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Short Note

Is Species Diversity of Various Crop "Pest Taxa" Proportionate to Efforts Paid to their Research? A Scientometric Analysis in the Czech Republic

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Abstract

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Taxonomical bias for the intensity of research in natural sciences is well documented but less data exists for crop protection, weed and phytopathology sciences. Here we test a hypothesis predicting a positive relationship between the number of pests recorded in various taxa ("pest-taxa") in the Czech Republic, their economic importance and numbers of persons engaged in research of crop protection, weed, and phytopathology. In contrast, we established an imbalance in the distribution of manpower and the number of pest species. The most counterintuitive result of this study was that the number of scientists was weakly inversely related to the average economic importance of particular taxa.

Keywords: scientometry; pest; pathogen; weed; taxon; species richness; number of scientists

Taxonomy has traditionally created fundaments for most research in biology, medicine, ecology, and crop protection. As estimated by May (2011), more than 1.5 million distinct eukaryotes have been named and recorded by taxonomists at the worldwide scale. It would be rational to expect to see more or less proportional coverage of various biological taxa in relation to their species richness by relevant research manpower (i.e. numbers of taxonomists) and resources (i.e. institutional or grant funding). Instead, there is documentation showing a strong and rationally unsubstantiated asymmetry between taxa richness and number of scientists dealing with a particular taxonomical group. Gaston and May (1992) demonstrated that the taxonomic effort is approximately divided 1 : 1 : 1 among vertebrates, plants, and invertebrates, whereas plant species are roughly 10 times, and invertebrates 100 times, more numerous than vertebrates. What are the reasons that some taxa are better worked out, while others are not? It may be related not only to the species richness but even to species size and attraction as demonstrated by conservation biologists (e.g. Ward *et al*. 1998; Frynta *et al.* 2010). There is also documentation for geographical and economic bias in taxonomy. For example Narendran's (2001) study revealed that taxonomic research in India is greatly neglected and underfunded compared to developed countries. Pysek *et al.* (2008) documented strong geographical and taxonomic bias in studies of invasion ecology. Their analysis (based on 2670 papers and 892 invasive species) showed that invasive organisms of Africa and Asia are poorly studied. Moreover, although major taxa of invasive organisms are well studied, most information on the mechanisms of invasion has emerged from work on a limited number of the most harmful species.

Cultivated plants and crops, stored seeds and products are vulnerable to infestation of a huge

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variety of pathogenic, weed or animal pest organisms (e.g. Kůdela & Kocourek 2002; Oerke & Dehne 2004; Trematerra 2013; Stejskal *et al.* 2014, 2015). The actual numbers of pest species in particular taxa and their economic importance are subject to temporal change (Šefrová 2004) which is also due to changing climate (Šefrová & Laštůvka 2005; Laštůvka 2009). As a consequence, crop protection also has to deal with increasing species diversity and richness. But is the attention paid to particular "pest taxa" proportionate to their size and importance? We may expect that numbers of scientists will be allocated proportionately not only to the numbers of pest species recorded for specific taxa but also with respect to their importance – simply because of economic pressure on practical efficiency of applied research. Surprisingly, as far as we know, there exists no analysis of this subject. Since global data are difficult to obtain, we started testing the hypothesis using available data from the Czech Republic.

MATERIAL AND METHODS

For testing our hypothesis we mainly used the data published (*i*) in a fixed time period and (*ii*) in the Czech Republic. Numbers of scientists working in "plant health" research were retrieved from Kůdela (2002, 2004). Numbers of pest species were retrieved from Kůdela and Kocourek (2002), Kůdela *et al.* (2012), and Lebeda (2013). Numbers of published papers related to particular taxa by the Czech scientists were taken from Stejskal and Aulicky (2003) and corrected according to Lebeda *et al.* (2014). The economic pest status of particular taxa was retrieved from crop loss estimates calculated by Oerke and Dehne (2004). Data were subjected to correlation analysis, using the statistical program Statistica v. 10.0 (released November 2010; StatSoft – Dell Software, Tulsa, USA).

RESULTS

In the Czech Republic the numbers of specialists studying the six groups of pest organisms (grouped according to their affiliation to higher taxa) are not proportional to the numbers of pest species in these groups (Figure 1A). Thus virology was staffed by 45 research scientists. To be comparable in size, entomology should be staffed by 350 scientists (instead of 65), plant pathology except aforementioned for virology by 240 scientists (instead of 71). This is not because the taxa with most pest species are relatively less economically harmful or that small taxa are more important and therefore more intensively studied. The number of scientists is weakly negatively related to the average economic loss caused by particular taxa (Figure 1B). This is also not because large research groups are associated with important specialists with high scientific productivity, as the number of papers on particular taxa is proportional to the number of scientists studying them (Figure 1C).

DISCUSSION

According to our opinion, this short analysis revealed counterintuitive results showing the rationally unsubstantiated imbalance in the distribution of manpower and the number of pest species and their economic importance. Here we analysed the published information on manpower regarding the available information on the number of pests and average long-term economic importance. Other factors that might explain this imbalance provide a rational explanation for this imbalance. But we are not aware of these factors or they are not available for all orders. For example, it would be interesting to analyse the situations when economic loss caused by a particular taxon is caused by a small number of important pest species, or by a great number of minor pests. Although this is an interesting aspect, its testing is difficult due to the lack of proper information; in the Czech Republic the relative economic pest status of various pest species is available only for several taxa and shows a significant temporal variability (e.g. Šefrová 2004).

It may also be interesting to explore whether the pest/scientist ratio growing with increasing pest-taxon diversity appears not only in the Czech Republic but also worldwide. If it is so (and this fact would deserve further analysis), we would propose three alternative explanations for this general "imbalance": (1) **Economic limits**: Numbers of students are adequate for small taxa but research teams cannot grow proportionally to the taxon size because of economic limits on research funds. Consequently, studies of large taxa are less staffed and correspondingly less studied. (2) **Intra-institutional competition**: within an institute/university each taxon related disciplines

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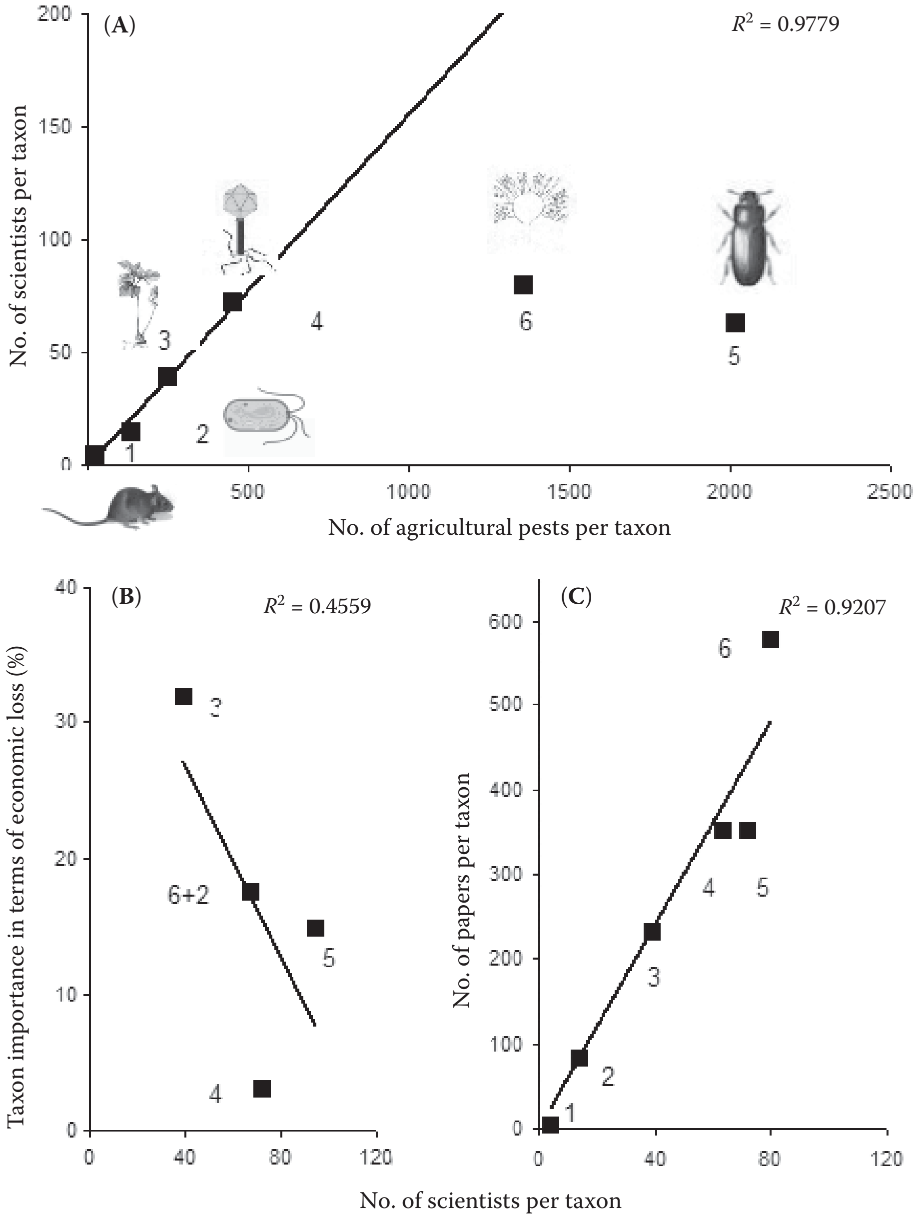

Figure 1. (**A**) The relationship between the number of scientists working on particular groups of pest species (taxa) and the number of pest species (Kůdela & Kocourek 2002; Kůdela 2004) in the taxon. The trend of a proportional increase in the numbers of scientists and the number of pest species per taxon studied does not hold good for fungi and insect pests; (**B**) The importance of pest groups (grouped according to the affiliation to higher taxa), measured in terms of their economic loss potential (Oerke & Dehne 2004), is not proportional to the number of scientists studying each taxon; (**C**) The number of papers published on each pest taxon between 1950 and 2002 in Plant Protection Science [a national scientific journal publishing a significant part of Czech applied research on crop pest species (Stejskal & Aulicky 2003)] is directly proportional to the number of scientists working on each taxon (1 – rodents; 2 – bacteria; 3 – plants (weeds); 4 – viruses; 5 – insects + mites; 6 – fungi)

usually represent separate units that tend to be of equal size as other units irrespective of the size or economic importance of the studied subject. In small countries like the Czech Republic there commonly exists a single plant protection unit/department at some work places. In that case, there is usually one specialist (if any) representing a particular taxonomic group of pests, which may also cause an imbalance between scientific manpower and economic importance/numbers of pests belonging to various "pest

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taxa"; (3) **Historical constraints**: imbalance may be a relic of the historical and personal situation in manpower distribution. The hypotheses are not mutually exclusive. However, their application in explaining personal situations of particular research groups, scientific progress in particular time periods and social stratification within particular institutions requires rather a historical than scientometric study. According to our opinion, the last hypothesis is the most probable. However, since we do not have any support, our suspicion should be further evaluated.

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