

Population and species concepts in conservation biology and their treatment in textbooks of ecology and genetics

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KEYWORDS: BIOLOGICAL CONCEPTS – ECOLOGY – GENETICS – POPULATION – SPECIES – TEXTBOOKS

ABSTRACT: Concepts concerning population and species are fundamental in Biology, both closely linked to genetics and ecology. From this perspective, it is advisable for genetics and ecology textbooks to offer an thorough picture of these concepts. However, a review of specialized handbooks offers a discouraging picture. We believe that accurate and informative definitions of both concepts are needed, either in the glossary or in the specific chapters. Our review evidence the scant attention paid to these concepts in textbooks, which therefore need to be improved.

RÉSUMÉ: Population et espèce sont deux concepts fondamentaux dans la Biologie et ils sont très rapportés avec la génétique et l'écologie. Par conséquent, les manuels de génétique et d'écologie doivent offrir une vision correcte dans ces concepts. Cependant, la révision de ces manuels offrit une vision décourageante. Nous pensons que les manuels doivent comprendre définitions complètes et correctes de les deux concepts dans le glossaire et dans le chapitre spécifique. Notre révision montre que les manuels donnent attention faible a ces concepts, laquelle a besoin d'être amélioré.

INTRODUCTION

Population and species' concepts are basic for the understanding of the biology, as well as the performing of fieldworks and related management. Some of the current career opportunities for graduates in biology are related with environmental management and conservation biology, both closely linked to genetics and ecology, and increasingly needed in the current loss of global biodiversity, the so-called sixth extinction by some authors (Leakey and Lewin, 1998; Delibes de Castro, 2001).

Species is considered the basic unit for conservation due to several reasons: it is a natural biological category, many of them are easily identified by people, and cannot be replaced in the case of extinction. However, populations can also be conservation units in some cases where they show some unique qualities (Mayr, 2006).

Future biologists receive their instruction from both teachers and textbooks. Sometimes, when the pupils decide don't attend to the classroom, books are the single way for learning. From this perspective, it is required that textbooks of genetics and ecology offer an exhaustive picture of the cited concepts, since the practice of conservation biology requires a clear understanding of them, as well as their limitations and difficulties.

The aim of this study is to know the way in which these concepts are treated in the textbooks of genetics and ecology.

METHODOLOGY

We revised the textbooks of genetics and ecology available to the undergraduate students of Biology and Environmental Sciences at the Faculty of Sciences of the Granada University. The sample includes 14 textbooks of genetics, published between 1972 and 2007, and 20 of ecology, published between 1982 and 2006. We searched for the definitions of species and population both in the glossary and in the specific chapters. After that, we compared the definition of species with the *biological species concept* (Mayr 1942) and the definition of population with that given by Smith and Smith (2000) book: "*Grupo de individuos de la misma especie que viven en un área definida y en un tiempo concreto*" (A group of organisms of the same species occupying a particular space at a particular time). Apart of these definitions, in the genetics textbooks we also noted other relevant aspects of the concepts.

Our aim is not to offer an "ideal" definition of both concepts, because they have been widely defined and discussed along its history without a general agreement on which are the best. From

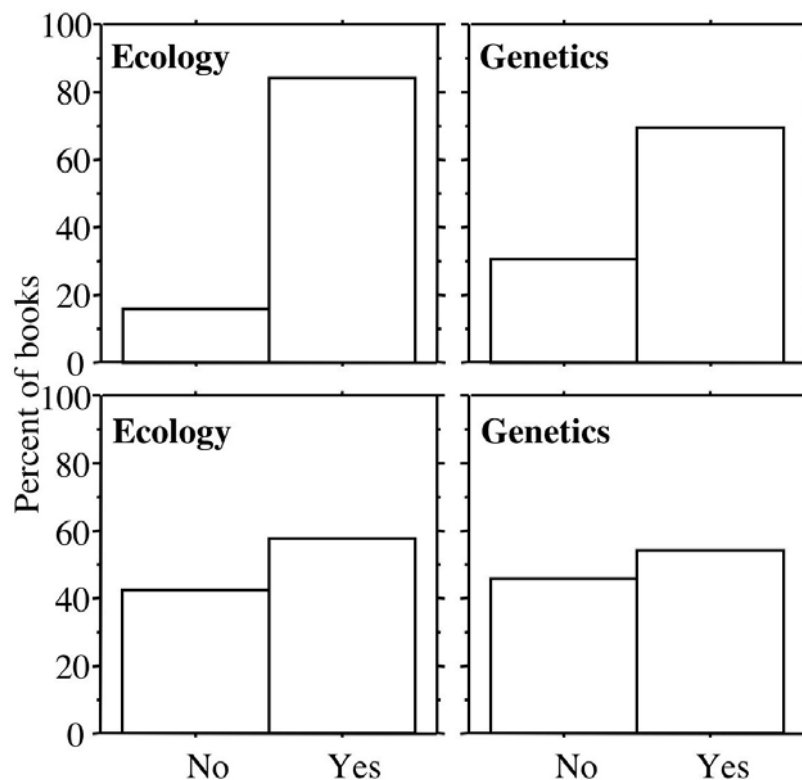
that perspective, there are numerous discussion and bibliography (Berryman 2002, Pigliucci 2003, Mayr 2006, Schaefer 2006). Rather, our objective is to offer some guidelines which contain a didactic meaning and provide the reflection and discussion in pupils.

RESULTS AND DISCUSSION

Neither genetics nor ecology are devoted to the species' description and classification, but species is at the basis of their studies, as for instance in population studies. In this way, it would be interesting that population and species' definitions appear in the specific chapters. These definitions provide, apart of the introduction to the concepts, a good opportunity to contrast them, discussing and thinking about their difficulties of application, when it is needed in fieldwork and research, and their repercussions. For instance, in the cases of biodiversity conservation, our judgement can be decisive when doing a selection about the population or species searched.

Despite the interest of presenting these concepts in the corresponding chapters, many books, both of genetics and ecology, do not make it (Figure 1). Some of them compensate this lack defining the concepts in the glossary, helping to the pupils to remember these words sometimes when they use the textbooks. However, there is also some cases, in both kinds of textbooks, in which the definitions are provided neither in the chapter nor in the glossary.

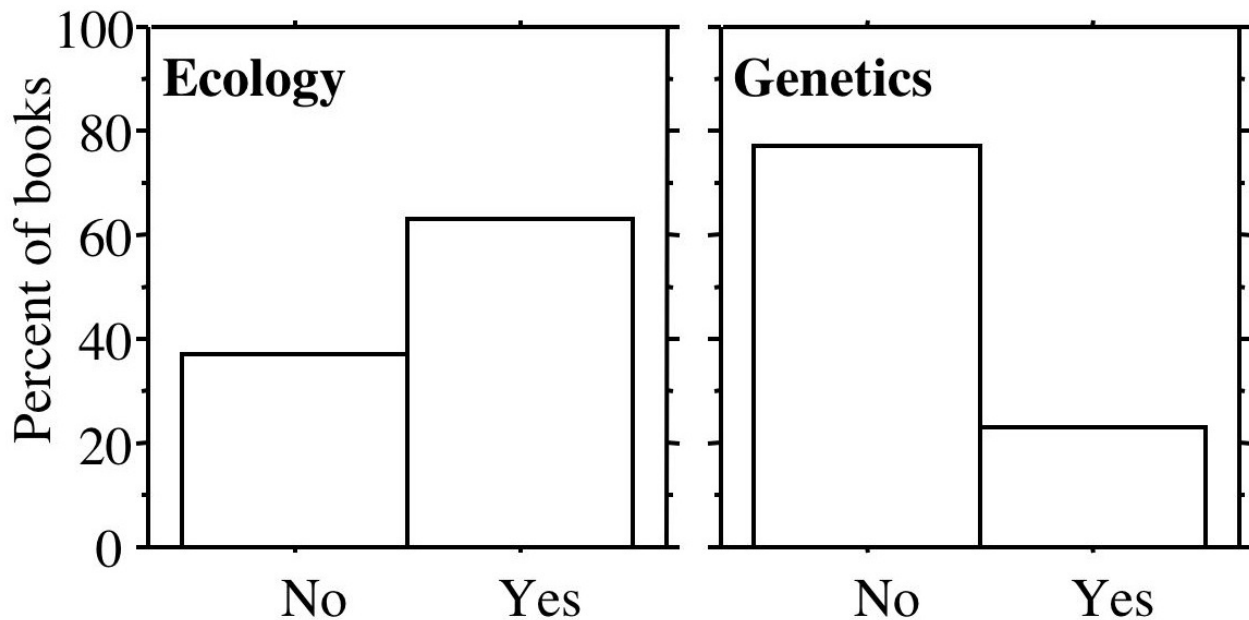
Figure 1. Percent of books defining population in text (above) and in glossary (below).



The population concept deserves a different treatment in both textbooks. So, in all the ecology textbooks, definitions include the expression: “organisms of the same species”. By contrast, some of the textbooks of genetics did not. This reference to the species concept is important, since frequently the pupils confound the meaning of the concepts of population and species (Develay and Ginsburger-Vogel 1986, Jiménez-Tejada unpublished data). By including the sentence “organisms of the same species” pupils can discriminate between the two concepts. Despite the interest of results, they significantly differ from expected.

The expression “occupying a defined geographic area” appears only in some ecology and, less frequently, in genetics books (Figure 2). Again, the reference to the occupied area is important, because it permits to think about the problems when applying this aspect to searches. Although, with some definitions its possible to do it, so in Begon et al. (1988) say: “It is usual to use the term *population* to describe a group of individuals of one species under investigation. What actually constitutes a population, though, will vary from species to species and from study to study.” Furthermore, the spatial aspect, help us to differ both concepts and to understand the evolution like changes in populations.

Figure 2. Percent of books referring to the expression “occupying a defined geographic area” when defining population concept.



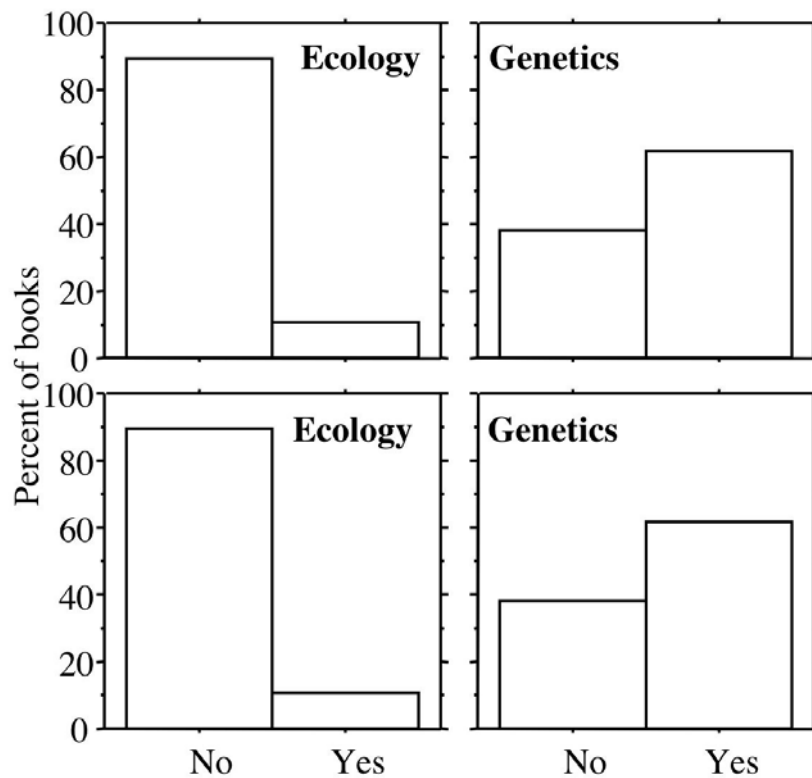
We can't forget the significance for the fieldworks because they use populations. Finally, in the conservation biology it is necessary to delimit the populations, since to protect the greatest part of species we need big populations (Primack and Ros 2002). Also, the results obtained in the spatial aspect differ significantly from expected.

Including the expression “the same time” is also necessary because the populations change along time and can give origin to new species. However, this aspect is rare in ecology books and does not appear in genetics ones. Some definitions replace the temporal and spatial aspect by including the “chance of reproduction”. Sum up, for the population concept, both time and place are key features because they can be very important for our judgement (Cowen et al. 2000, Freckleton and Watkinson 2003).

We draw our attention to the word *community* when the textbooks of genetics define the population concept. For example, Strickberger (1978): *Geneticists usually define the population like a community of organisms that reproduce sexually or have the ability to do*. Pupils frequently confound the concepts of population and community (Adeniyi 1985, Berzal de Pedrazzini and Barberá 1993, Develay and Ginsburger-Vogel 1986) and the misuse of the word community could reinforce this mistake. The word community is quoted in 44% of the population definitions in genetics textbooks.

We have found some other mistakes when defining species or population. For instance the aforementioned population definition by Strickberger (1978) completely ignores the species with asexual reproduction. In the same way, Gardener et al. (1998) define population: “A whole group of organisms belonging to a type, group of plants or animals that interbreeding, wide group from which can be taken a sample...” thus ignoring all the living beings that are neither animals nor plants. We cannot omit the definition in Sánchez-Monge and Jouve (1982) “*Conjunto de individuos de la misma especie que conviven en un mismo nicho ecológico*” (Group of individuals of the same species that occupies the same *ecological niche*). This definition is an example of conceptual mistake in textbook because “ecological niche” is used instead of “a given area”.

Figure 3. Percent of books referring to “interbreeding” (above) and “reproductive isolating mechanisms” (below) when defining species concept.



The species concept received a more homogeneous treatment than population concept in both textbooks, where is frequent to use the biological concept of species (Figure 3). All books where this concept is defined, refer the “interbreeding” and “reproductive isolating mechanisms”, except one, in which only interbreeding is mentioned. The inclusion of the “genetic isolating mechanisms” is interesting because two or more populations can belong to the same species if there is not genetic isolating, in spite of the fact that these populations cannot interbreed.

The expression “common genetic stock” is present only in some of genetics books. Its mention is valuable because gives an historical vision to the species and also helps to understand the evolution.

CONCLUSIONS

We have shown that the textbooks give an inadequate treatment to the concepts of species and population, and sometimes this treatment is far from the recommendable. Textbooks should include the definitions of both concepts in specific chapters to make easy to remember them, to introduce the subject and, finally, to allow the reflection about populations and species. When definitions are not included in chapters, the definitions should be, at least, in the glossary with an exhaustive

treatment, but this is unusual because definitions are usually more complete in chapters and more succinct in glossary. In spite of the complexity of both definitions, they should be in the textbooks in an exhaustive format. They will help pupils to think about its difficulties in practical applications. It is also important the use of the adequate words, in order to avoid any mistake that can provoke inadequate decisions in practice. In our opinion, all these outflaws result because textbook authors assume that readers know both concepts and their difficulties. However, this assumption is not justified: undergraduates in biology in fact make mistakes, confounding species and populations, or populations and communities (authors, unpublished data). Then, we need to raise in question the way in which pupils are trained in both concepts, from textbooks and from our job in the classroom, refreshing them and pushing the discussion.

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