

Academia's obsession with quantity

Joern Fischer¹, Euan G. Ritchie² and Jan Hanspach¹

¹ Faculty of Sustainability, Leuphana University Lueneburg, Scharnhorststrasse 1, 21335 Lueneburg, Germany

² Deakin University, School of Life and Environmental Sciences, 221 Burwood Hwy, Burwood, VIC 3125, Australia

We live in the era of rankings. Universities are being ranked, journals are being ranked, and researchers are being ranked. In this era of rankings, the value of researchers is measured in the number of their papers published, the citations they received, and the volume of grant income earned. Academia today is governed by one simple rule: more is better.

The idea to reward those who are productive seems fine at face value, but that idea has become ideology. Metrics of quantity once were the means to assess the performance of researchers, but now they have become an end in their own right. Ironically, once individuals actively pursue certain indicators of performance, those indicators are no longer useful as independent yardsticks of what they were once meant to measure [1,2].

Only a few years ago, a researcher publishing ten papers a year was considered highly productive. Now, leading researchers in ecology and evolution publish 20, 30, or, in some cases, over 40 papers a year, with a tendency for further increases. This volume of papers is attained via large laboratory groups and research consortia, which in turn require massive amounts of funding. Given that successful fundraising is a trusted performance indicator in its own right, funding keeps going to some of the biggest groups, keeping them big or growing them even further. However, a bigger group of researchers does not necessarily produce better science, just more of it [3]. Thus, some research themes of solid (but not necessarily exceptional) quality can dominate the literature, just because they produce many papers. The type of work that ecologists produce is also different compared with just a decade or two ago: papers are shorter; reviews are increasingly quantitative not qualitative; the scope of papers has shifted from local to global [4]; modeling papers are replacing field-based papers [5]; and more papers focus on black-versus-white analyses because there is no journal (or mental) space for nuanced discussions. A recent high-profile example is the polarized debate on whether policy should encourage land sparing or land sharing [6,7].

The picture we paint is, of course, stylized. We acknowledge that there are exceptions among the most productive academics, the largest research groups, and the highest impact journals. However, despite exceptions, the overall trend is deeply concerning. Academics are increasingly busy with more papers, more grants, and more emails to keep the machinery going. The modern mantra of quantity is taking a heavy toll on two prerequisites for generating wisdom: creativity and reflection.

Creativity greatly benefits from an environment that is supportive, collaborative, and facilitates trialing new approaches, but suffers from working under excessive pressure [8]. Similarly, reflection is vital for questioning assumptions and learning from experience [9]. The gradual loss of creativity and reflection necessarily will affect our science. Many past landmark papers were full of good ideas, but were speculative and discursive [10,11]. Would such papers be published today and, if they were, who would read them in depth? Is it possible to obtain and communicate deep insights via 'twitteresque' research sound bites?

Beyond the science itself, the quantity mantra is taking a toll on the quality of human interactions and relationships. Supervisors are increasingly too busy to discuss ideas at length with their research students. Academics work long hours, a supposed requirement for success [12], as if insight, motivation, and wisdom could not also arise from more balanced and family-friendly lives. The stressful environment of academia leads to many talented young people opting out of academia, and can lead to burnout in those who stay.

Along with political and spiritual leaders, academic leaders have a responsibility to help society move towards a better future, where we understand the world better, and use that understanding to live a 'good life'. However, how can we do this if our professional rat race just mirrors the ills of society at large? Starting with our own university departments (but not stopping there), it is time to take stock of what we are doing. We must recreate spaces for reflection, personal relationships, and depth. More does not equal better.

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Corresponding author: Fischer, J. (joern.fischer@uni.leuphana.de).

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The mean strikes back: mean–variance relationships and heteroscedasticity

Shinichi Nakagawa¹ and Holger Schielzeth²

¹National Centre for Growth and Development, Department of Zoology, University of Otago, PO Box 56, Dunedin New Zealand

²Department of Evolutionary Biology, University of Bielefeld, Morgenbreede 45, 33615 Bielefeld, Germany

In a recent *TREE* review entitled ‘The return of the variance’ [1], Violle *et al.* highlighted the importance of considering intraspecific as well as interspecific variation in community ecology. The authors rightly point out that the focus on the mean has dominated this field and that it is high time to draw attention back to the variance. To aid such a shift, they proposed a set of indexes named T-statistics (T for trait), which are the ratios between variance components of functionally important traits across different levels of ecological hierarchies (i.e. individuals, species, populations and communities). As Violle *et al.* show, T-statistics, inspired by Wright’s *F*-statistic, can be easily incorporated into theoretical models of community ecology and can be used to test theoretical predictions.

We welcome the contribution of Violle *et al.* and add that the variance has already returned to another branch of ecology, namely behavioral ecology, via the study of animal personality (also known as behavioral syndromes) where between- as well as within-individual variation in behavioral traits are of great importance. *TREE* has published at least seven articles featuring animal personality in recent years, which demonstrates the revolutionary nature of this return [2–8].

To our surprise, Violle *et al.* do not discuss two issues, which we consider to be essential when studying variance: (i) mean–variance relationships; and (ii) heteroscedasticity. We believe that neglecting these statistical phenomena hampers a smooth transition from the mean to the variance. Here, our main aim is not to criticize Violle *et al.* but to extend the usefulness of their significant contribution.

As its name suggests, a mean–variance relationship implies a situation in which the mean and variance are not independent of each other. The exact relationships for the mean and the variance are well established for traits that follow Poisson process (e.g. the number of seeds or breeding events) and binomial process (e.g. presence–absence of flowers or proportion of seeds that germinate). For example, in a Poisson-distributed trait, the mean equals the variance so that examining its variance is just

as good as examining its mean. Thus, the claim that the T-statistics can be applied to ‘any trait’ is misleading, at least without further clarification (see Box 2 in [1]). Generalized linear mixed models (GLMMs) decouple (or at least weaken) the mean–variance relationship via the link functions [9], and this framework can be used for extracting variance components on latent scales [10], which can be utilized for calculating T-statistics.

Violle *et al.* mention that intraspecific variation arises from different sex and age classes; however, species might also differ in the amount of intraspecific variation that they exhibit. Heteroscedasticity occurs when subgroups in a population or populations in a community have different variability and such patterns are probably the norm rather than the exception [11]. When one is interested in the variance of traits, one needs methods that model heterogeneity of the variance in different classes appropriately [11]. Again, the framework of GLMMs [9] can be utilized to model and partition variance accordingly; we refer readers to the quantitative genetic literature where many methods for modeling heterogeneity are already available [11]. Consequently, one should be aware that one type of T-statistics (e.g. $T_{IP/C}$) could be calculated for different classes (e.g. $T_{IP/C}$ for species A, $T_{IP/C}$ for species B, and so on).

We also point out that T-statistics, as presented by Violle *et al.*, are related to a more widely used statistic called the intraclass correlation coefficient (ICC; also known as repeatability in behavioral ecology [10]). T-statistics and ICC are very similar in the way that both are ratios between variance components and both have the total variance in the denominator. Whereas ICC holds the between-class variance in the numerator, the proposed T-statistic puts the within-class variance there. T-statistics are also related to another less known statistic, the variance partition coefficient (VPC) [12]. VPC is a type of ICC conditional on a specific value of a continuous variable [12] and so accommodates heteroscedasticity across ecological gradients. To deal with this type of heteroscedasticity, T-statistics should be extended by incorporating this important aspect of VPC.

We finish by noting that when one works with the variance, care should be taken to inspect the mean–

Corresponding author: Nakagawa, S. (shinichi.nakagawa@otago.ac.nz).