ANIMAL BEHAVIOUR, 2003, **65**, 1065–1068
doi:10.1006/anbe.2003.2143

ANNIVERSARY ESSAY

Too much natural history, or too little?

STEVAN J. ARNOLD
Department of Zoology, Oregon State University

(Received 14 January 2003; acceptance 18 January 2003; MS. number: AAE-4)

A number of commentators have recently expressed concern about the fate of both natural history and naturalists in the modern world. In this essay I examine those concerns from a historical perspective. From this standpoint, I conclude that natural history is alive and well, but its future critically depends upon conceptual infusions from adjacent disciplines. Naturalists are proliferating rather than dying out.

The next time I find myself in a public debate about natural history I am going to follow a colleague's advice. I will keep my mouth shut. I made this resolve last summer in Banff at the annual meeting of the American Society of Naturalists. The Society's President, Peter Grant, convened a symposium on the role of the naturalist in various contemporary contexts (e.g. genomics, biological invasions). During the symposium several participants commented on the need for more natural history information. At the end, when discussion was invited from the floor, the state and fate of natural history was the main topic under debate. The discussion was lively, impassioned, disjointed, engaging and frustrating. I found myself voicing opinions that I instantly regretted. Later, I decided I did not understand natural history or my feelings about it. I went to the library.

Naturalists who worry about the fate of natural history have recently produced a distinctive genre of essays (Bartholomew 1986; Greene & Losos 1988; Greene 1994; Noss 1996; Futuyma 1998). Among the claims in this genre are the notions that naturalists are dying off and that natural history is unappreciated and disappearing. I think these notions are wrong, born of a narrow, non-historical view of naturalists and natural history. The view that I favour is that natural history is a vigorous, blossoming enterprise. I arrived at this view by adopting the perspective of historians of science, especially that of Provine (1971), Mayr (1982), Kingsland (1985) and Farber (2000). From a historical perspective, viewing natural history as a lineage that includes descendants, the title of this essay is a trick question, an absurdity.

Correspondence: S. J. Arnold, Department of Zoology, Oregon State University, Corvallis, OR 97331-2914, U.S.A. (email: arnolds@science.oregonstate.edu).

NATURAL HISTORY YESTERDAY

Natural history emerged as a discipline in the 18th century as part of the Enlightenment, a philosophical movement in western Europe based on rationalism (Mayr 1982). Farber (2000) identifies the quest to find order in nature as the core of the natural history tradition. From its onset, the tradition sought order in three realms, which today would be called geology, botany and zoology. Carl Linnaeus and Georges Buffon were pivotal figures in the early stages of the discipline. Linnaeus devised a system for organizing the diversity of known plants and animals. Buffon pursued a massive compilation of facts about animals, resulting in a 36-volume encyclopaedia. The immediate effect of work by Linnaeus and Buffon was to stimulate energetic pursuit of discovery, an activity that continues to the present time. For the modern biologist, the early history of 'natural history' conjures up images of students and descendants of Linnaeus and Buffon looking for unknown plants and animals by prowling the jungles of Asia and South America. These romantic images are only part of the picture. Linnaeus and Buffon were consummate organizers of large-scale projects. Furthermore, new species were not sought in a vacuum. Field workers operated in a framework of taxonomic organization and encyclopaedic accretion. This conceptual and organization side of the picture tends to be forgotten, but it is crucial to a full appreciation of contemporary natural history. In the decades from 1750 to the present, the conceptual framework for natural history became more detailed and complex. These developments, the most important of which was Darwinism, merely modified a conceptual framework that was present from the onset of the discipline, a framework that sought order in nature.

0003–3472/03/$30.00/0

Table 1. Founding dates for various societies

Society	Date founded
Linnean Society of London	1788
Zoological Society of London	1826
American Society of Naturalists	1883
Ecological Society of America	1915
Genetics Society of America	1931
Association for the Study of Animal Behaviour	1936
Society for the Study of Evolution	1946
Animal Behavior Society	1964
International Society for Behavioral Ecology	1986

A sense of natural history's genealogy, from the mid-1700s to the present, can be captured by focusing on the fields that diverged from the ancestral discipline (Farber 2000). Early divisions produced geology, botany and zoology. The later dates at which familiar societies were founded help sketch the tempo of specialization (Table 1). A founding date does not represent the actual birth of a discipline, but it does indicate the date at which critical mass was achieved for a self-conscious movement. Founding dates also roughly correspond to the dates at which specialized courses appeared in university curricula. The transformation of natural history into more specialized societies continues at an accelerated pace. Many modern disciplines derived from natural history reached critical mass during the 20th century. Within the last two decades new societies and journals have appeared that are devoted to such topics as behavioural ecology, molecular ecology, molecular evolution, bioinformatics, genomics and so on. These too are natural history derivatives.

To be sure, viewing natural history as a genealogy neglects the influence of ideas imported from other disciplines. Conflict accompanied the most important conceptual infusions. One of the most important imports was the experimental approach that arose in the early 1800s in physiology (Farber 2000). Allied with medical education, the early physiologists represented a separate tradition from natural history. Experimentation was the hallmark that most cleanly separated the physiologists from the naturalists. Over the next century experimentation merged with the natural history tradition by infusion through a variety of disciplines: embryology, ecology, genetics, evolutionary biology and animal behaviour. These infusions generated tensions that persist to the present day. Some naturalists see experiments as too simplistic; some experimentalists see nonmanipulative analyses as hopelessly ambiguous. Mathematical modelling first produced similar tensions in genetics and later when modelling entered ecology. Stress in ecology between modellers and nonmodellers was intense in the 1930s and again in the 1960s (Kingsland 1985) and can still be detected today (see below). Currently, we are in the midst of a merging of molecular biology with the various disciplines derived from natural history. Molecular biologists struggle to understand Darwinism; animal behaviourists wrestle with the new molecular vocabulary. The marriage is both joyous and contentious.

NATURAL HISTORY TODAY AND TOMORROW

Commentators on the current plight of 'natural history' usually take a narrow view of the naturalist's tradition. Bartholomew (1986, page 326) did take a broad historical view of natural history, but also noted that 'At its most stereotyped, natural history has been, and is, strictly phenomenological'. Greene (1994) adopts this more stereotyped vision when he focuses on descriptive ecology and ethology as the building blocks of natural history. When Noss (1996, page 1) argued that 'The naturalists are dying off and have few heirs', he means individuals who can identify all the inhabitants in a local community and describe their interactions. Futuyma (1998) circulated a questionnaire among graduate and postdoctoral students and obtained revealing answers to the question, 'What is your reaction to someone who says he/she is interested in natural history?' Among the responses: (1) 'You won't get a job', (2) '. . . you must not be a successful academic biologist', (3) '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.' How can we reconcile these narrow, sometimes pejorative views of 'natural history' with a 250-year-old naturalist's tradition that includes the development of Darwinism and other major concepts as well as the incorporation of experimentation and model building? Why do we take a narrow view of 'natural history'?

As new disciplines split off from natural history, the genealogical trunk kept the original name, but in time the trunk was whittled down to a remnant. It is not surprising that scientists identify with derivatives rather than with the trunk. Each new generation of scientists focuses on new developments in their fields. There is also a premium on adopting the moniker of a newly christened discipline. Beginning in the 1870s many scientists followed T. H. Huxley's lead and called themselves 'biologists' to proclaim their interest in everything from cells to evolution. Henceforth, 'natural history' meant field work and work with collections (Farber 2000). The meaning of the term 'natural history' continues to contract. Today, systematists are not likely to say that their field is natural history, nor are behavioural ecologists. The current trend is to define natural history by what it is not. Within a few decades, in this narrow view, 'natural history' will be a small sliver-like remnant, a vacant scientific profession.

NATURAL HISTORY AS A LIVING TRADITION, RATHER THAN A DYING REMNANT

Natural history lives today in the bustling enterprises of its descendant disciplines. The bustle is largely due to new concepts that are imported or generated within these disciplines. Collections, life-history facts, and ethograms are products of conceptual pursuits in natural history sensu lato. Collections, in the large sense of specimens

and the information associated with them, are hugely important resources; but collections are not the essence of natural history. Great naturalists are remembered for their concepts rather than for their fieldwork and collections. Natural history lives and breathes because of the concepts it has produced and continues to produce. The powerful concepts of the naturalist's tradition, past and present, include: natural order in biological diversity, descent with modification, natural selection, Mendelian inheritance, polygenic inheritance, competitive exclusion, logistic population growth, allopatric speciation, trophic structure, adaptive landscapes, island biogeography, correlated response to selection, inclusive fitness, optimal foraging and sexual selection. All of these are conceptual tools for finding order in nature. They are powerful because they change the way we perceive nature. These concepts, and many others, are the triumphs of natural history, the essence of the discipline and its descendants.

A focus on natural history as a concept-building enterprise changes what we see as natural history and who we see as naturalists. Equations and computer simulation can be powerful weapons in the arsenal of the naturalist. The key is whether these weapons are aimed at issues in the natural world. It follows that some naturalists are theoreticians. You do not have to have dirt under your fingernails to be a naturalist. The essential requirement is that you follow Linnaeus and Buffon in pursuit of order in nature. I reserve special admiration for naturalists who excel both in the field and at the blackboard (e.g. R. H. MacArthur, W. H. Hamilton, E. O. Wilson), but a naturalist does not have to be biphasic, an expert in both of those realms. Niko Tinbergen and George Schaller are great naturalists because of their special talents at uncovering the lives of free-ranging animals. If we could erase the constraints of time, these naturalists could report directly to Buffon. But now we confront a quandary. If equations and simulations, as well as field experiments and observations from blinds, are all legitimate parts of natural history, why do we hear our colleagues disparage each other's activities? Why are there conflicts within the natural history community, sensu lato? Where does the tension come from?

PAST AND CURRENT DEBATES IN HISTORICAL PERSPECTIVE

Conflict in scientific communities is a revealing behavioural phenomenon that has attracted the attention of historians of science. Most scientists would like to believe that scientific debates are objective intellectual exercises, divorced from base motivations and emotions. Historical analysis suggests otherwise (Provine 1971; Kingsland 1985; Farber 2000).

Vehemence and intensity in a scientific conflict are indications that something is at stake (Kingsland 1985). Sometimes the stakes are power and resources, or the threat of extinction. Some conflicts in the natural history community are recurrent, as well as intense, another indicator of deep roots. A debate with all of these characteristics concerns the role of modelling in ecology and, more recently, in conservation biology. Reactions in the 1930s to the models of population dynamics produced by Lotka, Volterra, Nicholson and Bailey in the 1920s and 1930s have a familiar ring. The main complaints were that theory had gone far beyond observation and experimentation and that the complexity of nature was not represented in the models (Kingsland 1985). A similar litany of complaints was voiced in the 1960s and 1970s in reaction to models by MacArthur, Wilson and Levins. Most recently, conservation biologists have jousted over the role and importance of models (Noss 1996; Bowen & Bass 1996), using much of the same language. Power, influence and even extinction were at stake in the first two episodes, and may be at stake in the third. In the early days the ranks of the modellers were thin. The fate of a new approach was at stake, and the defenders of modelling came out swinging. These days models are everywhere. It is the defenders of natural history sensu stricto who feel their backs are against the wall. The operative words here are sensu stricto.

I do not think we have to fret about the fate of stand-alone, descriptive natural history. It is not that the 'facts' of natural history aren't important. They are, and we should keep reporting them. My point is that the future of the naturalist's tradition lies in concept development. Observation, discovery, experimentation, models and simulation are all subservient to the task of concept building. All of these tools are valid, legitimate and worthy of our respect. And, just as it seems silly to argue that someone who uses just a hammer is the only true carpenter, history does not support the idea that the field worker armed with just a notebook is the only true naturalist. There are many varieties of naturalist and, so, no real threat of extinction.

CONCLUSIONS

Although I will stay on the sidelines at the next debate, I have reached four conclusions by taking a historical perspective on natural history.

(1) Natural history is a vital, proliferating lineage. Worries about the fate of natural history arise when we focus on the small twig that now carries the name 'natural history' rather than on the lineage itself. Viewed as a lineage with all of its branches, natural history is a flourishing enterprise.

(2) The crux of the natural history tradition is the search for order in nature. The goal of the tradition is, and always has been, to formulate concepts that allow us to perceive order in nature. It is the pursuit of the goal, rather than the tools of employment, that defines the tradition and hence the naturalist. The tools of the naturalist are equations and sequencers, as well as binoculars and notebook.

(3) The naturalists are not dying. You may not think you are a naturalist, but you probably are. If your eyes are on the prize of finding order in nature, you are part of a naturalist tradition that stretches back to the 1750s. Look around at your next scientific meeting. Naturalists and their heirs are all around you.

(4) The vitality of the naturalist's tradition depends on new ideas and tools from other disciplines (Wilson 1989). Our future depends on new infusions even though they can produce tension and conflict. We need an inclusive vision of natural history rather than a tussle over the discipline's mantle. Disciplinary coexistence, mutual respect and collaboration serve our own mental health as well as the future of natural history.

Acknowledgments

I thank L. K. Arnold, P. L. Farber, L. D. Houck, M. K. Manier, M. Westphal and A. M. Wood for helpful discussions.

References

Bartholomew, G. A. 1986. The role of natural history in contemporary biology. *BioScience*, **36,** 324–329.

Bowen, B. W. & Bass, A. L. 1996. Are the naturalists dying off? *Conservation Biology*, **10,** 923–924.

Farber, P. L. 2000. *Finding Order in Nature: the Naturalist Tradition from Linnaeus to E. O. Wilson*. Baltimore, Maryland: John Hopkins University Press.

Futuyma, D. J. 1998. Wherefore and wither the naturalist? *American Naturalist*, **151,** 1–6.

Greene, H. W. 1994. Systematics and natural history, foundations for understanding and conserving biodiversity. *American Zoologist*, **34,** 48–56.

Greene, H. W. & Losos, J. B. 1988. Systematics, natural history and conservation. *BioScience*, **38,** 458–462.

Kingsland, S. E. 1985. *Modeling Nature: Episodes in the History of Population Ecology*. Chicago: University of Chicago Press.

Mayr, E. 1982. *The Growth of Biological Thought, Diversity, Evolution and Inheritance*. Cambridge, Massachusetts: Belknap Press.

Noss, R. F. 1996. The naturalists are dying off. *Conservation Biology*, **10,** 1–3.

Provine, W. B. 1971. *The Origins of Theoretical Population Genetics*. Chicago: University of Chicago Press.

Wilson, E. O. 1989. The coming pluralization of biology and the stewardship of systematics. *BioScience*, **39,** 242–245.