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Title: A Falsification of the Citation Impediment in the Taxonomic Literature

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ABSTRACT

Current science evaluation still relies on citation performance, despite criticisms of purely bibliometric research assessments. Biological taxonomy suffers from a drain of knowledge and manpower, with poor citation performance commonly held as one reason for this impediment. But is there really such a citation impediment in taxonomy? We compared the citation numbers of 306 taxonomic and 2,291 non-taxonomic research articles (2009-2012) on mosses, orchids, ciliates, ants, and snakes, using Web of Science and correcting for journal visibility. For three of the five taxa, significant differences were absent in citation numbers between taxonomic and non-taxonomic papers. This was also true for all taxa combined, although taxonomic papers received more citations than non-taxonomic ones. Our results show that, contrary to common belief, taxonomic contributions do not generally reduce a journal's citation performance and might even increase it. The scope of many journals rarely featuring taxonomy would allow editors to encourage a larger number of taxonomic submissions. Moreover, between 1993 and 2012, taxonomic publications accumulated faster than those from all biological fields. However, less than half of the taxonomic studies were published in journals in Web of Science. Thus, editors of highly visible journals inviting taxonomic contributions could benefit from taxonomy's strong momentum. The taxonomic output could increase even more than at its current growth rate if (i) taxonomists currently publishing on other topics returned to taxonomy and (ii) non-taxonomists identifying the need for taxonomic acts started publishing these, possibly in collaboration with taxonomists. Finally, considering the high number of taxonomic papers attracted by the journal Zootaxa, we expect that the taxonomic community would indeed use increased chances of publishing in Web of Science indexed journals. We conclude that taxonomy's standing in the present citation-focussed scientific landscape could easily improve – if the community becomes aware that there is no citation impediment in taxonomy.

Keywords: Animals; citations; impact factor; microorganisms; plants; scientometrics; taxonomic impediment; taxonomy.

Biological taxonomy, the science of characterising, classifying, and naming animate beings, is essential in most basic and applied biosciences – and even beyond (Bortolus 2008). For example, Australian wheat worth AUD 18 million was wasted for reasons of taxonomic confusion in biosecurity control (Boykin et al. 2011). Nevertheless, taxonomy is currently facing a shortage in knowledge and manpower. This shortage blocks the desirable acceleration of describing the remaining unknown species as well as progress in fighting the ever worsening biodiversity crisis. Many reasons for this taxonomic impediment have been proposed, such as a limitation of job opportunities for taxonomists (Agnarsson and Kuntner 2007; Ebach et al. 2011; Lester et al. 2014), a decreasing number of taxonomists (Gaston and May 1992; Mora et al. 2011), insufficient propagation of taxonomic knowledge at universities (Swiss Academy of Sciences 2007; Bilton 2014), and an advantage of non-taxonomic over taxonomic proposals with funding agencies (Swiss Academy of Sciences 2007). Another reason proposed is that taxonomists are not competitive enough in quantitative science evaluations in which standard bibliometric measures are used (Krell 2000; Valdecasas et al. 2000; Krell 2002; Ebach et al. 2011; McDade et al. 2011; Valdecasas 2011; Venu and Sanjappa 2011; Benítez 2014; Bilton 2014; De Carvalho et al. 2014; Pyke 2014).

The reasons identified for taxonomists' poor performance according to standard bibliometrics include: (1) Taxon authorities are not included in the reference sections of most publications (Werner 2006; Sundberg and Strand 2009; Bininda-Emonds 2011). (2) Taxonomy is a slow field with long time lags between publication and citation of papers (Krell 2002; Venu and Sanjappa 2011). (3) It is the editorial policy of most journals with high impact factor (IF) to discourage taxonomic publications (Agnarsson and Kuntner 2007; Ebach et al. 2011); various journals aiming to increase their IF have shifted their scope from taxonomy to phylogenetics and molecular research (Shashank and Meshram 2014). (4)

Taxonomic papers have small immediate audiences (Ebach et al. 2011) and receive few citations even when published in high-quality journals (Valdecasas et al. 2000). (5) Journals included in Web of Science (WoS) that publish taxonomy tend to receive a low IF (Werner 2006; Venu and Sanjappa 2011; Bilton 2014; Shashank and Meshram 2014). (6) Many journals publishing taxonomy are not included in WoS and thus have no IF at all (Krell 2000; Boero 2001; Krell 2002; Swiss Academy of Sciences 2007; Boero 2010; McDade et al. 2011; Benítez 2014; Shashank and Meshram 2014).

Various countermeasures have been proposed to overcome the taxonomic impediment, many of which need policy measures, e.g., providing more funding ear-marked to taxonomy within universities, museums, and funding agencies (e.g., De Carvalho et al. 2007). Without denying the importance of such measures, there have been suggestions for strategies manageable by scientists themselves, aimed at improving the competitiveness and thus the standing of taxonomists. One suggestion to achieve this within the existing system of science evaluation is to include taxonomic authorities in the reference sections of publications in all instances (Werner 2006; Bininda-Emonds 2011; Wägele et al. 2011) or at least when credit is due (Agnarsson and Kuntner 2007). Others have gone further and suggested alternative evaluation methods (e.g., McDade et al. 2011; Valdecasas 2011; Venu and Sanjappa 2011; Schekman 2013; Pyke 2014). However, despite the generally acknowledged criticism of the established bibliometric methods (Simons 2008; Adler 2009; Adler and Harzing 2009; Patterson 2009; Brumback 2012; Eyre-Walker and Stoletzki 2013; Foley 2013; Kaushal and Jeschke 2013; Schekman 2013), these are widely used for evaluating individuals, institutions, and journals in research (Simons 2008; Vale 2012; Kaushal and Jeschke 2013). Thus, at least in the shorter term, it seems difficult for the field of taxonomy to avoid citation-based evaluations.

We ask whether citation-based evaluations indeed are a drawback for taxonomy. To our knowledge, the citation performance of taxonomic papers has not been compared quantitatively with that of non-taxonomic papers. In more detail, we address five questions. Does publishing taxonomy harm a journal's citation performance? Is it within the possibilities of journal editors to influence taxonomy's visibility? If more high-visibility journals opened their doors to taxonomic publications, would taxonomy's productivity be sufficient for an increase in the number of taxonomic papers in these journals? Can taxonomy be published by taxonomists only or by a larger community? And finally, would the community use the chance to publish more taxonomic papers in highly visible journals?

PUBLISHING TAXONOMY DOES NOT GENERALLY HARM AND MIGHT EVEN BOOST JOURNALS

We present the results of a citation analysis on primary research articles on mosses, orchids, ciliates, ants, and snakes as representatives of non-vascular plants, vascular plants, heterotrophic microorganisms, invertebrates, and vertebrates, respectively. The five taxa were randomly chosen among candidate taxa; candidate taxa needed to meet the criteria of (*i*) sufficient taxonomic and non-taxonomic publications for sufficient sample sizes, and (*ii*) the trivial and the scientific name applying to exactly the same taxon (e.g., every orchid belongs in the Orchidaceae, and all species of the Orchidaceae are orchids). We were interested in the current situation and thus chose the years 2009 to 2012; 2013 was not yet feasible because papers need some time to become cited. For each of the five taxa, we selected the ten journals included in WoS that published the largest numbers of articles on the selected taxon in this period, totalling 47 journals (overlap of three journals among taxa; Table 1; see Online Appendix 1, at http://dx.doi.org/10.5061/dryad.3t761, for the protocols of database queries and manual content curation and Online Appendix 2 for the data). We classified the 2,597 publications on the focal taxa according to what we term the factor Taxonomy, i.e., into taxonomic (n=306) or non-taxonomic (n=2,291). Papers were considered as taxonomic if they included taxonomic acts at the genus to variety level, i.e., not just descriptions of new taxa but also synonymisations, revivals from synonymy, and new combinations. All these taxonomic acts represent relevant achievements by taxonomy and are needed to properly assess biodiversity. We then analysed the number of citations obtained by each publication as of 15 August 2014.

When all taxa and all journals were included in the analyses, the average numbers of citations were, as expected, lower for taxonomic papers than for non-taxonomic papers. This difference was significant (Fig. 1a) in analysis of variance using as factors Taxonomy, Journal, and Year, and their two- and three-level interactions calculated via Type III sum of squares; as for all other statistical analyses, SAS 9.4 was used. In taxon-by-taxon analyses of all journals, however, four of the five taxa were without significant differences. For the fifth taxon, ciliates, taxonomic papers were significantly more cited than non-taxonomic ones.

Just 14 of the 47 journals published both taxonomic and non-taxonomic papers on the focal taxa on a yearly basis in the years 2009-2012 (Table 1). The analysed taxonomic publications in these 14 journals might have experienced lower visibility than publications in the other 33 journals. This is due to the fact that the average IF 2012 of the 14 journals with both taxonomic and non-taxonomic publications was significantly lower (1.16±0.51 standard deviation) than the average IF of the other 33 journals (2.66±1.60; Student's t-test, $P<0.001$).

We thus repeated the analysis of variance including interactions, now focusing on the 14 journals which published both taxonomic and non-taxonomic papers. We found that, for these journals, taxonomic papers received more citations than non-taxonomic ones; the effect was not significant, though (*P*=0.066; Fig. 1b), significance potentially being masked by significant interactions involving Taxonomy. In the taxon-by-taxon analyses of these 14 journals, taxonomic publications on ciliates received significantly more citations than non-taxonomic ones, there were no significant differences for papers on mosses, ants, and snakes, whereas taxonomic publications on orchids received significantly fewer citations than non-taxonomic ones. Because of the correction for journal visibility, we consider the results for the 14 journals to be more representative of the citation performance of taxonomic vs. non-taxonomic *per se* than the results for all journals.

We infer that taxon-specific effects exist, at a frequency still to be determined. Citation behaviour is non-trivial to predict, and variation of citation traditions is known to occur even across the areas of a subfield (Bornmann and Daniel 2008; Erikson and Erlandson 2014). A frequently mentioned effect is that the citation performance of a field depends on the size of the field (Bornmann and Daniel 2008; Casadevall and Fang 2014). For taxonomy, this has been postulated to apply to the number of taxonomists working on a particular taxon (Krell 2002; McDade et al. 2011). We estimated the 2009-2012 research community sizes for the five taxa analysed here (see Online Appendix 3 for the protocol used) and found differences by up to a factor of three (mosses: 2,352 authors, orchids: 1,993, ciliates: 1,281, ants: 3,923, snakes: 2,540). Contrary to expectations, we found no significant increase of the number of citations with increasing community size across the five taxa (*P*=0.166; covariance analysis using the means of citations, Taxonomy as factor, and community size as covariable). Other established factors influencing citation practices include journal-dependent ones such as the accessibility and prestige of the journal, article-dependent ones such as the length and the number of authors on a paper, and author/reader-dependent ones such as the number of colleagues an author is personally acquainted with (Bornmann and Daniel 2008). Any or all of these factors as well as interactions with the factor Taxonomy as analysed here might have influenced citation performances across taxa, but it is beyond the scope of our study to explore these. Analyses of these factors for a broad array of taxa will be needed to address these issues properly.

Importantly, we infer that publishing taxonomic contributions does not generally harm and might even enhance the citation performance of journals, in stark contrast to previous belief (see above). Broad monitoring will be needed to confirm this finding for taxa beyond those addressed here.

EDITORS CAN INCREASE THE VISIBILITY OF TAXONOMIC PUBLICATIONS

For strengthening the impact and prospects of taxonomy, equal opportunity is needed for taxonomists and non-taxonomists. In practice, this means that taxonomists should be able to publish in highly visible journals (those included in WoS and with a good standing). Editors of highly visible periodicals that include taxonomy will contribute actively to reducing the taxonomic impediment and, considering our analyses, might on top of this do the best for their journals. Of course, taxonomy might not fall within the scope of all journals, but among the 33 journals in Table 1 that did not publish taxonomy on the focal taxa on a yearly basis from 2009 to 2012, 19 accept such contributions in principle and have indeed been publishing taxonomy but at a comparatively low rate. The IF 2012 of these 19 journals that (in principle) publish taxonomy (2.61±1.64) does, on average, not differ significantly from that of the 14 journals that do not publish taxonomy at all (2.73±1.61; Student's t-test, P=0.84) meaning that equal visibility for taxonomists and non-taxonomists might, in fact, not be out of reach. In essence, for many editors of highly visible periodicals, it might not so much be a question of changing the scope of their journals but of increasing the frequency of taxonomic publications and thus simply of communicating the readiness to publish taxonomy to the community. Many journals are now embracing social media to better connect with their community, so it is not so outlandish to imagine that editors might soon start tweeting that they are happy to publish taxonomic papers.

TAXONOMY'S PRODUCTIVITY WOULD BE SUFFICIENT TO INCREASE THE NUMBER OF PAPERS IN HIGHLY VISIBLE JOURNALS

It is not enough, however, for editors of highly visible journals to actively invite taxonomic contributions. A crucial question about whether increasing taxonomy's visibility will work is the capacity of taxonomy to follow the invitation. One way to approach this issue is looking at the growth rate of taxonomy. To have enough data points for a regression analysis, we analysed the period 1993-2012. Over this period, the number of taxonomic publications in journals included in WoS grew steadily, and the growth is better explained by an exponential than by a linear model, for all organisms (Fig. 2a; see Online Appendices 4 and 5 for the protocols of database queries and statistical analysis, respectively) as well as for plants, microorganisms, and animals (Fig. 2b). Possibly even more importantly, taxonomy as represented in WoS grew over the same period with greater speed than biology, again for all organisms as well as for plants, microorganisms, and animals (Fig. 2d) despite the decelerated growth rate of all biodiversity research in the past few years (Stork and Astrin 2014). This greater speed in growth makes it plausible that editors publishing taxonomy might indeed boost their journals.

Another approach to the question of taxonomy's capacity is whether there are sufficient publications in total, i.e., including in journals not indexed in WoS. This might be especially relevant to editors of WoS-indexed journals who decide to publish taxonomy on a frequent basis. To our knowledge, a comprehensive taxonomic literature database is available just for animals, Zoological Record (ZR). For 2012, the latest year considered here, ZR lists 2.1 times more publications on animal taxonomy than WoS (Fig. 2b, c). This indicates that already in the short term, there is sufficient taxonomic publication output for editors of highly visible journals to indeed increase their share in taxonomy. Also, just as in WoS (Fig. 2b), animal taxonomy grew in ZR (in line with Tancoigne and Dubois 2013) with an exponential rather than linear growth rate (Fig. 2c).

Taxonomy Can Also be Published by Non-Taxonomists

There is, however, realistic hope that the potential to publish taxonomic papers might be even greater than the ZR analysis suggests. Firstly, the dichotomy between taxonomists and non-taxonomists does not always exist. Some scientists do both sorts of research, either because of diverse interests in the first place or because of publishing on ecology, evolution or biogeography as a survival strategy of taxonomists in today's IF-ruled scientific system (Samyn and Clock 2012; also see Halme et al. 2015). Quantifying their number appears difficult, but these biologists could increase easily their activity in taxonomy, once aware that publishing taxonomy could be beneficial to their career.

Secondly, there are biologists who are spending a considerable amount of time and money on topics pertinent to species delimitation but have never included taxonomic acts in their publications, which focus on phylogeny or phylogeography. This has been criticised as a diversion of funds (Wheeler 2004). However, it also means there is a ready capital from which taxonomy could start profiting: Of 353 sets of specimens included in a literature analysis of studies that reported arthropod diversity at the species level, the need for taxonomic change was revealed for 123, but taxonomic change was published for just 48 (Schlick-Steiner et al. 2010). Given that interdisciplinarity between, for example, physics and biology is now common (West 2014), it should be relatively easy to achieve this cross-talk between taxonomists and non-taxonomist biologists.

On the whole, the capacity for increased publication of taxonomy in highly visible journals seems to be there. Accepting that the potential exists, there is still a question of whether taxonomy's flexibility will be sufficient for a change in publication culture to be realised.

THE COMMUNITY WOULD LIKELY USE THE CHANCE TO INCREASE TAXONOMY'S VISIBILITY

It is difficult to predict to which degree all those publishing taxonomy would accept changes in editorial policy, but there is a prominent example that speaks for optimism. The journal Zootaxa was founded in 2001 to "help taxonomists overcome the taxonomic impediment by enabling them to describe biodiversity in a rapid and efficient way" (Zhang 2011). Zootaxa was included in WoS in 2004 with a subsequent increase in the numbers of contributions published and citations received (Zhang 2011). Zootaxa has published a considerable fraction of the overall number of taxonomic papers on animals in WoS and in ZR (Fig. 2b, c; Tancoigne and Dubois 2013). This suggests that taxonomists indeed would use also other chances of publishing in highly visible journals, should the opportunity arise. The resulting shift from aiming at low-visibility to targeting highly-visible journals will be very important for taxonomists in working towards both an improved image (Carbayo and Marques 2011) and an improved measure of their scientific impact (Agnarsson and Kuntner 2007).

Conclusions

Criticisms of the use of bibliometric tools such as the IF in decisions about who gets funded and who gets academic jobs are justified (Benítez 2014; Erikson and Erlandson 2014; Pyke 2014). However, these tools are currently used widely and, as long as this is the case, taxonomy would benefit from a positive bibliometric performance. We suggest that changes in publication culture might help reduce the taxonomic impediment. Editors of highly visible journals in biology could help (1) increase the visibility of taxonomic publications by encouraging taxonomists to publish in their journals (thereby generally not harming but possibly boosting their journals), and (2) increase total taxonomic output by making it attractive for scientists working in species delimitation (with their primary focus different from taxonomy) to publish the taxonomic consequences of their research.

The task of taxonomic authors, in turn, will be to follow the invitation and to submit indeed their best papers to the best-visible journals available for submission – just as authors of non-taxonomic papers do. These actions together would very likely increase the citation strength of taxonomy as measured by the IF and similar tools and thus improve taxonomists' chances in competing for academic positions and research funding.

Here, we have revisited one seemingly well-established explanation for the taxonomic impediment, taxonomy's poor citation performance, with surprising results. We personally doubt that other explanations for the taxonomic impediment such as difficult job and funding situations would likewise turn out to be preconceived ideas – but evidence-based scrutiny is needed.

Supplementary Material

Supplementary material, including database query protocols and data, can be found in the Dryad data repository (http://dx.doi.org/10.5061/dryad.3t761).

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TABLE 1. The journals included in Web of Science publishing the largest numbers of publications on mosses, orchids, ciliates, ants, and snakes (2009-2012) and their 2012 Impact Factor

				All years		2009		2010		2011		2012	
Taxon		**Journal**	**IF 2012**	**Tax**	**Non-tax**	**Tax**	**Non-tax**	**Tax**	**Non-tax**	**Tax**	**Non-tax**	**Tax**	**Non-tax**
Mosses	•	Bryologist	0.98	25	58	9	16	4	18	6	16	6	8
	•	Cryptogamie Bryol.	1.04	9	49	3	17	2	6	2	9	2	17
		Environ. Pollut.	3.73	0	28	0	10	0	5	0	5	0	8
		Global Change Biol.	6.91	0	23	0	7	0	1	0	6	0	9
	•	J. Bryol.	1.35	18	75	4	22	4	13	9	16	1	24
	(•)	New Phytol.	6.74	0	26	0	8	0	2	0	8	0	8
	•	Nova Hedwigia	0.81	9	43	2	4	5	19	1	11	1	9
		Oecologia	3.01	0	22	0	8	0	1	0	8	0	5
	(•)	Polar Biol.	2.01	0	23	0	7	0	5	0	4	0	7
		Sci. Total Environ.	3.26	0	18	0	3	0	2	0	10	0	3
		All Journals		**61**	**365**	**18**	**102**	**15**	**72**	**18**	**93**	**10**	**98**
Orchids	(•)	Am. J. Bot.	2.59	0	33	0	4	0	5	0	12	0	12
	(•)	Ann. Bot.-London	3.45	1	44	1	22	0	4	0	10	0	8
	(•)	Aust. J. Bot.	1.20	0	17	0	9	0	4	0	2	0	2
	(•)	Bot. J. Linn. Soc.	2.59	4	40	0	9	1	11	2	6	1	14
	•	Nord. J. Bot.	0.60	16	12	3	5	4	2	4	2	5	3
	(•)	Phytotaxa	1.30	16	16	1	0	1	0	4	3	10	13
	(•)	Plant Biology	2.32	0	14	0	4	0	3	0	6	0	1
		Plant Cell Tiss. Org.	3.63	0	23	0	7	0	6	0	8	0	2
	•	Plant Syst. Evol.	1.31	5	32	1	7	1	5	2	11	1	9
		Sci. Hortic.-Amsterdam	1.40	0	42	0	10	0	8	0	12	0	12
		All Journals		**42**	**273**	**6**	**77**	**7**	**48**	**12**	**72**	**17**	**76**
Ciliates	•	Acta Protozool.	0.98	16	24	3	6	6	8	6	6	1	4
	(•)	Appl. Environ. Microb.	3.68	0	22	0	6	0	6	0	6	0	4
	(•)	Aquat. Microb. Ecol.	2.04	0	37	0	8	0	8	0	14	0	7
	•	Eur. J. Protistol.	1.51	29	44	8	13	8	11	7	10	6	10
	(•)	Hydrobiologia	1.99	0	17	0	5	0	4	0	5	0	3
	•	J. Eukaryot. Microbiol.	2.16	31	45	3	12	11	10	13	7	4	16
	(•)	J. Plankton Res.	2.44	0	27	0	5	0	7	0	10	0	5
		Mar. Ecol. Prog. Ser.	2.55	0	24	0	7	0	6	0	4	0	7
	(•)	PLoS One	3.73	0	25	0	2	0	1	0	8	0	14
	(•)	Protist	4.14	1	28	0	6	0	6	0	7	1	9
		All Journals		**77**	**293**	**14**	**70**	**25**	**67**	**26**	**77**	**12**	**79**
Ants		Anim. Behav.	3.07	0	53	0	12	0	14	0	12	0	15
		Ecol. Entomol.	1.95	0	53	0	11	0	18	0	13	0	11
		Environ. Entomol.	1.31	0	49	0	13	0	15	0	14	0	7
	(•)	Insect. Soc.	1.33	0	120	0	24	0	26	0	41	0	29
	(•)	J. Insect Sci.	0.88	0	51	0	9	0	20	0	11	0	11
	•	Myrmecol. News	2.16	10	71	1	18	2	10	3	22	4	21
		PLoS One	3.73	4	120	0	11	0	23	1	30	3	56
	(•)	P. Roy. Soc. B-Biol.Sci.	5.68	1	51	0	16	0	12	1	13	0	10
	•	Sociobiology	0.58	21	199	2	52	3	48	9	52	7	47
	•	Zootaxa	0.97	36	34	15	9	4	8	6	9	11	8
		All Journals		**72**	**801**	**18**	**175**	**9**	**194**	**20**	**217**	**25**	**215**
Snakes	(•)	Amphibia Reptilia	0.68	2	33	2	8	0	10	0	7	0	8
	•	Copeia	0.64	5	31	1	8	2	8	1	6	1	9
	•	Herpetologica	1.08	9	26	3	4	3	7	2	8	1	7
		Herpetol. Conserv. Bio.	0.67	0	40	0	12	0	11	0	13	0	4
		J. Exp. Biol.	3.24	0	25	0	4	0	10	0	3	0	8
	(•)	J. Herpetol.	0.89	2	60	0	16	0	8	2	14	0	22
		J. Venom. Anim. Toxins	0.55	0	65	0	16	0	17	0	15	0	17
		PLoS One	3.73	0	41	0	2	0	5	0	16	0	18
		Toxicon	2.92	0	213	0	52	0	67	0	47	0	47
	•	Zootaxa	0.97	36	25	10	7	4	4	10	6	12	8
		All Journals		**54**	**559**	**16**	**129**	**9**	**147**	**15**	**135**	**14**	**148**
All Taxa		**All Journals**		**306**	**2291**	**72**	**553**	**65**	**528**	**91**	**594**	**78**	**616**

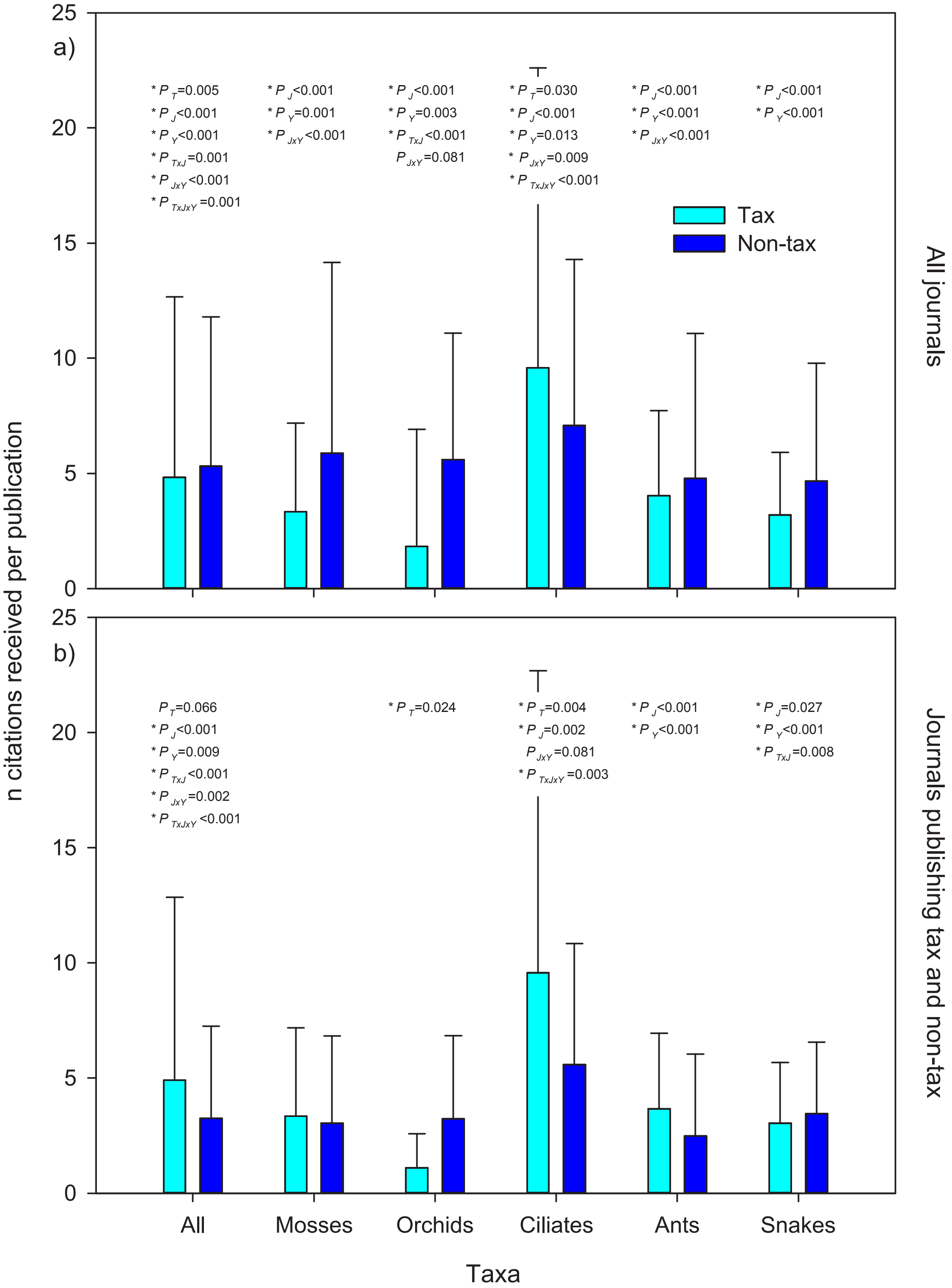
Notes: For each of the five taxa, the ten journals included in WoS were selected that published the largest numbers of articles on that taxon; see Online Appendix 1 for the protocols used and Online Appendix 2 for the data.

Abbreviations: IF, impact factor; tax/non-tax, number of taxonomic/non-taxonomic publications; (●)/●, journals publishing both taxonomic and non-taxonomic publications in principle/on the focal taxa on a yearly basis 2009-2012.

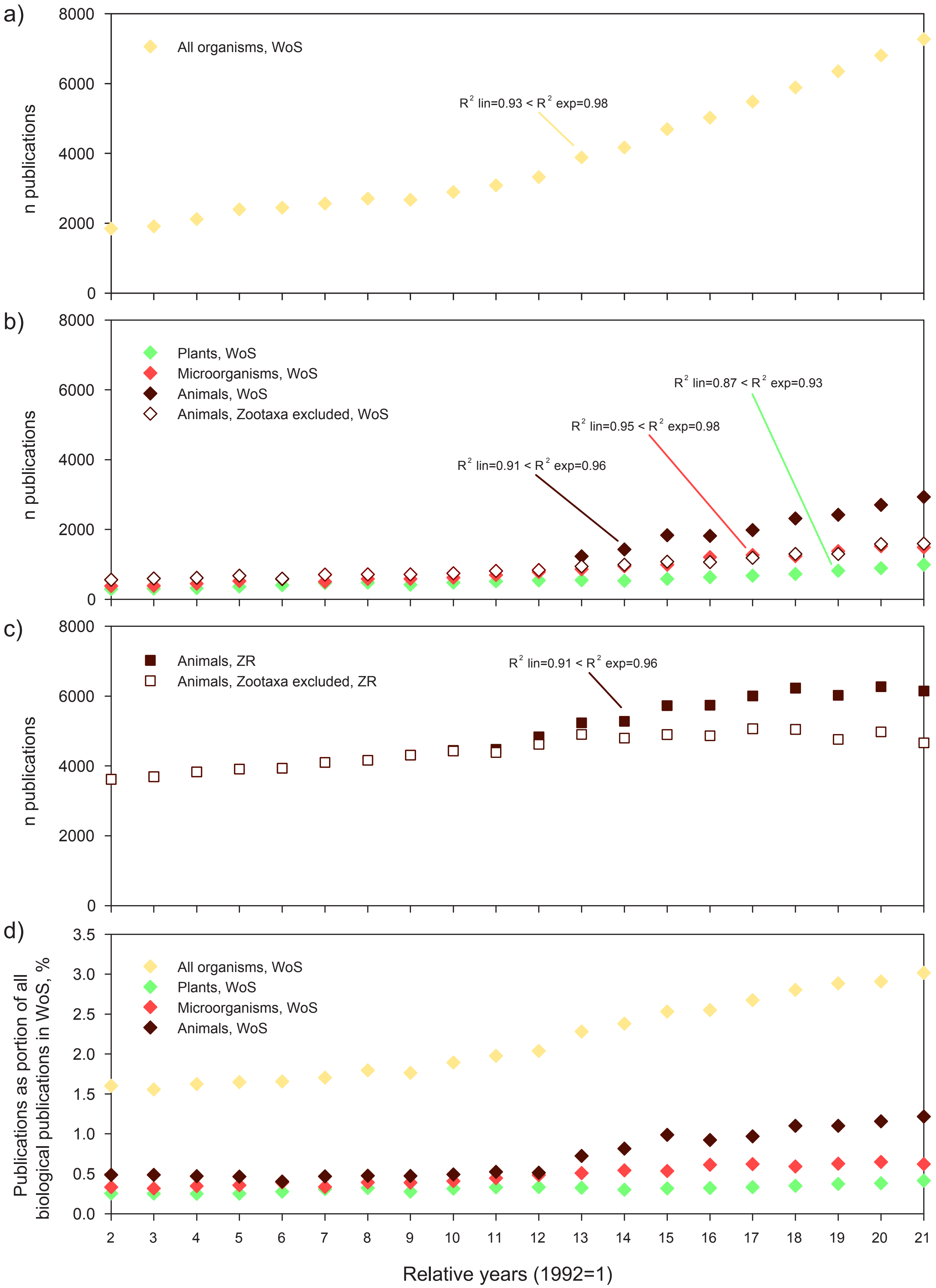
Figure captions

FIGURE 1. The average numbers of citations received (as of 15 August 2014) by taxonomic vs. non-taxonomic publications on mosses, orchids, ciliates, ants, and snakes based on Web of Science, for (a) all journals given in Table 1 and (b) the journals in Table 1 that published both taxonomic and non-taxonomic contributions on a yearly basis (2009-2012). Error bars represent one standard deviation. *P* values above bars are the results of analyses of variance comparing the numbers of citations for the factors Taxonomy (taxonomic vs. non-taxonomic publications, P_T), Journal (P_J), and Year (P_Y); × interactions among factors; *P* values <0.10 shown; * values significant at $\alpha=0.05$. See Online Appendix 1 for the protocols used and Online Appendix 2 for the data.

FIGURE 2. The number of taxonomic publications (1993-2012) included in (a, b) Web of Science (WoS), and (c) Zoological Record (ZR), on (a) all organisms, (b) plants, microorganisms, and animals, and (c) just animals; in addition, in (b, c) the numbers are shown for animals when excluding the journal Zootaxa. The results of regression analyses comparing the R^2 of linear (lin) and exponential (exp) functions are added. (d) The portion of taxonomic publications on all organisms and on plants, microorganisms, and animals included in WoS of all biological publications in WoS. See Online Appendix 4a-h for the database query protocols used and Appendix 5 for the regression analysis results. Years are given as relative years as used in the regression analyses: 2=1993, 21=2012.



a)
* P T=0.005
* P J<0.001
* P Y<0.001
* P TxJ=0.001
* P JxY<0.001
* P TxJxY=0.001
* P J<0.001
* P Y=0.001
* P JxY<0.001
* P J<0.001
* P Y=0.003
* P TxJ<0.001
P JxY=0.081
* P T=0.030
* P J<0.001
* P Y=0.013
* P JxY=0.009
* P TxJxY<0.001
* P J<0.001
* P Y<0.001
* P JxY<0.001
* P J<0.001
* P Y<0.001
Tax
Non-tax
All journals
b)
P T=0.066
* P J<0.001
* P Y=0.009
* P TxJ<0.001
* P JxY=0.002
* P TxJxY<0.001
* P T=0.024
* P T=0.004
* P J=0.002
P JxY=0.081
* P TxJxY=0.003
* P J<0.001
* P Y<0.001
* P J=0.027
* P Y<0.001
* P TxJ=0.008
Journals publishing tax and non-tax
n citations received per publication
All
Mosses
Orchids
Ciliates
Ants
Snakes
Taxa



a)
All organisms, WoS
R² lin=0.93 < R² exp=0.98
n publications
b)
Plants, WoS
Microorganisms, WoS
Animals, WoS
Animals, Zootaxa excluded, WoS
R² lin=0.87 < R² exp=0.93
R² lin=0.95 < R² exp=0.98
R² lin=0.91 < R² exp=0.96
n publications
c)
Animals, ZR
Animals, Zootaxa excluded, ZR
R² lin=0.91 < R² exp=0.96
n publications
d)
All organisms, WoS
Plants, WoS
Microorganisms, WoS
Animals, WoS
Publications as portion of all biological publications in WoS, %
Relative years (1992=1)