

Theory articles in *EER* and other ecology journals versus climate change research

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ABSTRACT

Questions: What are the trends in the number and proportion of theory papers in *Evolutionary Ecology Research (EER)* compared with those in ecology papers in ISI's *Web of Science*? How do these compare with trends in climate change papers? What are the trends in the number and proportion of theory papers within the category of climate change papers?

Methods: Enumeration and regression analysis of papers in *EER* published between 1999 and 2012 with the word 'theory' in their title or keyword list. Enumeration and regression analysis of papers in the ISI *Web of Science* published between 1982 and 2012 (Category: Ecology; Document Type: Article).

Results: The annual proportion of theory articles in *EER* showed no trend during the period analysed. But the proportion of theory articles in ISI-listed ecology journals decreased markedly. During the same period, the total number of ecology papers quadrupled and the absolute number of ecological theory papers doubled. Climate change papers showed an explosive increase during the period but only a tiny fraction of them were theoretically oriented.

Keywords: climate change, ecological literature, theory papers.

INTRODUCTION

Ecology is a relatively young scientific discipline (Peters, 1991). In the last decade, ecologists were still debating whether there are general laws in ecology (Lawton, 1999; Berryman, 2003; Colyvan, 2003; Simberloff, 2004) and discussing the conceptual framework required to understand and predict ecological processes and patterns (Chisholm and Pacala, 2011; McLachlan and Ladle, 2011). A proposal for a unifying theory of ecology, the metabolic theory (Brown *et al.*, 2004), has received support from the community of ecologists, but several points of discrepancy remain (see *Forum* following Brown *et al.*, 2004; Cassemiro and Diniz, 2010; and Price *et al.*, 2010). A dominant theory of plant ecology, the resource availability hypothesis (Coley *et al.*, 1985; Coley, 1988), which explains interspecific patterns of defence allocation against herbivores, has received much support in experimental studies (Endara and Coley, 2011). However, it still needs to incorporate the within-species approach because it is at the population scale where natural selection operates and,

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eventually, leads to interspecific patterns. Therefore, we still need a thriving scientific community of ecologists working on the conceptual foundations of the discipline and the unification of its constituent theories (Scheiner and Willig, 2008; Novičič *et al.*, 2012).

METHODS

I conducted several separate analyses. First, I used the search engines available in the website of *Evolutionary Ecology Research (EER)* to examine all 14 completed volumes of the journal (1999–2012). I recorded the total number of articles and those with the word ‘theory’ in their title or keyword list. Then I calculated the relative proportion of theory articles year by year.

Second, aiming to compare the *EER* results with a very broad database, I surveyed ecological studies in the *ISI Web of Science* published between 1982 and 2012 (Category: Ecology; Document Type: Article). I recorded those articles with the word ‘theory’ in their title and calculated their relative proportion year by year. I used linear regression analysis to assess the variation in publication records with time.

Third, again using the *ISI Web of Science* (1982–2012), I recorded those ecology articles with the words ‘climate change’ in their title. Finally, again using the *ISI Web of Science* (1982–2012), I recorded those ecology articles with the words ‘climate change’ in their title, but I filtered the output to restrict it to those classified by the *Web of Science* to have ‘theory’ as a topic.

RESULTS

In *EER*, the annual proportion of theory articles did not vary during the period analysed ($R^2 = 0.02$, $F_{1,12} = 0.205$, $P > 0.65$, $N = 14$) (Fig. 1). This would suggest that theory-driven research in *EER* has stayed relatively constant since the journal was founded. *EER* published 62 papers in its first 14 volumes with the word theory in their title or keyword list (average 4.4 per year).

In contrast with *EER*, theory articles in ISI-listed ecological journals (which include *EER*) showed a significant decrease in their relative contribution to ecological research between 1982 and 2012 ($R^2 = 0.35$, $F_{1,29} = 15.508$, $P < 0.001$, $N = 31$) (Fig. 2). The decrease is not explained by a decrease in the production of (or interest in) theory papers in ecology. Thus, the absolute number of theory papers doubled from 1982 ($n = 34$) to 2012 ($n = 68$). During the same period, however, the total number of ecology papers increased nearly four-fold (from 3913 to 15,900); consequently, the relative contribution of theory-oriented papers diminished.

During the same period (1982–2012), climate change articles showed an explosive increase (from 0 to 256 articles per year). The trend fits a cubic polynomial ($R^2 = 0.95$, $F_{3,27} = 163.195$, $P < 0.001$, $N = 31$) (Fig. 3).

Starting in 2001, only 42 climate change papers had ‘theory’ as a topic. Although the sample size is small (only 12 years = points in the analysis), and thus the results cannot be taken as conclusive, I did conduct the same regression analysis. Results show that, within climate change articles, there was no change in the proportion of theory articles with time ($R^2 = 0.13$, $F_{1,10} = 1.495$, $P > 0.24$, $N = 12$). The number of theory articles was in all cases low, ranging from 0 in both 2003 and 2005 to 11 in 2012 (11 of 15,900 papers published that year).

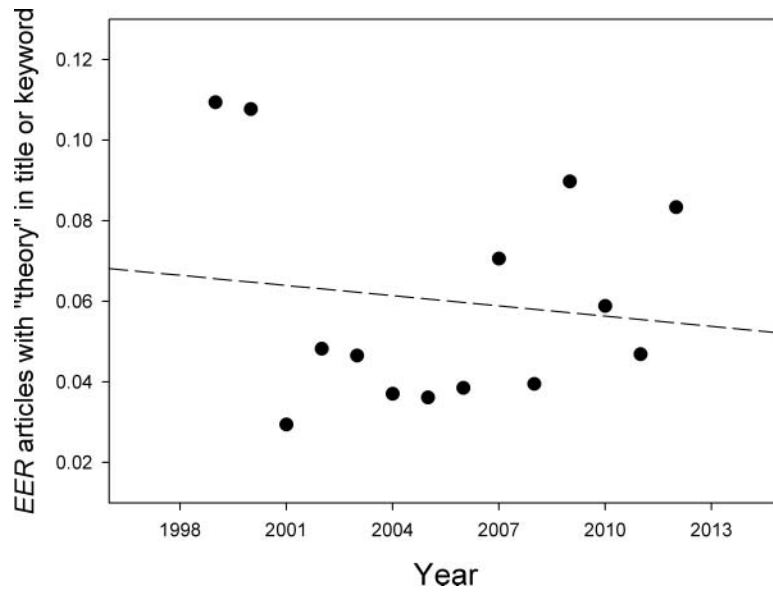


Fig. 1. The proportion of all articles published in *EER* between 1999 and 2012 with the word 'theory' in their title or as a keyword (evolutionary-ecology.com/search.php). The dashed line corresponds to a linear regression fit ($R^2 = 0.02$, $P > 0.65$).

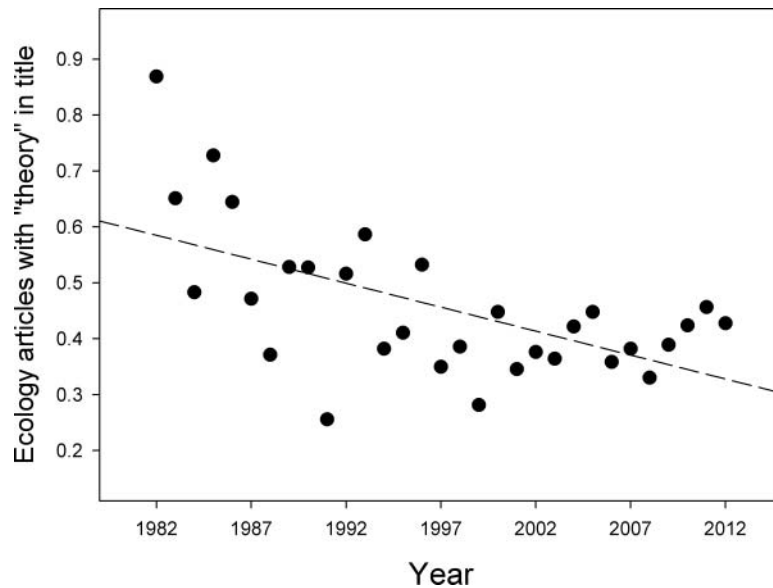


Fig. 2. The proportion ($\times 100$) of all articles published in ecology journals between 1982 and 2012 with the word 'theory' in their title (source: ISI *Web of Science*). The dashed line corresponds to a linear regression fit ($R^2 = 0.35$, $P < 0.001$).

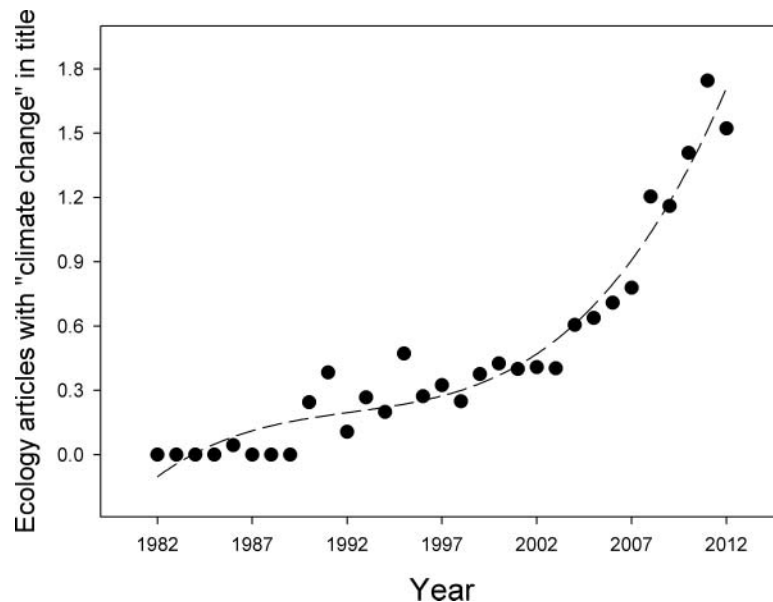


Fig. 3. The proportion ($\times 100$) of all articles published in ecology journals between 1982 and 2012 with the words 'climate change' in their title (source: ISI *Web of Science*). The dashed line corresponds to a cubic polynomial fit ($R^2 = 0.95$, $P < 0.001$).

DISCUSSION

What research field in the ecological sciences could have increased disproportionately so as to dilute the relative input of theory-driven papers? Among several possible candidates, I explored the possibility that climate change research could be involved.

Global awareness of the various challenges that climate change poses for human welfare and biodiversity has led to increased research on its pervasive effects on natural and anthropogenic ecosystems (Walther *et al.*, 2002; Root *et al.*, 2003; Parmesan, 2006; Lavergne *et al.*, 2010; Novičič *et al.*, 2012; O'Connor *et al.*, 2012). Several scientific journals specifically devoted to climate change research have been launched in the last decade, and both individual scientists and funding agencies are allocating greater resources than ever before to ecological research linked to climate change.

A caveat for the search criterion that I used is that there may be theory articles that do not have the word 'theory' in their title; conversely, some articles retrieved by the searches may not be theory articles. However, the same applies for climate change articles. Despite this imprecision in the survey, I consider the analyses adequate enough for comparative purposes, as there is no bias.

A possible explanation for the contrasting patterns found is that increased climate change research has come at a cost: a slower development of ecological theory in the scientific community. However, causality should not be necessarily inferred from inspection of the curves in Figs. 2 and 3. For instance, the proportion of articles addressing theoretical issues might be also decreasing in scientific disciplines unrelated to climate change research, reflecting an overall decline in the relative interest in theory papers. Alternatively, research

fields other than ecological theory might be equally affected by the increasing dominance of climate change research in ecological sciences.

Meanwhile, it is evident that the proportion of theory papers within the climate change literature is rather low. This suggests that climate change research is not a field where theory commands much attention and that climate change articles focusing on theory have not found a conspicuous niche.

From the individual scientist's standpoint, it could be argued that the time necessary to document the effects of climate change on the study species or community in question is time that cannot be dedicated to basic investigations that may contribute to the development of ecological theory. Thus ecologists may be adjusting their research efforts in order to contribute solutions to human welfare and/or biodiversity conservation problems. But it is also possible that the pattern reflects compliance with current mainstream trends related to climate change, or a desire to match funding opportunities.

Although the importance of climate change research for society cannot be questioned (Gleick *et al.*, 2010), it is also true that we need basic ecological research and theoretical tools to understand the complexity of ecological systems at the local scale, where climate change impacts are evident (Walther *et al.*, 2002; Parmesan and Yohe, 2003; Simberloff, 2004). Theory-driven research and theoretical models not only contribute to the development of ecology as a science, but also enhance our understanding of climate change effects on natural populations (O'Connor *et al.*, 2012) and the adaptive responses of organisms to the associated selective pressures (Hoffmann and Sgrò, 2011). It has been shown how theoretical knowledge of ecological principles can make the difference between success and failure when tackling biodiversity conservation issues (Crouse *et al.*, 1987; Doak and Mills, 1994; Wallington *et al.*, 2005; Valladares and Gianoli, 2007).

It is important to stress that I do not disregard the fact that findings arising from climate change research might contribute to the development or refinement of ecological theory. However, as far as I am aware, such contributions are yet to be reported. The closest case is the discussion by Chevin *et al.* (2013) of conceptual issues arising from studies on tree responses to drought and temperature.

Finally, I suggest that enhanced funding of climate change research, badly needed by society, should not come at the expense of funding of basic research, which will provide the underpinnings of future ecological research.

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