Herpetologica, 54(Suppl.), 1998, S3–S5

TEACHING HERPETOLOGY

ERIC R. PIANKA, DAVID M. HILLIS, DAVID C. CANNATELLA, MICHAEL J. RYAN, AND JOHN J. WIENS[1]

Department of Zoology, University of Texas at Austin, Austin, TX 78712, USA

ABSTRACT: Because science currently tends toward reductionism, taxon-oriented courses such as herpetology require a multidisciplinary, concept-oriented perspective. Such an approach encourages integration of ideas rather than a focus on details. One must learn to ask and answer questions and to make mental connections rather than merely to acquire facts. Few career opportunities exist for a "herpetologist", and undergraduate students are better off acquiring a diversity of intellectual skills and tools. Nonetheless, organisms and their particulars continue to motivate and stimulate us.

Key words: Herpetology; Education; University of Texas at Austin

DURING the last few decades, the excitement generated by advances in molecular biology fostered a trend toward reductionism such that taxon-based courses became quite unfashionable and were dropped from many curricula. How do taxon-based courses such as herpetology survive in the face of such trends?

One answer is that the way science is done changes. In recent years, a new trend in organismal and population biology has developed, a trend towards multidisciplinary studies that unify rather than isolate fields. For example, phylogenetics is no longer the exclusive domain of the systematist; phylogenetic trees are now widely exploited in evolutionary studies of morphology, behavior, and ecology. The field of environmental or ecological physiology embraces techniques of selection analyses and quantitative genetics. Behavioral ecologists have been reminded that sensory systems guide behaviors and that these sensory systems are not created de novo in response to every environmental challenge but have an evolutionary history that must be interpreted to understand fully how and why animals behave in the ways that they do. In conservation biology, concepts such as conspecific cueing (developed by behaviorists studying reptiles) are now part of their lexicon.

A second answer is that students of biology (ourselves included) continue to find organisms interesting. A taxon-based course such as herpetology serves students best when it reviews the entire biology of the organism, allowing students to elucidate and integrate relationships among different aspects of its biology. At the same time, the integration rather than isolation of concepts forces those of us who teach to go beyond our own intellectual domains.

Thus, teaching of herpetology is not just the domain of herpetologists. W. Frank Blair, who taught Herpetology at The University of Texas for many years until his death in 1984, became interested in frogs as part of his research in speciation and hybrid zones in mammals. We now team-teach herpetology, which we believe contains the necessary ingredients for the nearly "perfect" course. Each of us brings a very different perspective to the subject, although all of us embrace an evolutionary approach. This is quite a challenge, because expertise with a wide range of biology is required. We are exceedingly fortunate that herpetologists in our department span the entire range from molecules to morphology to mating behavior to metapopulations. Hillis is a molecular systematist, Cannatella is a curator and functional morphologist, Ryan is a behavioral ecologist, Pianka is a population and community ecologist, and Wiens is a morphological systematist.

Because we teach a taxon-oriented course, we emphasize a problem-oriented approach to biological questions. Accord-

[1] PRESENT ADDRESS: Section of Reptiles and Amphibians, Carnegie Museum of Natural History, 4400 Forbes Ave., Pittsburgh, PA 15213, USA.

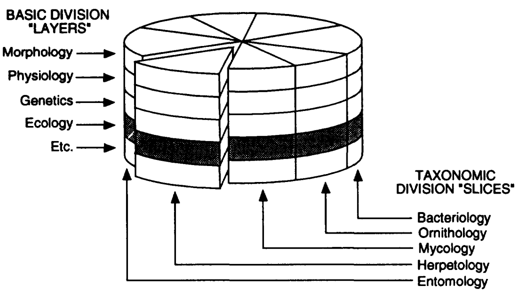

FIG. 1.—Alternative partitions of the biological cake. After Odum (1971).

ingly, we offer students an entire slice of the biological cake rather than a mere layer (Fig. 1), to encourage future ecologists, behaviorists, systematists, morphologists, etc., rather than future "herpetologists". Our outline is an example rather than a prescription. Therefore, we do not cite specific papers or readings; our next herpetology course doubtless will differ. We use no textbook, but many handouts are provided and numerous readings from the primary literature are assigned.

Hillis begins the course with a lecture on the history of herpetology, followed by a discussion of species concepts, classification, and phylogeny. He discusses sources of systematic information and uses herpetological case studies to demonstrate the role of morphological, molecular, and cytogenetic analyses. He then uses molecular studies as a focal point to show how amphibians and reptiles have been critical to advances in genetics and cytogenetics, and how these studies in turn have been informative about the basic biology of herps. This topic leads naturally into such issues as hybridogenesis, gynogenesis, and parthenogenesis; hybridization and origin of rare alleles in hybrid zones; and evolution of environmental versus genotypic sex determination.

Hills and Cannatella discuss higher-level phylogeny and historical biogeography of modern amphibians and reptiles; character support for these trees is developed more fully in the laboratory (see below). This, of course, necessitates presentation of tetrapod phylogeny in general. Phylogenies serve to provide not only a classification of reptiles and amphibians, but also an evolutionary framework for the rest of the course.

Cannatella also lectures on the origin of amphibians and reptiles from extinct tetrapod relatives, emphasizing the contribution of fossils to understanding relationships of extant taxa. He emphasizes historical transition from water to land and functional constraints imposed on locomotion, respiration, hearing, feeding, and reproduction. He discusses functional ecomorphology of locomotion and feeding in selected amphibians (larvae and adults) and reptiles. Heterochrony and constraints related to amphibian development and metamorphosis are treated as well.

Ryan lectures on sensory biology, behavioral and physiological genetics, and ontogeny of navigation systems in birds versus other reptiles, using the incredible site fidelity of homing sea turtles as a focal point. He also discusses visual and auditory communication in terms of signal–receiver systems, reproduction (including courtship, mate choice, and parental care), and social behavior among amphibians and reptiles.

Pianka talks about population and community ecology, which include spatial and temporal patterns of activity, thermoregulation, foraging and feeding ecology, reproductive tactics and life history, demography, interspecific competition, parasitology, anti-predator adaptations, guild structure, and community organization.

We also expose students to research by other faculty and graduate students in the form of guest speakers both in lecture and laboratory. For example, David Crews talked about physiology of reproductive behavior and sex determination in lizards, and Carl Gans gave a guest lecture on the biology of amphisbaenids. In the laboratory, mini-lectures are given by several graduate students and postdocs, on topics such as molecular systematics of salamanders, reproductive behavior of lizards, cytogenetics of treefrogs, and historical ecology of turtles.

Wiens (now at the Carnegie Museum) was in charge of the laboratory part of the course. The primary aims of the laboratory are to become familiar with the diversity and basic anatomy of reptiles and amphibians, to learn synapomorphies (shared derived, diagnostic features) of higher taxa, and to learn to identify most species of reptiles and amphibians in Texas. Morphology is emphasized not for its own sake but because most widely accepted phylogenetic trees are still based largely on morphological evidence. Some students have questioned the amount of anatomical detail covered: "Remember we are not all aliens from Planet Herpetology" said one. However, we believe that taxa for which there is evidence of monophyly must be distinguished from taxa for which there is none, and this demands examination of supporting characters.

Several laboratories concentrate on major groups (i.e., salamanders, turtles), using preserved and skeletal material (from the Texas Memorial Museum) from Texas and the rest of the world. Students are given handouts in advance, containing phylogenetic trees, lists of synapomorphies, synopses of natural history and systematics for higher taxa and Texas species, labelled anatomical diagrams, and illustrated identification keys. Questions at laboratory stations are designed to focus students' attention on certain features and concepts, to gauge their retention, and (occasionally) to try and make them think.

To supplement this material, other laboratories include a slide show of local herps, observations of live specimens in various behaviors (e.g., a constricting snake killing and eating a mouse), information on snake-bite treatment, museum techniques, and analysis of frog calls.

We have developed a web site (www.utexas.edu/courses/herps/) for this course which includes many links to other herpetology web sites. We envision a day when all such information is linked together and readily available to anyone interested.

Field trips are of variable length and intensity, and they demonstrate that herpetology can be enjoyable as well as intellectually stimulating. Instructors set an appropriate example for student behavior. A brief trip to a campus pond serves for observing several species of turtles. One evening field trip centers around frog call playback experiments. Short day trips are used to demonstrate field techniques and to introduce conservation biology in the context of local herps, including the Houston toad and Austin's endemic Barton Springs salamander. Longer weekend trips include areas such as the Rio Grande Valley in south Texas, the Hill Country of the Edwards Plateau, the Big Thicket area in east Texas, and Big Bend National Park in west Texas.

No herpetology course can ever be fully comprehensive; students probably finish courses with little understanding of the systematics of cheloniid sea turtles or the physiology of *Sphenodon*. But such gaps will always exist. We prefer that students acquire intellectual tools not only to fill these gaps but also to make new connections and to discover other gaps.

Returning to our initial question: how does a taxon-oriented course such as herpetology survive? Many or most professional herpetologists kept amphibians and reptiles as pets or pursued them in the field. Reptiles and amphibians get our attention, so much so that we cannot help but ask what a female túngara frog hears when a male calls, or whether the troglobytic Texas blind salamander can possibly be closely related to its surface-dwelling neighbors, or why there are so many species of lizards in the Australian Desert. The animals make students of us all, leading us to question, to think, and to explain.

Literature Cited

Odum, E. P. 1971. Fundamentals of Ecology. Saunders, Philadelphia, Pennsylvania, U.S.A.

Accepted: 19 December 1995
Associate Editor: Henry Mushinsky