept of global fractionation/distillation

12.Jacobs, MN; Santillo, D; Johnston, PA; Wyatt, CL; French, MC; (1998) Organochlorine residues in fish oil dietary supplements: Comparison with industrial grade oils. Chemosphere 17 (9-12): 1709-1721

Description of impact of global release and redistribution of organochlorine pollutants upon food chains using fish oils as an illustration

13.Simmonds, MP; Johnston, PA; French, MC; Reeve, R; Hutchinson, JD; (1994) Organochlorines and mercury in pilot whale blubber consumed by Faroe islanders. The Science of the Total Environment 149: 97-11

Unusual example of food chain contamination with organochlorine chemicals

14. Johnston, PA; Stringer, RL; French, MC; (1991) Pollution of UK estuaries : historical and current problems. The Science of the Total Environment 106: 55-70

Discussion of the regulation of complex effluents in the UK context

15. Santillo, D; Stringer, RL; Johnston, PA; Tickner, J; (1998) The precautionary principle: Protecting against failures of scientific method and risk assessment. Marine Pollution Bulletin 36 (12): 939-950

Discussion of regulation in the context of ecotoxicology and risk assessment.

16. Johnston, P; Santillo, D; Stringer, R; (1999) Marine environmental protection, sustainability and the precautionary principle. Natural Resources Forum 23: 157-167

Development of arguments and discussions covered in Attachment 15.