

How to maintain ecological relevance in ecology

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Ecology has developed from a descriptive science to a scientific field that fostered general theories such as island theory and optimal foraging. It has become a hypothesis-driven science with scientists around the world working on the same body of theory. This has been fruitful, but also poses an increasing challenge for the reviewing process. This is not only due to the growing number of manuscripts and the increasing complexity of experimental design and statistical analyses [1,2], but also to the expanding number of species and ecosystems that are studied. Sufficient knowledge of the studied species and ecosystems is often essential to assess the ecological relevance and scientific merit of the paper.

Drawing ecological-evolutionary conclusions from studies on species interactions is at the heart of ecology and a solid knowledge of the ecology of the studied species is essential. This is of particular importance in competition experiments as they only have ecological relevance if the species tested (can) co-occur in natural situations and are tested under the conditions in which they (can) co-occur. However, in his bibliography on competition in plant communities Paul Keddy [3] aptly noted that “One of the most difficult tasks in reading the literature is sifting through large numbers of experiments in which investigators have haphazardly selected (a pair of) species and grown them in mixture, without adequately justifying their choice of species and study design.”

However, such issues are not limited to competition studies; in studies on the interaction between plants and insects adaptation and co-evolution is often wrongfully assumed. For example, the model system of *Arabidopsis thaliana* and *Pieris rapae* is commonly used to study the interaction between plants and their specialist herbivores. However, *P. rapae* feeds on a large number of plant species and is irrelevant as a herbivore of *A. thaliana* as there is a phenological mismatch; *A. thaliana* grows in winter and early spring while *P. rapae* emerges in May [4]. This model may still be suitable to test physiological responses, but interpreting them in an ecological or evolutionary context, assuming co-evolution, does not make sense [for examples see 4]. Other examples of fundamental errors cover studies on trophic interactions between species from different continents, tests of scenarios that do not occur under natural conditions, or use of single genotypes [for examples see 5]. Even though the hypotheses might be tested correctly this does not contribute to insight in the interactions among organisms and their environment in the natural world.

Our aim here is not to review ecologically faulty studies but to point out that, this is a general issue spanning different research fields. Research that lacks ecological relevance is a waste of resources but the consequences can reach much further. In a recent study, α -diversity was used to evaluate the success of ecological restoration. The authors conclude that the dragonfly community can be restored within three years after rewetting of a drained peatland [6]. However, when community composition is considered, and not merely species number, it becomes clear that most, if not all, habitat-specialists have not returned. This puts the conclusions in a very different perspective. There is an obvious irony in studies that claim to consider conservation a priority, while paving the way for dubious mitigation of anthropogenic impact.

These examples from different fields of ecology show that poor ecological knowledge can lead to studies that lack ecological relevance. In any study on the interaction between species or an organism's response to environmental variation it is essential that this represents a realistic and suitable scenario. This issue is not likely to resolve itself, especially because of the expanding number of species and ecosystems that are studied. To begin with, we unequivocally stress the importance of knowing your study system, including basic ecology and taxonomy, and this should be reflected in teaching [7,8]. The primary responsibility lies with the researchers with the review process functioning as a quality control. It is however not realistic to assume that reviewers or editors have sufficient knowledge on the species studied and their ecology. This means that such problems of oversight are currently not intercepted in the review process. We propose that editors ask reviewers to flag possible issues on ecological relevance and acknowledge when this is beyond their expertise, as is customary with complex statistics. When this is the case the editor can ask the authors for clarification or consult a specialist with sufficient knowledge of the species concerned. Similarly, such best practice would be highly beneficial during the evaluation of grant proposals. We hope that a more stringent quality control on the ecological realism of papers forces researchers to think more explicitly about the ecological relevance of the hypotheses they are testing. By doing this we will not only be answering questions correctly but also answer the correct questions in ecology.

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