Scientometrics (2015) 103:333–336
DOI 10.1007/s11192-015-1534-5

Academia's never-ending selection for productivity

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Received: 12 January 2015 / Published online: 15 February 2015

Over the last decade, a debate has been emerging on "Academia's obsession with quantity" (Lawrence 2007; Fischer et al. 2012a) and the subsequent Impact Factor Race, an unhealthy game played by scientists (Cherubini 2008; Brischoux and Cook 2009). Despite being widely despised by the scientific community (but see Loyola et al. 2012), the "publish or perish" dogma and the use of productivity indices (e.g., journal's impact factor, number of published articles) to assess a researcher's output seem to hold on, as suggested by the relatively frequent publications on this subject (e.g., Lawrence 2007; McDade et al. 2011; Fischer et al. 2012a; Kaushal and Jeschke 2014; Jacobs 2014 see also Carpenter et al. 2014).

Yet, actual quantification of the effects of this deviance on the politics of scientific research remains complicated. For instance, this obsession with quantity is expected to produce tougher competition for positions in an already uncertain job market (Sanchis-Gomar 2014) and, more importantly, to delay the recruitment of young scientists leading therefore to some extent of precarity. Because of this tougher competition, young PhDs may have to accumulate precarious research positions prior to recruitment at a stable research and/or teaching position. However, quantifying these phenomena and trends over time is challenging. Indeed, researchers' recruitment in specific disciplines depends on the needs of a research institution (e.g., a university) that may dramatically vary through time, thereby precluding robust assessment of time series of the academic profiles of recruits.

As an attempt to quantify the evolution of the academic profiles of young researchers hired over time, we took advantage of the highly repeatable recruitment process used by the French CNRS ("National Centre for Scientific Research", the largest governmental research organization in France and the largest fundamental science agency in Europe). Indeed, each year and for each of the 41 research disciplines ("sections"), the CNRS recruits several young researchers through a similar competitive exam. For instance, each

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year the CNRS opens a specific number of positions dedicated specifically to young evolutionary biologists (section 29, CNRS). This scheme offers a rare, if not unique, opportunity to examine the evolution of the academic profiles of young researchers hired by this research institution over time.

We thus surveyed the academic profiles of evolutionary biologists (to limit variations between disciplines) recruited as "junior researchers" (to limit variations linked to age) at the French CNRS between 2005 and 2013 (to limit variations linked to long-term changes in scientific culture, e.g., Nabout et al. 2015). For each of the 56 researcher recruited over this decade, we collected through the "ISI web of knowledge" database several metrics of scientific productivity such as the career duration before hiring (time elapsed between publication of the first paper and recruitment), the number of published articles before

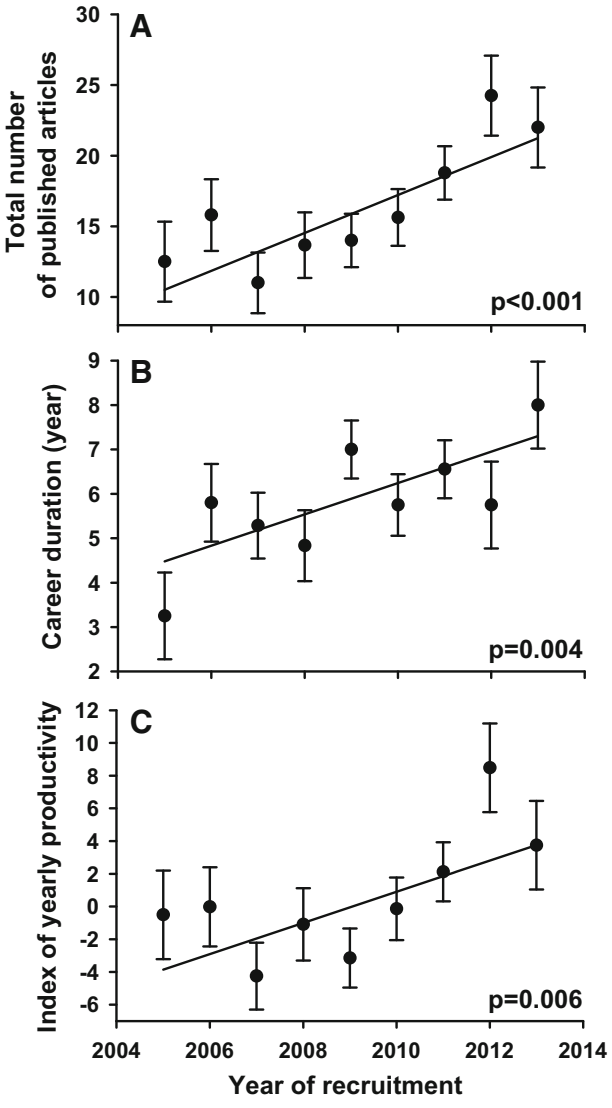

Fig. 1 Relationships between the year of recruitment and **a** the number of published article before recruitment ($F_{1,54} = 15.72$, $r = 0.47$), **b** the career duration before recruitment (time elapsed between publication of the first paper and recruitment, $F_{1,54} = 8.99$, $r = 0.38$), and **c** the mean number of article published per year before recruitment (residuals from the linear regression between the number of article and the career duration before recruitment, $F_{1,54} = 8.14$, $r = 0.36$)

hiring (international peer-reviewed journals referenced in ISI web of knowledge), and the impact factor of the journals in which these articles were published. We selected these few relevant metrics since they are classically used to rank scientific productivity (Carpenter et al. 2014).

Although the number of young evolutionary biologists recruited has remained stable between 2005 and 2013 ($F_{1,7} = 0.03$, $p = 0.87$, 6.22 ± 0.70 young evolutionary biologists recruited per year), their academic profiles have significantly changed. To get hired, young biologists now need to have published twice as many articles (Fig. 1a, 12.5 ± 2.4 papers in 2005 vs. 22.0 ± 3.4 in 2013) and to have had a much longer previous research career than those hired in 2005 (Fig. 1b, 3.25 ± 0.6 years in 2005 vs. 8.0 ± 1.7 in 2013). Furthermore the number of papers published each year before recruitment has significantly increased independently of the career duration (Fig. 1c). However, the mean Impact Factor of the journals in which they publish has remained steady ($F_{1,54} = 1.12$, $p = 0.29$, 5.8 ± 0.3).

Our analysis shows that to keep the hope of getting a research position (not so) young scientists need not only to have more research experience but also to be more prolific. This example demonstrates that the "publish or perish" dogma has accelerated by an unprecedented extent in the past few years. We acknowledge that our quantification deals with French scientists only, but we do not see any specific reasons why there would be a "French paradox" in this respect. However, we believe our analysis should usefully be repeated in other countries, as well as in other disciplines. Indeed, we do not know the solution, but we believe it is important to document, in a quantitative way, the problem.

Surprisingly, we did not report any increase in the mean impact factor of the journals in which young biologists publish. This may reveal that selection is made on productivity and quantity rather than creativity, thinking and risk-taking (Lawrence 2007; Brischoux and Cook 2009; Fischer et al. 2012a). In addition, these data further support the already well-known trend towards "salami slicing" of scientific results in order to artificially inflate one's number of publications (Jackson et al. 2013). Such toughening of the research job market may discourage young and motivated biologists from engaging in an academic career. More importantly, it may even thwart brilliant minds from performing perhaps less "productive", but far-reaching science. For instance, Nobel Prize Peter Higgs recently stated that he "wouldn't be productive enough for today's academic system" (Aitkenhead 2013). Recently, the San Francisco Declaration on Research Assessment (DORA 2013) militated for an evaluation of academic profiles of individuals or institutions based on the actual research content rather than through metrics (but see Carpenter et al. 2014). It remains to be implemented in the day to day practices of scientists (individual-mediated changes, Fischer et al. 2012b) and scientific institutions (structural adjustments, Fischer et al. 2012b) in order to promote sustainable policies of the assessment of scientific research (Jacobs 2013).

Acknowledgments We thank the CNRS and Morgan Reynaud for providing the list of young recruits, and Lucy Runacre for improving the English.

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