LSC Use Only
Number: ________
Action: ________
Date: ________

UWUCC Use Only
Number: 91-18
Action: ________
Date: ________

CURRICULUM PROPOSAL COVER SHEET
University-Wide Undergraduate Curriculum Committee

I. Title/Author of Change

Course/Program Title:	Biology of Higher Invertebrates
Suggested 20 Character Course Title:	Higher Invertebrates
Department:	Biology
Contact Person:	Robert S. Prezant

II. If a course, is it being Proposed for:

✓ Course Revision/Approval Only
___ Course Revision/Approval and Liberal Studies Approval
___ Liberal Studies Approval Only (course previously has been approved by the University Senate)

III. Approvals

Robert P. Hendron, Alicia V. Linzey — Department Curriculum Committee
Allan T. Andrew — Department Chairperson

[signature] — College Curriculum Committee
[signature] — College Dean*

________ Director of Liberal Studies (where applicable)
________ Provost (where applicable)

*College Dean must consult with Provost before approving curriculum changes. Approval by College Dean indicates that the proposed change is consistent with long range planning documents, that all requests for resources made as part of the proposal can be met, and that the proposal has the support of the university administration.

IV. Timetable

Date Submitted to LSC: ________

to UWUCC: ________

Semester to be implemented: ________

Date to be published in Catalog: ________

BI 420/520 Biology of Higher Invertebrates 2c-3l-3sh A phylogenetic overview of the higher invertebrates, Annelida through lower Chordata. A systematic approach on functional morphology and microstructure, behavior and physiology, under an evolutionary umbrella. Laboratory sessions offer additional research opportunities. Pre-requisites - BI 120

Biology of Higher Invertebrates
BI 420/520

COURSE SYLLABUS AND PREFACE

COURSE DESCRIPTION: Biology of Higher Invertebrates 2c-3l-3sh

A phylogenetic overview of the higher invertebrates, Annelida through lower Chordata. A systematic approach on functional morphology and microstructure, behavior and physiology, under an evolutionary umbrella. Laboratory sessions offer additional research opportunities.

The "invertebrates" compose between 95 and 99% of all animals on planet earth. The insects alone rank at the top of the list in terms of numbers of species with somewhere between 1 and 30 million species! The discrepancy lies between the number already described and those predicted to be living in the tropical rain forests of the world but not yet described or even discovered. Many (very likely most) of these will never be seen as we continue our destruction of these forests. We are presently losing between 1 and 5 species per day. The invertebrates are a prime source for substances with active antiviral, antitumor, antibacterial, and antifungal properties. They are prime cues to the "health" of a habitat; offer unique models for human medical research (i.e. most of our knowledge on the function of nerves comes from giant squid axons; aging of cells is studied in nematodes); are used for basic medical treatment (i.e. leeches are making a significant comeback as a means to control localized hematomas arising from small surgical procedures; and are being used extensively in basic medical research (as experimental subjects). None of these are the primary reason we should study the invertebrates. It is the plethora of organisms that lack a backbone that dominate this planet (and indeed will inherit it); we share the earth with these organisms that have arisen well before any backboned creature, have succeeded well in excess of any chordate, and thrive where we cannot even dwell. To escape knowledge of the so-called invertebrates is to miss the basis of life on earth itself.

1. INTRODUCTION [numbers in brackets represent lectures on topic]
   A. Early metazoan evolution: Hadzi, Haekel, Hyman
      The debate concerning the origin and evolution of the multicellular animals [2]

   B. Protostomes vs deuterostomes: Distinction between two evolutionary lineages, taxonomic boondogle or a tool for embryological analyses? [1]

   C. Mechanisms of invertebrate evolution: gradualism, punctuated equilibrium and stasis [.5]

2. ANNELIDA
   A. Annelid roots and the origin of the coelom [.5]

   B. Polychaeta: functional morphology and adaptive radiation
      Divergence between filter feeders, deposit feeders and predators [1]

C. Oligochaetes: Reproductive success in cocoon building hermaphrodites [1]

D. Hirudinea: Parasites or carnivores
   Adaptations towards an unobtrusive life style [1]

3. MOLLUSCA
   A. HAM: The argument for an ancestral acoelomate [1]

   B. Are molluscs eucoelomate or have they retained their acoelomate link? An argument against a true body cavity [.5]

   C. Monoplacophora: Living fossils
      Were the ancestors of the molluscs segmented? [.5]

   D. Gastropoda: a twisted step "up" from HAM
      The pros and cons of coiling and torsion [1]

   E. Aplacophora: the vermiform molluscs
      Primitive or highly specialized molluscs? [.5]

   F. Polyplacophora: Pseudosegmentation and the molluscs
      Adaptations to rocky intertidal habitats [.5]

   G. Scaphopoda: The tusk shells as ancestors to the bivalves [.5]

   H. Bivalvia: Success without a head!
      Adaptations to a sedentary life style [1]

   I. Cephalopoda: The most intelligent invertebrates
      Eyes and brains on par with the vertebrates? [.5]

4. ONYCHOPHORA
   A. Missing link between annelids and arthropods? [.5]

5. ARTHROPODA
   A. The most successful animals: Why? [.5]

   B. Evolution of the exoskeleton; structure and formation
      The bolt to molt

   C. Uniramia: A flying success [1]

   D. Mandibulata: Radiation in a tagmatized group
      Benthic dominance? [1]

E. Chelicerata: Divergence on land and in sea
Horseshoe crabs and spiders: Living fossils and terrestrial denizens [1]

6. ECHINODERMATA
   A. The argument for pentaramous symmetry in bilaterally symmetrical animals [.5]

   B. Origins and evolutionary demise [1]

   C. Crinoidea; upside down but the early echinoderms? [.5]

   D. Asteroidea: Adaptive radiation success as a result of the water vascular system [1]

   E. Ophiuroidea: The most motile echinoderms [.5]

   F. Echinoidea: Fusion of the skeleton as a key to new radiations [.5]

   G. Holothuroidea: De-fusion of the skeleton as a key to new radiations [.5]

7. HEMICHORDATA
   A. Defense in soft bodied animals [.5]

   B. Acorn worms as a possible "source" for chordates? [.5]

8. CHORDATA
   A. Urochordata: Vertebrate's spineless cousins? [1]

   B. Dispersal mechanisms and patterns in tadpole larvae [.5]

REQUIREMENTS

Your knowledge of the higher invertebrates will be tested by a series of essay exams and research papers. A midterm and final essay exam will divide the term in appropriate halves. The final will, however, be cumulative in terms of basic concepts.

Two research papers are also required. These will cover topics of your choice, with my approval, that cover some conceptual aspect of invertebrate functional morphology, adaptive radiation and evolution. These papers will be based on primary literature and will not be a review of text information. Appropriate interpretation and conceptualization is expected. We will discuss these expectations in detail. You will also present a short (15 minute) oral review of your papers in class. You will be allowed full access to my personal library. Class trips to the library at the University of Pittsburgh can be arranged.

Graduate students are expected to have their second paper be the result of actual research. This research can be on any member or group of the higher invertebrates. The work can involve functional morphology, functional microstructure, behavior, physiology, etc. The research results will be used to support the final conceptual paper and report. Graduate students will be given 30 minutes for their final oral report. All oral reports are to be supported by visual aids (slides, overheads, etc.).

TEXT: Willmer, Pat. 1990. Invertebrate Relationships, Patterns in Animal Evolution. Cambridge University Press.

BIOLOGY OF HIGHER INVERTEBRATES
GRADING SCALE

UNDERGRADUATE:	MIDTERM EXAM	20%
	FINAL EXAM	30%
	1ST PAPER	15%
	1ST REPORT	5%
	2ND PAPER	20%
	2ND REPORT	10%
	TOTAL	100%
GRADUATE:	MIDTERM EXAM	15%
	FINAL EXAM	25%
	1ST PAPER	15%
	1ST REPORT	5%
	RESEARCH[1]	10%
	2ND PAPER	20%
	2ND REPORT	10%
	TOTAL	100%

[1]Research will be graded based on a critical analysis of appropriate questions, hypotheses, methods, procedure, summarization, and interpretation. Grading of the research project will be based on formulation of appropriate questions and using appropriate methods in an attempt to answer those questions. Failure in research only results from poor formulation of questions and inappropriate methods used to answer those questions.

A. DETAILS OF THE COURSE

A1. The proposed course will fill a particular void within the Department of Biology. Courses in zoology are presently offered that concentrate upon the vertebrates, insects and lower invertebrates (in terms of the parasitic forms) (i.e. Field Zoology, General Entomology, Applied Entomology and Zoonoses, Herpetology, Comparative Vertebrate Anatomy, Mammalogy, Parasitology) however the higher invertebrates, minus the insects, are neglected. There is no opportunity for students to gain an appreciation of the echinoderms, lower chordates, annelids, molluscs, and non-insect arthropods, outside of introductory (and thus cursory) courses. There are few (none that I know of) Universities that do not have a course offering in Invertebrate Zoology.

The course is designed for upper level biology undergraduates and graduate students. The course is directed particularly towards students who wish to broaden their biological perspectives and towards those students hoping to pursue a career in zoology. No biology student should depart from a collegiate education, without being exposed to upper level courses in organismal biology and, within animal biology, the invertebrates compose about 99% of the described taxa.

A2. This course requires no change in content of any other course offered.

A3. Biology of Higher Invertebrates will not be a traditional offering. The course will require graduate student projects in functional morphology or microstructure (with access to our scanning electron microscopes). Upper level undergraduates can opt for a project grading system as well. The opportunity to pursue research on higher invertebrates (non-insect and non-parasitic) will be relatively novel at IUP. Students will have the opportunity to pursue field or laboratory projects on terrestrial, fresh water or marine invertebrates using multidisciplinary techniques. The students will be expected to prepare a publication style manuscript based on their research and give an "open" seminar presentation at term's end. Previous experience with this type of course offering has yielded graduate students from the undergraduate cadre and has even produced research that was close to publication quality. Some previous students have, in fact, gone on to pursue their research topics and these have yielded publications.

Additionally, previous experience has shown that students learn an extensive amount of material, and more importantly, start to think critically, when given the opportunity to enter into debates on controversial topics in zoology. The required text offers many such opportunities. This format, that is opening topics to debate, has previously led to extensive and exciting "arguments" with students pursuing topics independently as they try to "score" debate points. This will continue to be incorporated into this course.

A4. This course has been offered at IUP twice as a special topics, in the Spring 1988 and Spring 1991. The course was not offered in time to be placed in the reported schedule, but still drew 7 students, 6 Biology majors and 1 Geoscience major the first time and presently 11 students, 6 being graduate. When I taught a comparable course at Wallop's Island Marine Science Consortium, 12 students signed up.

A5. This is a dual level course open to all students that have taken Animal Biology (BI 120) or another general zoology course. It has been approved by the Biology Graduate Committee.

A7. Most universities, as previously noted, offer courses in Invertebrate Zoology.

A9. Most zoological societies strongly recommend a course in Invertebrate Zoology. [eg. American Society of Zoologists, American Malacological Union]. See attached article prepared by Council of Systematic Malacologists.

B. INTERDISCIPLINARY IMPLICATIONS

B1. This course will be taught by a single instructor.

B2. General Zoology or Animal Biology is required.

B3. This course offers a strong background for courses in paleontology and evolution. The course will emphasize evolutionary adaptations and lineages. Fossil as well as recent taxa will be explored.

C. IMPLEMENTATION

C1. a. Faculty: Course will be taught by R.S. Prezant

b. Space and equipment: Space is available in one of the several biology teaching laboratories. Sufficient general equipment is already on hand within the department and in the laboratory of R.S. Prezant for handling most living invertebrates.

c. Laboratory supplies requested will include living invertebrates from a wide geographic range (i.e. west coast and Gulf coast specimens). Funds will be requested from the department to round out the supply of dissection specimens of higher invertebrates. A personal collection of R.S. Prezant will be used for demonstration material.

d. Library materials; journals that concern themselves with the higher invertebrates are poorly represented in the IUP library at the present time. There are excellent journals that are being requested for the library to round out our biological collection. Additionally, the library is lacking in texts that deal with non-insect higher invertebrates, but we are also attempting to correct this. Reprints and texts from the personal library of the instructor will supplement regular readings. Nearby University of Pittsburgh and the Carnegie have excellent journal and text resources for our use as well.

e. Departmental and College funds will be requested for one weekend field trip to a marine or estuarine habitat.

C3. This course has been offered as a special topic. It succeeded in drawing students with very little lead time. I suggest it be made a regularly offered course, offered every other year in the fall term.

C4. Only a single section of this course is anticipated.

C5. The course will attempt to accommodate15 students to allow optimum development of student projects.

C7. This course will not be required of Biology majors but will be listed among options within organismal related courses.

D. MISCELLANEOUS

It is disconcerting that we have hundreds of biology undergraduates going through a program in biological sciences without being exposed to the full diversity and wealth of the invertebrate animals. If we are to produce well rounded students, we must be sure they leave IUP with an appreciation for the non-vertebrate, non-insect, non-parasitic animals on this planet. The invertebrates, if you will, make up the "backbone" of the Animal Kingdom and not only all biology students, but all "students" should have an awareness of their ecological and evolutionary significance. We are neglecting a large part of our student's education by not at least giving them the opportunity to become exposed to the mechanistic beauty and overwhelming complexity of the higher invertebrates.

SENTENTĬA

REPORT ON COURSES ADVISED FOR GRADUATE STUDENTS IN THE FIELD OF MALACOLOGY

Prepared for the Council of Systematic Malacologists
by
Committee on Course Standards

George M. Davis, Chairman
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August 1983

PREFACE

The following report was prepared at the request of the Council of Systematic Malacologists (CSM) and presented to the Council during the 1983 annual meeting of the American Malacological Union in Seattle. Washington. The report was endorsed by the Council as part of the National Plan for Malacology. The report represents the views of CSM, an organization of professional malacologists particularly concerned with collection resource management and use of collections for research.

Malacologists are here defined as persons trained in molluscan systematics or whose interests in the biology of the Mollusca require intensive training in molluscan systematics. Today, such __ologists, whether Ichthyologist or Herpetologist, must be proficient in systematics, ecology and evolution. Those whose career interest are in developmental biology, physiology, ecology, genetics etc. would not call themselves a Malacologist unless their interests were essentially devoted to the Mollusca in some systematic way. Persons specializing in these other fields would require a different array of courses.

REPORT

Many students attending meetings of the American Malacological Union have asked for advice concerning training required to become a Malacologist. Most of these students were undergraduate or beginning graduate students with an interest in systematics, general biology of the Mollusca. or in some special molluscan group.

The courses listed below reflect that today one cannot do state of the art systematic work without understanding the ecology of organisms and without competence in the field of evolution. These interlocking fields require a working knowledge of genetics, mathematics, and statistics.

The following list was compiled after considering the following criteria: 1) What knowledge is necessary to read and understand the current literature in systematics, ecology and evolution? 2) What skills are needed to conduct first-class research and write synthetic papers on the above subjects for publication in leading peer-review journals? 3) What general knowledge is necessary to address questions raised during job interviews by individuals on search committees? 4) What knowledge would provide the flexibility to apply for different types of jobs if a position in Malacology was not available? Students fully capable in areas based on the courses listed have found employment as invertebrate zoologists, malacologists, ecologists, geneticists, and in allied fields.

While the courses listed below are highly recommended as relevant today and for at least the next decade, proficiency in various topics, e.g. biogeography, can be obtained by extensive reading and self-education; this would suffice instead of taking a course.

Core courses suggested for modern work in Malacology include:

> *1. *Invertebrate Zoology:* based on comparative anatomy/embryology.
!2. *Malacology:* fundamentals of classification, systematics, ecology, genetics, physiology, comparative functional anatomy of mollusks.
±3. *Invertebrate Paleontology*
*4. *General Ecology*
!5. *Advanced Ecology:* (community, theoretical, etc.).
!6. *Population Genetics:* (sometimes included in good advanced ecology courses).
!7. *Evolution:* (including systematics, phenetic and cladistic methods).
!8. *Biogeography:* a modern course including historical, dispersal, vicariant, ecological aspects in balance.
*9. *Mathematics* through *Calculus.*
*10. *Biochemistry:* (laboratory course, 1 year).
±11. *Cell physiology:* (physiology, cellular biology).
*12. *Genetics:* (including background molecular genetics, cyto-genetics).
±13. *General Statistics*
!14. *Advanced Statistics:* (through multivariate analysis.) Capabilities with doing computer-mediated analyses are essential.

* best taken during undergraduate education
± take as undergraduate or in graduate school
! take during graduate education

Detailed comparative anatomy is the most underused yet highly valued area of study relative to studies of systematics, evolution, biogeography and adaptive radiation. No phylogenetic construction should be attempted without a data base including detailed anatomical information. Students should be encouraged in this area: anatomical studies should not be considered out of date, they are not. Coupled with sound statistical analyses and computer mediated analyses, comparative anatomical studies are highly desired and relevant. Modern systematics is dependent on detailed anatomical data bases where character-states are derived from an examination of all organ systems.

Modern systematics cannot be adequately undertaken without an understanding of the ecology of the organisms. Adaptive radiation is understood only in terms of adaptation to environmental variables. For example, shell banding may be due to polymorphism where the percentages of different morphs are maintained by predation. Shell shapes are often adaptations to substratum types. Radular differences often relate to different modes of feeding and food types. Reproductive structures may vary due to different reproductive strategies.

Systematists today must be prepared to use multiple data bases to answer questions. Comparative anatomy and ecological data alone may not be sufficient to resolve relationships or allow one to understand pathways of evolution. Severe problems of convergent evolution and genetic change without pronounced morphological change may necessitate use of other methods, e.g. molecular genetics. These biochemical tools have proven valuable during the past two decades for resolving many types of problems unresolved by use of comparative anatomy.

Systematic studies today should not only involve analyses of individual organisms, but also include studies of populations from which the individuals are taken, hence the need for knowledge of population ecology, population genetics, and statistics. The need is to understand variation within and between populations and, if possible, reasons for such variation. One cannot understand the limits of a species without knowledge of variation within and between populations of that species.

EAST STROUDSBURG UNIVERSITY

East Stroudsburg, Pennsylvania

1987-88 UNDERGRADUATE CATALOG 90th EDITION

BIOL 211 INVERTEBRATE ZOOLOGY (3:2:3)

● ● This course is a study of the phylogeny, morphology and taxonomy of the invertebrates with the exception of parasitic taxa and of insecta. Habitats, specializations, reproductive methods and possible origins of this vast assemblage of animals are considered together with an attempt to indicate their significance to vetebrates and to man. Prerequisite: BIOL 118.

BIOL 462 MARINE INVERTEBRATES (3:2:3)

● ● This course is a study of the life history, habits, origin, development, physiology, anatomy, and taxonomy of the main phyla of invertebrates. A phylogenetic sequence is followed to show interrelationships among the phyla. Special emphasis is given to the Atlantic marine invertebrates. Laboratory and field work deal with collection, preservation, and identification of local species. This course is periodically offered at the Marine

UNIVERSITY OF SOUTHERN MISSISSIPPI BULLETIN

Graduate Programs

1987-1988

● ● 508. **Invertebrate Zoology I.** 2 hrs. Functional morphology, systematics, and life histories of the phyla Porifera through the minor protostomes.

\+ 508-L. **Invertebrate Zoology I Laboratory.** 1 hr.

● ● 509. **Invertebrate Zoology II.** 2 hrs. Prerequisite: BSC 507. Functional morphology, systematics, and life histories of invertebrate phyla through the Hemichordata.

\+ 509-L. **Invertebrate Zoology II Laboratory.** 1 hr.

Villanova University Bulletin

THE GRADUATE SCHOOL

1987-88

Bio. 7201 Invertebrate Zoology (4 credits)

The taxonomy, structure, function and life cycles of invertebrates with major emphasis placed on the metazoan phyla.

Long Island University Brooklyn Campus

Undergraduate Bulletin 1986-1988

BIOLOGY 105. INVERTEBRATE ZOOLOGY

Special fee: $40.00

Prerequisite: Biology 2 or 4

Offered every fall

A study of the morphology, physiology, evolution and ecological relationships of representatives of selected invertebrate phyla. Two lecture hours, two two-hour laboratory periods. Four credits.

1986

Graduate Study Bulletin

Washington State University

510 ● ● **Invertebrate Ecology** 3 (2-3) Prereq Zool 322. Adaptations of invertebrates to their environment. (a/y)

bulletin of

Duke University 1986-87

Graduate School

- 274L. Marine Invertebrate Zoology
- 278L. Invertebrate Developmental Biology
- 280. Principles of Genetics
- 283. Extrachromosomal Inheritance
- 286. Evolutionary Mechanisms
- 287S. Macroevolution
- 288. Mathematical Population Genetics
- 293L. Population Biology
- 295S, 296S. Seminar
- 353, 354. Research
- 360, 361. Tutorials

University of Wisconsin-Madison

Bulletin

Graduate School, Natural Sciences

Zoology

260 Introduction to Ecology, 3
300 General Invertebrate Zoology, 3
315-316 Limnology—Conservation of Aquatic Resources, lab 2 cr; lecture 2
460 General Ecology, 4
510-511 Ecology of Fishes, lab 2 cr; lecture 2
518-519 Hydrobiology, lab 2 cr; lecture 2
532 Aquatic Insects, 4
615 Plankton Ecology, 3