

Ecological Terms Strongly Impact Research and its Implications

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“The ability to simplify means to eliminate the unnecessary so that the necessary may speak”

Hans Hofmann

There has been previous criticism of the propensity of ecologists to use inexact language (Thorpe 1986; Frazier 1994; Fauth et al., 1996). However, the use of incongruent phrasing in ecology remains a major concern because of the impact that the ecological lexicon can have on topic selection, study design, data assessment, interpretation, and, perhaps most importantly, the application of ecological theory (Larson 2011). Precise communication should be a central tenet in ecology if we expect to make significant contributions to biological conservation and societal wellbeing.

Ecology is inherently focused on interactions, yet interaction types are not equally considered. This may be most evident in traditional (Cooper 1993) and modern (Jones et al. 2012) treatments of species sharing access to available resources where “interaction” should be used in replacement of “competition”. Competition is certainly an important mechanism driving species compositions in ecosystems, but the emphasis on this sole interaction above others is unsubstantiated. Competition is usually assumed *a priori* in the study of concurrent species and defined as a hindering force for the interacting species, such that each suffers in some way, eventually leading to exclusion (Hardin 1960). However, interactions, even those involving the simultaneous use of common resources, can result in

many outcomes depending on context and scale, and even promote coexistence (Vandermeer et al. 2002).

While competitive interactions have been over-emphasized, interactions that benefit participant species have seen proportionately less attention (Bertness and Callaway 1994; Hacker and Gaines 1997). These interactions can promote individual growth, survival, and overall community structure. Furthermore, empirical and theoretical research suggests these interactions exist on a continuum where the strength of antagonism, competition, amensalism, and mutualism depends on biotic and abiotic factors that influence the dynamics at any given time (Holland and DeAngelis 2009; Long et al. 2012).

A recent characterization of predation and parasitism is the unified natural enemy concept (Raffel et al. 2008, Preston et al. 2014), which refers to interactions with an organism and its multiple predators and parasites. This jargon, however, is unnecessary and too simplistically implies that these organisms are constant enemies when in fact the antagonism exists on a spectrum. The interactive effects of predation and parasitism are important and should continue to be explored, as the presence of either could strengthen or weaken the effect of the other. This conditional approach to species interactions should be the focus of future research as it allows for changes in communities to reflect shifts in species responses (Mougi and Kondoh 2012).

Recently, Davis and colleagues (2011) expressed an outcry to end the indiscriminate use of the term “invasive” when referring to any “non-native species”. They argue that “Intentionally

or not, such characterizations... create pervasive bias against alien species...” The same authors emphasize that “... partly fueled by Elton’s book, proponents of biodiversity preservation and ecological restoration commonly used military metaphors and exaggerated claims of impending harm to help convey the message that introduced species are the enemies of man and nature” (Davis et al. 2011). Many claims on the catastrophic effects of non-native species were exaggerated and, in some cases, not supported by evidence (Davis et al. 2011). These authors argue that the effect of non-native species, as that of natives, changes in space and time and should be first assessed before expressing any unsupported negative interactions.

The use of an inaccurate lexicon and subsequent sensationalism affects study design and data interpretation. Using competition as a substitute for interaction leads to assumed linear responses that, when evaluated against potential non-linear responses among interacting species, results in wrong model specification and interpretation. This problem is magnified because most basic statistics courses in undergraduate and graduate ecology programs ignore non-linear responses.

Literal interpretation of an incongruent lexicon in ecology has contributed to organized operations leading to the reduction in abundance of many species and extinction. The way we convey information affects public response (Larson 2011). Emotional dispositions toward wolves predicted up to 20% of the variance of acceptability of their lethal control (Bruskotte et al. 2009). Military jargon is pervasive in the ecological

literature studying agriculture plagues and disease vectors. For example, a recent article describes "...an expansion of the limited arsenal of effective mosquito control tools" (Scholte et al. 2004). "Control campaigns" to eliminate "enemy" species continue, threatening many species all over the world. Pollution, mainly by synthetic pesticides, and biological antagonistic species used to control species are leading causes of the worrying decline of insects worldwide (Sánchez-Bayo and Wyckhuys 2019). When they fail, these campaigns frequently result in the development of species resistance to the means of intended control (chemical or other), increasing instead of reducing its impacts on human health and economy.

The widespread and inaccurate lexicon in ecology and other sciences borrowed from the corporate and military culture is not the only concern related to the influence of these organizations. Corporate and military culture increasingly influence the priorities and direction of research and education (Giroux 2007). Major tenets of these organizations are at odds with universities' goals of critical thinking and freedom of speech, with significant consequences in society (Giroux 2007). Ecologists should be aware of these issues and maintain a critical and objective attitude towards them, thus

allowing us to continue contributing to knowledge aimed to preserve biological diversity and improve societal wellbeing.

References cited

- Bertness MD, Callaway RM. 1994. Positive interactions in communities. *Trends in Ecology and Evolution* 9: 191–193.
- Bruskotter JT, Vaske JJ and Schmidt RH. 2009. Social and cognitive correlates of Utah residents' acceptance of the lethal control of wolves. *Human dimensions of wildlife* 14: 119–132.
- Cooper G. 1993. The competition controversy in ecology. *Biology and Philosophy* 8: 359–384.
- Davis MA et al. 2011. Don't judge species on their origins. *Nature* 474: 153–154.
- Fauth JE, Bernardo J, Camara M, Resetarits WJ, Jr, Van Buskirk J, McCollum SA. 1996. Simplifying the jargon of community ecology: a conceptual approach. *The American Naturalist* 147: 282–286.
- Frazier JG. 1994. The pressure of terminological stresses-urgency of robust definitions in ecology. *Bulletin of the British Ecological Society* 25: 207–209.
- Giroux H. 2007. *The University in Chains*. Paradigm Publishers. Boulder, CO.
- Hardin G. 1960. The competitive exclusion principle. *Science* 131: 1292–1298.
- Holland NJ, DeAngelis DL. 2009. Consumer-resource theory predicts dynamic transitions between outcomes of interspecific interactions. *Ecology Letters* 12: 1357–1366.
- Hacker SD, Gaines SD. 1997. Some implications of direct positive interactions for community species diversity. *Ecology* 78: 1990–2003.
- Jones EI, Bronstein JL, Ferrière R. 2012. The fundamental role of competition in the ecology and evolution of mutualisms. *Annals of the New York Academy of Sciences* 1256: 66–88.
- Larson B. 2011. *Metaphors for Environmental Sustainability: Redefining Our relationship with Nature*. Yale University Press.
- Long WC, Johnson EG, Gamelin EF, Hines AH. 2012. Density dependent indirect effects: apparent commensalism and apparent competition coexist in a two-prey system. *Marine Ecology Progress Series* 456: 139–148.
- Mougi A, Kondoh M. 2012. Diversity of interaction types and ecological community stability. *Science* 337: 349–351.
- Preston DL, Boland CE, Hoverman JT, Johnson PTJ. 2014. Natural enemy ecology: comparing the effects of predation risk, infection risk and disease on host behaviour. *Functional Ecology* 28: 1472–1481.
- Raffel TR, Martin LB, Rohr JR. 2008. Parasites as predators: unifying natural enemy ecology. *Trends in Ecology & Evolution* 23: 610–618.
- Sánchez-Bayo F and Wyckhuys KAG. 2019. Worldwide decline of the entomofauna: a review of its drivers. *Biological Conservation* 232: 8–27.
- Scholte EJ, Knols BG, Samson RA, Takken W. 2004. Entomopathogenic fungi for mosquito control: a review. *Journal of Insect Science* 4: 19. <https://doi.org/10.1093/jis/4.1.19>
- Thorpe JH. 1986. Two distinct roles for predators in freshwater assemblages. *Oikos* 47: 75–82.
- Vandermeer J, Evans MA, Foster P, Hook T, Reiskind, M, and Wund M. 2002. Increased competition may promote species coexistence. *Proceedings of the National Academy of Sciences of the United States of America*. USA 99: 8731–8736.

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