Natural Enemies—Metaphor or Misconception?

Interpreting natural phenomena in human terms is a two-edged sword, generating knowledge as well as opening the door to troubling misunderstandings.

Matthew K. Chew and Manfred D. Laubichler*

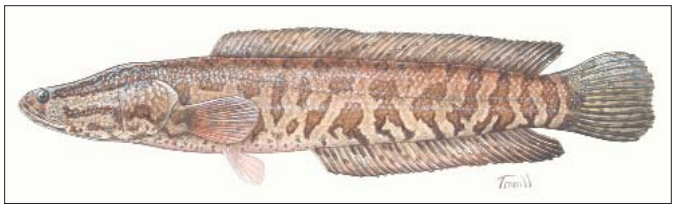
In a recent and well-publicized case, two northern snakeheads (*Channa argus*)—an Asian fish often raised for food in flooded rice paddies—were discovered along with a cohort of fingerling progeny in a suburban Maryland pond. State biologists all but panicked, and the media converged on the pond for a photo opportunity to go with the news story.

Metaphors carried the message: Snakeheads (see the figure, right) are not merely foreign, they are "Frankenfish." Like other immigrants, they were accused of immodest fecundity. State of Maryland biologist Bob Lunsford was quoted: "It's the baddest bunny in the bush. It has no known predators in this environment, can grow to 15 pounds, and it can get up and walk. What more do you need? If you catch it, kill it. It's not a dead or alive thing, we want it dead." (*1*). An official "unwanted" poster stated: "Kill this fish." *Nature* picked up the news story (*2*), and *Science* alluded to it in a NetWatch item (*3*). Each of these reports included the press release hyperbole: land-walking, voracious, an ecological disaster.

Metaphors are ubiquitous in science. Most biologists are familiar with archdeacon William Paley's illustration for the existence of an omniscient creator: in the same way a watch found on a beach implies the existence of a watchmaker, the complex design of organisms implies the existence of a designer. The popularity and persistence of this metaphor—with proponents of Intelligent Design as well as with ultra-Darwinists such as Richard Dawkins—lies in its simplicity and intuitive appeal.

Simplicity and intuitive appeal are also the main reasons why scientific language has never succeeded in "cleansing" itself from metaphorical "impurities," despite several attempts to do so. Indeed, metaphors appear to be essential to all forms of language and understanding (*4*). But if scientific language is by necessity to some extent metaphorical, then interpretation of its content depends on the cultural context that generates the metaphors that are used. And here the problems start.

Evolutionary biologists customarily employ the metaphor "survival of the fittest," which has a precise meaning in the context of mathematical population genetics, as a shorthand expression when describing evolutionary processes. Yet, outside of the shared interpretative context of evolutionary biology, the same metaphor has been employed to argue that evolutionary theory is fundamentally flawed. Natural Selection, the argument goes, leads to a survival of the fittest. The fittest are those that survive. Ergo, natural selection describes the survival of the survivors. Thus one of the core concepts of evolutionary theory is a tautology. While it is easy to see how such an argument represents a deliberate misunderstanding of evolutionary theory, it also alerts us to some problems inherent to the use of metaphors in science.



Kill this fish? *Channa argus* (northern snakehead) as presented by the U.S. Geological Survey (*13*).

Metaphors introduce a fundamental trade off between the generation of novel insights in science and the possibility of dangerous or even deadly misappropriation. The extension of genetics to eugenics owed much of its popularity in the United States and in Germany to its use of culturally resonant metaphors. Labeling people as a burden, a cancerous disease, or a foreign body (*Fremdkörper*) conveyed the "threat" to society in terms that people could relate to in their respective historical and cultural settings (*5*–*8*). Given this power of metaphorical language, it is understandable why several scientists have been concerned with the prevalence of metaphors in certain disciplines (*9*).

On the other hand, the use of metaphorical language in molecular biology—with its references to information, signaling, translation, editing, etc.—has contributed substantially to its breathtaking success during the past 50 years. These literary metaphors make extremely complicated molecular processes intelligible by highlighting their functional components in a human, or rather semiotic, reference frame. In this case, metaphors have helped to drive science to new insights.

As the example of molecular biology suggests, there is a correlation between the complexity of the phenomena and our dependency on metaphorical language. It is therefore not at all surprising that metaphors are ubiquitous in ecology. After all, ecological processes are complex on any number of scales (time and space, interdependence of large number of variables, sensitivity to initial conditions, etc.). When he coined the term "ecology," Ernst Haeckel self-consciously exploited the metaphorical currency of its Greek roots, *oikos* and *logos*, in defining ecology as the science of the household of nature.

For Haeckel, ecology was part of the physiological sciences, and the metaphor of the household of nature was well suited to capture the many interactions between organisms and their environments. Subsequently, many if not most ecological concepts reflected familiar cultural experience. Terms such as alien, assembly, cascade, colonize, community, competition, consumption, contest, defense, disturbance, efficiency, enemy, equilibrium, flow, founder, gradient, hierarchy, interaction, invasive, native, niche, node, productivity, sink, source, stability, succession, territory, web are all commonly used to define and communicate ecological ideas among specialists. They have gained at least tacit acceptance by authors, reviewers, editors, and readers of the scientific literature, who no longer question their metaphorical origins, but interpret them in the context of scientific theory.

Metaphors allow us to build on our experience when we extend familiar relationships to unfamiliar contexts, and help us to com-

The authors are in the School of Life Sciences of the Biology and Society Program, Arizona State University, Tempe, AZ 85287, USA.

*To whom correspondence should be addressed. E-mail: manfred.laublichler@asu.edu

municate new ideas to others who share our experiences and are therefore able to interpret the metaphors. In science, much that we consider knowable is inferred rather than directly observed. As a result, access to adequate metaphors can make the difference between comprehension and confusion. Familiar as they are from common contexts and experiences, most such metaphors can readily be employed to communicate ecology to nonspecialists. But ready recognition also carries a cost. The contexts from which terms are borrowed are not static; the interpretation of specific terms will vary and evolve. Therefore, common metaphors adopted to carry specialized meanings can lead us astray; they can constrain understanding as easily as they facilitate it, and may do both simultaneously.

...metaphorical abstractions all too easily become concrete objects...

Our opening example of "dangerous alien invaders" is an example of the widespread use of the "natural enemy" metaphor in the ecological literature. Online, full-text searches of *Science* and *Nature* alone have turned up 54 items that used the term since January 1997. These papers, mostly research-based reports, are all about ecological topics and have undergone rigorous scientific and editorial review. Further searches and analysis confirmed that they are representative of larger trends in the ecological literature.

Two-thirds (36) of the papers in *Science* and *Nature* included either an explicit or implied definition or clarification of the term. Of those 36 studies, 23 provided the clarification after "natural enemy" (or enemies) appeared in the text. The remaining 18 articles did not define or clarify their use of the term natural enemy (-ies), apparently concluding that its meaning was self-evident.

Throughout the ecological literature, natural enemies refers to relationships that can be more precisely described as herbivory, predation, parasitism, parasitoidy, or pathogen infection. Therefore, it is hard to see what the persistent use of the term natural enemies technically contributes to any ecological discussion. The popularity of the metaphor with ecologists thus suggests that the image carries a particular rhetorical power, that it helps in "getting the message across."

In the case of the northern snakeheads, the use of the metaphor was clearly successful in alerting the public to a perceived threat. However, a less passionate analysis of the case reveals a more equivocal scenario. Northern snakeheads are Perciformes from a 26-member Old-World genus. In neutral ecological terms, *Channa argus* is comparable to the North American bowfin, *Amia calva,* a relic of the Triassic order Amiiformes that is still present in Maryland. Both are about the same size and shape, with "air-breathing" adaptations to low-oxygen waters; they share appetites for a broad array of prey, and both have been described as being able to "bite another fish in half" (*10*, *11*). In many ways, they are a compelling example of convergent evolution.

As a result of that convergence, species that survive cohabitation with bowfins may well survive in the presence snakeheads, and vice-versa. When discovered 2 years after their release, the snakeheads were not alone in their Maryland pond. Although a detailed inventory was not released, the two-step application of herbicides and rotenone, intended to kill all the snakeheads (and everything else in the pond), revealed the presence of a variety of organisms, including "thousands of fish." In the end, a simplified pond was the solution to a simplified problem.

We are not saying that the presence of the snakeheads could not have dramatically altered the ecology of freshwater ponds, nor that the public need not be informed about the large-scale changes in the distribution of many species as a result of human action (including the purposeful or inadvertent movement of animals, plants, and microorganisms, as well as changes in global climate, habitat alteration, etc). But we are concerned about the implications of the frequent use of bellicose metaphors such as natural enemies in the ecological literature. The use of the term natural enemies to describe several different ecological interactions implies that such a category objectively exists in nature. This assumption can have serious consequences not only for the snakeheads, but also for the ability of scientists to comprehend ecological phenomena and for a society that looks to science for an objective interpretation of the natural world.

"Enemy" is fundamentally a human construct identifying a malevolent foe. In our current cultural context, "natural" has a strong positive value. This can be seen in the ecological literature where the lack of natural enemies is portrayed as a negative condition. Without natural enemies, an "invasive" species has an "unfair advantage" (*12*); released from a natural enemy, a once naturally constrained species may become a "pest." In both cases, the metaphor is interpreted as normative.

In scientific or experimental contexts, dichotomies such as predator and prey or parasite and host can help us to understand specific processes in nature. But scientists are (or should be) aware that these are idealized abstractions. Such idealizations are not restricted to ecology. In molecular biology, for instance, multiple concepts of the gene refer to a variety of relationships between DNA "coding" and development. Given the intricacies of RNA editing, complex regulatory networks, genetic redundancy, and molecular pathways, it is meaningless to identify any one concrete natural object as the gene. Yet the existence of such a concrete object is the prevailing notion shared by a large public and professional community and is reinforced by the metaphorical language of scientists.

What troubles us is that biology's metaphorical abstractions all too easily become concrete objects and substitute for specific, describable processes. Maximal diversity becomes evolution's telos instead of its tendency. Biogeographical frontiers become prescriptive and enforceable, rather than descriptive and conceptual. Seasonal "disturbances" such as floods interrupt normal ecological processes, instead of exemplifying them. Biological "productivity" and "diversity" become not only measurable, but virtuous.

Perhaps we cannot avoid metaphors altogether in scientific language. But scientists must be aware of the potential problems inherent in invoking the familiar as a convenient way for describing their ideas. At the very least, we should be concerned about what the frequent use of "natural enemies" (and the notable absence of "natural allies," describing an equally familiar set of ecological interactions) reveals about the ways in which we interpret nature through metaphorical lenses, especially in the current historical situation.

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