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Point of view/Coluna opinião

Publish what? A reply to Scarano

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ABSTRACT – (Publish what? A reply to Scarano). Fabio Scarano (2008) shows an attractive picture of the motivations leading to the final goal of the scientific enterprise, *i.e.* why scientists must publish their findings. Moreover, he proposes that scientists must aim for creativity and originality through question-driven papers, rather than unenlightening descriptive ones. I agree, but I will show that this view, albeit necessary, is incomplete. The most important flaw is that he does not show how that, in order to be creative and original one needs a deep understanding of a domain of knowledge. I will argue that these qualities cannot be reached in a theoretical vacuum. It must be remembered that the scientific enterprise is a complex cognitive process. One can only advance, learn and understand from the springboard of what one already knows. The improvement of established theories or the proposition of new ones can only be possible through a deep analysis, synthesis and integration of accepted scientific knowledge. This is only possible through the scrutiny of the concepts, propositions and predictions of accepted theories. Going deeper into Scarano's ideas, I propose that to further our comprehension of nature and to give a basis for the generation of knowledge, Brazilian ecologists should look for a specific set of question-driven papers. These are what I will call the 'why-question' papers. Only why-question driven papers can provide accounts which advance scientific knowledge and foster explanations of the mechanisms behind ecological processes.

Key words - science in Brazil, scientific knowledge, theories in ecology

RESUMO – (O que publicar? Uma réplica a Scarano). Scarano (2008) apresentou uma análise bem fundamentada das motivações que levam aos cientistas a alcançar o objetivo final da jornada científica, *i.e.*, a publicação de suas descobertas. Além disto, Scarano propôs que devemos buscar criatividade e originalidade em artigos que levantem questões, ao invés de publicar artigos puramente descritivos. Apesar de concordar com esses pontos, considero que esta visão, mesmo sendo necessária, é incompleta. A principal falha é que não foi demonstrado que para ser criativo e original é necessário um profundo entendimento de um domínio específico do conhecimento. Além disto, criatividade e originalidade não podem ser alcançadas em um vácuo teórico. Deve-se lembrar que a jornada científica é um processo cognitivo complexo. Nosso aprendizado e entendimento somente podem avançar a partir do que já sabemos. O avanço nas teorias já estabelecidas ou a proposição de novas teorias ocorre através da análise, síntese e integração do conhecimento científico atualmente aceito. Isto só é possível através do exame minucioso dos conceitos, proposições e predições das teorias atualmente aceitas. Indo além das ideias propostas por Scarano, eu proponho que para avançar nossa compreensão da natureza e para lançar as bases para a construção de conhecimento, os ecólogos Brasileiros devem ter como objetivo um conjunto específico de artigos. Esses artigos são os que levantam questões sobre o porquê dos fenômenos naturais. Somente esse tipo de artigo pode ter algum papel no avanço do conhecimento científico e promover a explicação dos mecanismos subjacentes aos processos ecológicos.

Palavras-chave - ciência brasileira, conhecimento científico, teorias em ecologia

Introduction

In his article entitled "Why publish?" (Scarano 2008), Scarano presents a well structured analysis of the motivations that lead scientists to publish their findings. I think, notwithstanding its contribution, that some important aspects should be extended in order to further the comprehension of not only why we should publish but also of what deserves to be published. This is now an urgent question that needs to be addressed. During recent years the Brazilian Graduate Program has increased as never before and produced already a massive number of articles published every year, comparable with that of many developed nations of the world (Scarano 2007). As Scarano contends, it is time to improve the quality of our articles and our journals (see Scarano's comments on some measures that nowadays are often used to judge the quality of journals and papers).

His suggestion to improve the quality of Brazilian articles is that "we should move from a strictly descriptive approach to question-driven efforts". In addition, he argues that the "editorial policy of competitive Brazilian journals

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should privilege originality and creativity". Scarano is correct in his worries, but my aim here is to show that his approach is incomplete. Regarding creativity and originality, he seems to speak to only one side of the audience, *i.e.* to the reviewers. Thus, taking into account the writer's side, his argumentation is flawed, since he does not mention what the necessary background is in order to achieve creativity and originality in science. This is crucial. It is easy to recognize when someone is using creativity to solve a difficult problem, or when one reads an original paper. A more difficult task, however, is to identify in advance which are the mental skills necessary to be creative and original (Claxton & Lucas 2005, Torre 2005). In everyday life it is very common to hear the exclamation: 'why did not I think of that?' My point here is in accordance with an observation made by Pasteur long ago: "the chance only happens to the prepared mind".

Creativity and originality are only two of several components used to generate scientific knowledge (Peters 1991, Ford 2000, Pickett *et al.* 2007). These qualities, however, cannot be acquired in a theoretical vacuum. One must remember that scientific enterprise is a complex cognitive process. We can only learn from what we already know (Novak & Gowin 1984, Ausubel 2000). From this point one can define the degree of understanding of a specific subject. As Zugman (2008) points out, it is impossible to be creative without having a deep comprehension of a domain. The domains of scientific knowledge are construed by passing through the realms of accepted theories (see Pickett *et al.* 2007 for domain definitions in Ecology).

In his account, Scarano does not mention the central role of theories in the synthesis and construction of scientific knowledge. He only defends the proposal that journals should prioritize papers that raise new ideas. The way to develop new ideas, he proposes, is to turn away from descriptive papers and towards question-driven papers. I have reason to believe that his proposition needs improvement. Firstly, I think he uses "new ideas" as a loosely framed term for scientific theories. Thus, in the following I will discuss the meaning of the concept theory and the central role it plays in scientific knowledge generation. Secondly, I will argue that question-driven papers of any kind are not enough to solve the problem of the quality of papers published in Brazilian journals. One needs, rather, papers that contribute through explanations of natural phenomena (Bunge 2006). Therefore, I propose that only a specific set of questions will help to advance scientific knowledge through explanation of the mechanisms behind ecological processes. These are the why-questions.

The structuring role of theory in scientific knowledge

Curiously, Scarano does not mention the fundamental role that theories have in knowledge generation. Theories in science have the role of synthesizing and systematizing scientific knowledge. Data cannot be interpreted in a theoretical vacuum (Bunge 2006). What is a theory, however? One clear and uncontroversial definition is that a theory is "a set of propositions or a system of conceptual constructs put together to advance the explanation of the causes of observable phenomena" (Bunge 1998, Ford 2000, Pickett *et al.* 2007). It is clear from this definition that concepts and propositions are the fundamental building blocks of scientific reasoning. In this case, propositions are used to establish a relationship between concepts that are representations of regularities, and these propositions may be true or false (Mahner & Bunge 1997, Ford 2000). Scientific concepts, moreover, sometimes have a great level of complexity due to their high level of abstraction or due to interconnection with other concepts. For instance, to achieve the meaning of the concept of "adaptation", it is necessary to include and understand simultaneously the concepts of variation, heredity, natural selection, reproduction, fitness and more besides.

In knowledge generation, theories set the grounds defining what is already know, but theories may be improved from time to time. This is to say that they are open to criticism. When there are some observations that are not in accordance with established theories or when there is no theory to explain some novel phenomenon, theories can be modified or new ones can be proposed (Lakatos 1980, Bunge 2006). Thus, scientists get involved in scientific programs with the aim of generating knowledge. Central to knowledge generation is the interconnection of data, hypotheses and theories. In the words of Pickett *et al.* (2007), the "most useful and compelling hypotheses are those that are clearly connected to a theoretical context. If a person proposes a hypothesis that is entirely disconnected from established or emerging theory, it may not be terribly useful to act on that hypothesis".

But then, what differentiates studies that only gather information from studies that may contribute to knowledge generation? The crucial difference is that the latter proposes a causal mechanism to explain the phenomenon of interest. Thus, studies must have propositions that, according to theoretical predictions, must restrict the universe of possible outcomes. The major problem with descriptive studies is that any outcome is possible. For

example, if you ask what the photosynthetic rates of restinga plants are, it will be fine whether you find them to be 5, 10 or 30 μmol CO_2 m^{-2} s^{-1}. However, according to theories that relate the nitrogen concentration in leaves to photosynthetic capacity, it is a great certainty that some values will be more probable than others, and they provide a framework to judge when the results are in conflict with accepted theories and, in this manner, it is possible to advance knowledge about nature.

However, not everything is a bed of roses. Using the words of Bunge (2006), "theories need laws (lawful mechanisms) or at least generalizations". Therefore, one needs not only to obtain some data in descriptive studies but also to search for general patterns and to propose causal explanations for them. Generalizations can be of different types (Cooper 1998). In any case, they have in common some degree of simplification (Pickett *et al.* 2007). One way to find confirmed generalizations in Ecology is to extend the inferences of the patterns detected, or to define in which circumstances it applies. For instance, whether the process of interest is related to a group of species, it is necessary to test whether the outcome is invariable with the inclusion of more species. The same applies to spatial and temporal scales. What transpires is that the domain of applicability of the generality one want to confirm should be specified and tested.

Being able to find general patterns and to propose causal mechanisms to explain them is the only way to develop theories and advance knowledge. In reality this is not an easy task, but there is no other way to improve the understanding of ecological processes. Thus, I have reason to believe that any question-driven papers, such as Scarano proposes, will not be enough to solve our problem. Ecologists need instead, why-question driven papers with sound theoretical underpinning. Scarano is very convincing in his demonstration of the reasons why we should publish our findings, but not when it comes to explaining what is to be published. I hope that in this reply I have been able to further our comprehension about what should publish. Such a clarification of the approach to be taken as (Brazilian) scientists and researchers publishing nationally and internationally, would certainly have a profound effect on our position in the global scientific community.

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