VOL. 151, NO. 1 THE AMERICAN NATURALIST JANUARY 1998

Wherefore and Whither the Naturalist?*

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Submitted April 4, 1997; Accepted July 23, 1997

When I learned that I should have to address the American Society of Naturalists and began to ruminate on possible topics, I found inspiration in the name of the society and its journal. I had certainly thought of myself as a naturalist when I first opened the journal as an undergraduate, and still do. Yet the name of naturalist hardly seemed to apply to much of my own work, and *The American Naturalist* seemed likewise not only an anachronistic, but also a downright incongruous label for its contemporary contents. What, I asked, does *naturalist* mean today? Do naturalists contribute to *The American Naturalist*? What is the role of the naturalist in today's—and especially tomorrow's—biology?

In order to seek guidance, I provided questionnaires to graduate and postdoctoral students at the 1993 annual meeting of the American Society of Naturalists, the Society for the Study of Evolution, and the Society of Systematic Biologists at Snowbird, Utah. The 136 returns almost surely do not represent a random sample of interests and attitudes; undoubtedly those most interested in organisms as such responded disproportionately. Nevertheless, the responses, however unrepresentative, were both heartening and disconcerting.

One question was, "What is your reaction to someone who says he/she is interested in natural history?" There were many positive responses, such as "Great! Teach me what you know." But at least as many said things like:

You won't get a job.

Great—but you must not be a successful academic biologist.

I most often hear this used to describe the interests of older members of my department. I interpret this to mean they are not very conceptually oriented or maybe not very current.

*This article is based on the presidential address delivered to the American Society of Naturalists at a joint meeting with the Society for the Study of Evolution, the Society of Systematic Biologists, and the Society for Molecular Biology and Evolution, June 16, 1994, at the University of Georgia. Intended for verbal presentation, the text has been only slightly changed for publication. (Revised July 14, 1997.)

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Am. Nat. 1998. Vol. 151, pp. 1–6. 0003-0147/98/5101-0001$03.00.

These are not new reactions. In 1950, in a delightful book called *The Nature of Natural History*, Marston Bates (a former president of this society) wrote that "the word 'naturalist' has got into academic disrepute because it has come to be associated with the term 'nature lover' " (p. 253). Perhaps the respondents to my questionnaire made a similar association. Certainly many of today's naturalists—whatever that might mean—both study and "love" nature. This was more conspicuously true in the early days of *The American Naturalist*. For instance, one of the editors of the first issue, in 1867, wrote an article titled "New England Reptiles in April." It opens:

> The month of gladsome sounds has come! . . . The little Tree Toads have left their winter homes, and come forth to announce in joyful chorus that Spring is here; that the cold and dreary days are over, and to bid us welcome the bright and happy ones to come.
>
> Let us accept the invitation and visit the spot where the little revelers of night invite us so cordially. . . . Hark! ten thousand little throats are sounding their welcome. We are near them. . . . *Peep, peep*, comes from a spot not far away. Another *pee-e-p*, still nearer; then *pee-weep, pee-weep, pe-weep*, and the chorus is at its height. The thousand invisible musicians are satisfied that we love their sounds. (Putnam 1867, p. 107)

From this passage, we learn, first, that "reptiles" were even more paraphyletic in 1867 than they are now, and, second, that *The American Naturalist* has seen a few changes during its history. The journal was first identified in its masthead as "A Popular Illustrated Magazine of Natural History," and for its first few decades it included everything from nature poetry to travelers' observations to semipopular articles in biology, geology, and anthropology, as well as reports about important scientific publications. It became increasingly academic and increasingly focused on biology, so that by 1908, its masthead was "A Monthly Journal Devoted to the Advancement of the Biological Sciences with Special Reference to the Factors of Evolution." In 1951, the journal was adopted by the American Society of Naturalists as its official journal, and the masthead emphasized the need for synthesis: "Devoted to the Advancement and Correlation of the Biological Sciences." Its current slogan, "Devoted to the Conceptual Unification of the Biological Sciences," was adopted in 1977. The 1977 change portrays a shift in attitudes and values that is, in fact, my subject.

The term *naturalist* undoubtedly has the pejorative connotation of a lack of conceptualization, of intellectuality, of scientific rigor. But there is such a thing as a *scientific* naturalist, and many distinguished evolutionary, ecological, and organismal biologists can justly bear that title. I think of a scientific naturalist as a person with a deep and broad familiarity with one or more groups of organisms or ecological communities, who can draw on her knowledge of systematics, distribution, life histories, behavior, and perhaps physiology and morphology to inspire ideas, to evaluate hypotheses, to intelligently design research with an awareness of organisms' special peculiarities. Even more, perhaps, he is the person who is inexhaustibly fascinated by biological diversity, and who does not view organisms merely as models, or vehicles for theory but, rather, as the raison d'être for biological investigation, as the *Ding an sich,* the thing in itself, that excites our admiration and our desire for knowledge, understanding, and preservation.

It should be superfluous to describe the contributions of the scientific naturalist, but I can recall many occasions when a reminder seemed necessary. A colleague once dismissed a lecture about a massive molecular study of bird phylogeny with the remark, "It's great, if you like birds." (However tentative the results of this study, they have since been used for many applications of the comparative method.) When I was editor of *Evolution,* a well-known figure told me that that journal was old-fashioned because it was "mostly natural history"—it did not have enough on molecular evolution. So let me recall some contributions of naturalists, first by noting contributions by naturalists to the Evolutionary Synthesis (see Mayr 1980, 1982). The Synthesis was chiefly the union of three groups of biologists: geneticists, paleontologists, and naturalists (including systematists). Now imagine that the only parties to the Synthesis had been the geneticists and paleontologists, and that the naturalists had abstained. Almost all paleontologists of the time were preoccupied with "progressive" trends and embraced neo-Lamarckism or saltationism—almost any evolutionary theory except neo-Darwinism. Moreover, their fossil material provided little evidence on natural selection or the origin of species. Most laboratory geneticists, such as T. H. Morgan, had little use for natural selection, and neither they nor the great theoretical population geneticists were in any position to say much about the importance of genetic variation, natural selection, or gene flow in natural populations. Nor could any of them address more inferential questions on the nature or origin of species, the genesis of ecological diversity, or the gradual versus saltational origin of higher taxa. An *empirically justifiable* synthetic theory could not have been developed without the tradition of systematics and natural history.

This tradition was brought to the synthesis by people like Theodosius Dobzhansky—who had worked on the systematics and variation of ladybird beetles and whose *Drosophila* work was dedicated to explaining diversity; by E. B. Ford, a consummate naturalist; and by botanists such as E. B. Babcock, Edgar Anderson, and G. Ledyard Stebbins, whose genetic work was inseparable from their deep knowledge of plant systematics and natural history. It was also brought by the zoologist Bernhard Rensch, who is surely the neglected giant of the Synthesis, because he wrote in German and had the bad luck to begin his book in 1938 and not see it translated into English until 1959. Probably more than anyone else, through his work on variation and speciation in birds, rodents, snails, and beetles, Rensch provided evidence for adaptive geographic variation and helped to develop modern concepts of species and speciation. Later, he worked extensively on heterochrony and other macroevolutionary topics and wrote brilliant papers, in 1939 and 1943, that anticipated many of George Gaylord Simpsons's arguments (1944, 1953), to the effect that random mutation and natural selection explain all evolutionary phenomena. The naturalist-systematist tradition was also represented by Ernst Mayr, who, drawing on his intimate knowledge of birds, provided not only his well-known ideas on species and speciation but also many other ideas that we are exploring 40 or 50 years later, as if they were new (Futuyma 1994). These include a verbal equivalent (Mayr 1933) of MacArthur and Wilson's (1967) theory of island biogeography, suggestions (Mayr 1942) that geographical uniformity of species may be due to post-Pleistocene range expansion, that habitat selection creates mosaic hybrid zones, and that rapid, localized speciation can give rise to populations classified as genera or other higher taxa, and Mayr's (1954) proposition that localized speciation can create the paleontological pattern that Eldredge and Gould (1972) would later call punctuated equilibrium.

Knowing about the diversity and the particulars of organisms is important today as well. It would be invidious to single out contemporary figures, but every evolutionary biologist or ecologist should be able to think of individuals whose comprehensive knowledge of organisms has been a foundation for important contributions in community ecology, comparative physiology, morphological evolution, behavioral ecology, ecological genetics, and of course paleobiology and systematics. Robert MacArthur, whose profound influence on community and behavioral ecology may be controversial but is nonetheless incontestable, "really knew his warblers," as G. E.

Hutchinson (himself a superb naturalist) remarked (1975, p. 516).

Of course, natural history alone is far from sufficient, and is not always necessary, for progress in ecology and evolutionary biology. Much of the best empirical work on organisms tests and is guided by theory, some of it developed by individuals who have had deep biological insight despite little personal knowledge of organismal diversity. The greatest progress in certain fields such as evolutionary genetics and evolutionary developmental biology has stemmed less from comparative studies than from studies on model organisms. The importance of new techniques, most notably those provided by molecular biology, cannot be overemphasized. But at the same time, comparative studies that rely on knowing the diversity, phylogeny, and idiosyncrasies of organisms are among our most important tests of general hypotheses. Likewise, comparisons of organisms have revealed a diversity of genetic systems and developmental patterns that have fostered new questions and hypotheses. Comparative and phylogenetic studies have provided data on rates of molecular evolution, variations in codon bias, and other phenomena that molecular evolutionary biology is challenged to explain (Li 1997); differences among taxa in the apparent role of genes, such as *Hox* genes, have required evolutionary developmental biologists to discard hypotheses that seemed plausible only a few years ago (Müller and Wagner 1996; Raff 1996). For abundant examples of how knowledge of organisms can put molecular tools to use in evolutionary biology, ecology, and conservation biology, one need read only a few pages of Avise's *Molecular Markers, Natural History and Evolution* (1994).

Perhaps, trained in an age when a biology student could drink deep at the well of organismal biology, I am rationalizing nostalgia—but I think not. Many respondents to my questionnaire described feelingly the importance of knowing about natural history:

> Knowledge of organisms reduces our arrogance in modelling the world. Natural history information is my most important reality check, foundation, and source of intellectual renewal and personal growth.

> Generalizable principles will require detailed knowledge about a great diversity of organisms. Systems such as *Drosophila* and *E. coli* allow demonstration of what is possible . . . but only comparative data can test questions about what may have been of *general* importance.

> It is essential for understanding everything else about organisms. I'm constantly frustrated by my lack of natural history training. [A recurrent theme.]

> The best ideas are generated by observations of natural systems; nothing in evolutionary biology makes sense except in the light of natural history.

> Age cannot wither, nor custom stale, their infinite variety. There are no better stories in the world than the diversity of adaptations and the twisty course of history.

It may sound as if I am preaching to the converted, because most of us surely agree that natural history is important. However, it seems that many of us, in teaching and training students, do not substantially act on our conviction. Only about 31% of the respondents to the questionnaire felt they had had as much access to training in organismal diversity and natural history as they would like. It seems clear that many students of ecology and evolutionary biology—and not just those dedicated to modeling, molecular evolution, or laboratory population genetics—are emerging from graduate school with little knowledge of organisms beyond the species they did their dissertation on, often a system suggested by their adviser. Of the respondents to the questionnaire, 79% claimed "substantial knowledge" of the systematics or biology of a higher taxon, a figure that I suspect reflects a nonrandom sample. Asked to rank several kinds of experience as the source of their knowledge of organisms, 71% ranked self-training highest; a mentor was the second most important; only 18% ranked either undergraduate or graduate courses as most important; and only one-third of the respondents ranked either kind of course in either first or second place.

These results may confirm my impression that course offerings in organismal biology have dwindled at many universities. They may also indicate that students are not encouraged to learn this kind of material. Some students cited both of these as reasons for their lack of formal training. Why should this be, when so many of their teachers study organisms and acknowledge the importance of knowing their diversity?

One of the many possible answers is reflected in the students' answers to questions about motivation. Among motivations for going into our field, "a longstanding love of nature or organisms" and "intellectual curiosity or challenge" ranked highest and about equal. Among factors that "most motivate you *now*," "intellectual curiosity or challenge" greatly outranked any other. We can certainly, in some ways, applaud this change—hopefully we all grow in sophistication and come to identify ourselves with an intellectual, problem-solving enterprise. But with this growth in sophistication, experienced by each of us individually and by the field as a whole, there may be some subtle, darker consequences.

We all know that biologists are supposed to have physics envy, since the physical sciences, we have been told, epitomize real, rigorous science. (See Mayr 1997 for a cogent critique of this myth.) I doubt that most of *us* would admit to physics envy, but we might have internalized the message that we are inferior. Certainly biology as a whole did so. Early in this century, *Entwicklungsmechanik*—experimental analysis of development—supplanted embryology, which was tinged with phylogenetic speculation. Geneticists such as Morgan scorned evolutionary studies because he considered them speculative, not the experimental, reductionist, almost chemical science he proclaimed genetics to be. Physiologists and cell biologists became the respectable members of biological society, and in the 1950s molecular biology assumed its elite status. And perhaps reflecting the need to portray ourselves as physicalist and reductionist—as scientific—our field evolved its own dominance hierarchy, with mathematical theory at the top (it most resembles physics, after all), followed perhaps by experimental population genetics (now molecular population genetics), with ecological and evolutionary field studies situated well below; and at the bottom, the older studies of paleontology, systematics, and descriptive natural history that a truly "modern" biologist would pursue only with some apology or embarrassment except among like-minded peers. Theory and conceptual generalization became ascendant; knowledge of organisms as such became a less exalted goal. Following the shift in attitude came institutional changes: universities disposed of their research collections; departments of zoology, entomology, and (except by vigorous resistance) botany were dismantled and replaced by departments of biochemistry, ecology and evolutionary biology, and the like. Rare since has been the department that has sought a botanist qua botanist or an ichthyologist qua ichthyologist to fill its ranks. Of course, the shift in emphasis has paid benefits in conceptual progress and unification and in explosive growth of the self-conscious disciplines of ecology and evolutionary biology that transcend the old taxonomic divisions. But the cost has been a generation or more of biologists who by and large, though well versed in conceptual principles, are poorly trained in the knowledge of organisms that is equally indispensable for progress in ecology and evolutionary biology. In ecology, hardly anyone is more closely identified with conceptual generalization than G. E. Hutchinson, but Hutchinson (1975, p. 516) cautioned that "many ecologists of the present generation have great ability to handle the mathematical basis of the subject. Modern biological education, however, may let us down as ecologists if it does not insist, and it still shows too few signs of insistence, that a wide and quite deep understanding of organisms, past and present, is as basic a requirement as anything else in ecological education. It may be best self-taught, but how often is this difficult process made harder by a misplaced emphasis on a quite specious modernity."

I also wonder if we ecologists and evolutionary biologists, in our struggle against the hegemony of molecular and the rest of "skin-in" biology, have changed our perception of our goal. All of us agree that science does and should seek generalizations, formulate and test hypotheses, and develop the simplified conceptualizations that enhance understanding. But possibly we have come to focus too exclusively on the theoretical aspect of our enterprise. For surely the purpose of theories and conceptualizations is *not merely to exist in themselves, as monuments to our ingenuity and insight* but to organize the myriad details of the natural world as well. We all hope for general principles and the conceptual unification of the biological sciences—but, in addition, the glory of biology—its mark of distinction, its inexhaustible appeal—is the diversity of its subjects, the variety of organisms that "age cannot wither, nor custom stale." The theories that appear in our journals hardly begin to capture, and certainly cannot predict, the richness of biology found in a textbook of invertebrate zoology, or entomology, or botany. Our theories, mutable and usually ephemeral, should be viewed as vessels for the abiding information on the real properties of real organisms; and our vessels are as meaningless, if they are empty, as a catalog system is for a library that lacks books.

I do not at all disparage theory or conceptual progress. I am not suggesting that one kind of knowledge is more important than another. I only urge balance, and I believe we should be concerned about the prospective growth of purely factual knowledge of organisms. We need it, and we do not have enough of it. We need it to fill our theoretical vessels. For example, from 1979 to 1993, about 75 papers in *The American Naturalist* tested hypotheses by using information on phylogeny or natural history—on life histories, physiology, and the like—gleaned from the literature of botany, ornithology, and other "ologies." But if you wished to compare host associations of regional faunas of herbivorous insects (e.g., Futuyma and Mitter 1996), you would be frustrated because comprehensive information exists for exactly one part of the world: Britain. If we study plant ecology in Georgia or sexual selection in birds, we take it for granted that a book or at least a taxonomist is available to identify our species and guide us to critical biological literature; but if we study the ecology of Amazonian beetles or the coevolution of figs and fig wasps, we cannot take that for granted. We need factual knowledge of organisms, moreover, to address successfully a host of practical problems, ranging from pest management to conservation.

On this note, I believe that if we as a community of evolutionary and ecological biologists have one overriding ethical responsibility, it is to contribute what we can to preserve the biological diversity that is our subject; to fight the looming extinctions by political action, by education, and by applying our knowledge and expertise. In doing so, certainly we can offer insights on sampling design, some debatable principles on minimal viable populations, and critically important ecological and genetic analyses. Ultimately, however, conservation efforts absolutely require individuals who really know plants (or birds or mollusks and so forth)—their taxonomy, habitat requirements, biogeography, patterns of endemism. The Systematics Agenda 2000 (SA2000 1994) is right on the mark with its assertion that we desperately need to train—and employ—more systematists, on a worldwide basis. And, I would add, people who not only know species but also find out what they do.

Nonetheless, I could not begin to estimate the number of students I have met who, in explaining their work on some aspects of the biology of birds, plants, insects, frogs, have hastened to say that they are not interested in birds or insects as such but, instead, as models for studying principles; that they are not botanists or herpetologists but ecologists or evolutionary biologists—as if "ornithologist" or "botanist" were a scarlet letter, a badge of shame. I cannot cast the first stone, for I have often done the same. But in parallel with my other experiences of life, I have come to feel that as a closet entomologist, I should come out and stand proud.

There may not yet be a crisis, but there is certainly cause for concern that the store of living knowledge of organismal diversity can dwindle (Holden 1989; Barrowclough 1992; New 1993). Birds and angiosperms are not in trouble, but there are innumerable groups of relatively unpopular organisms, from moths to microbes, of which our ignorance is breathtaking. How can we keep the knowledge alive and growing, how stimulate students not only to study *The American Naturalist* but also to study organisms?

First, we can erase the dichotomy between "naturalists" and "scientists," the supposition that one can be either an old-fashioned "ologist" or a builder of conceptual frameworks, but not both. *Si monumentum requiris, circumspice:* we have no lack of role models. If Ernst Mayr could publish on both ornithology and evolutionary theory throughout a lifetime (Gill 1994), if E. O. Wilson could make major contributions not only to ecology and sociobiology but also to myrmecology (Wilson 1994), if Willi Hennig could both elucidate the systematics and evolution of Diptera and lay the foundation of modern phylogenetic method, why should their successors not aspire to do likewise?

Second, many students would like nothing better than to both pursue the conceptual growth of our field and to add to the store of knowledge of the biology and systematics of the organisms that most intrigue them—if they were encouraged to do so, if their teachers served as models. Ask yourself how many courses your department offers in the biology and systematics of groups of organisms—systematic botany, malacology, entomology, and the like. (Fewer than there used to be, I suspect.) Think of how inspiring some such course perhaps was in your own development—and how much more exciting it might be now, when it could add to the traditional botanical or entomological material some of the stunning contemporary work in evolutionary biology, ecology, or developmental biology. Think of how many of your fellow evolutionary biologists and ecologists could teach not only about those subjects but also about the organisms they know; and how they might need to cover and integrate everything from ecology and phylogeny to physiology and development. In fact, perhaps the "ologist" best has the opportunity or the need to integrate the biological sciences. (Remember this journal's masthead.) Think of how easy it *should* be, in filling an ecological or evolutionary faculty line, to hire someone who could also teach such a course, someone who could not only introduce students to the thrilling developments in our conceptual subject matter but who could also inspire students with the diversity of organisms that, as Darwin said, excite our admiration.

Acknowledgments

I am extremely grateful to the students who returned the questionnaires on which parts of this presentation are based and apologize that I did not use them more fully. I thank the editor, Joel Kingsolver, and others who suggested that this address might be publishable, and express my appreciation to those who taught me by example that to be a scientific naturalist is a respectable and rewarding calling. This is contribution no. 1008 from the Graduate Program in Ecology and Evolution at the State University of New York at Stony Brook.

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Editor: Joel G. Kingsolver