Why impact factors don't work for taxonomy

Its long-term relevance, few specialists and lack of core journals put it outside ISI criteria.

Sir — In an earlier Correspondence[1], I explained why impact factors are irrelevant for judging the quality of taxonomy. E. Garfield[2] requested quantitative arguments to support my hypothesis that taxonomy follows different "regularities" from most sciences, making the impact factors as calculated by the ISI (formerly the Institute of Scientific Information) inapplicable.

If ISI impact factors are to judge research meaningfully, as discussed in a recent News Feature[3], they have to be a roughly accurate estimate of the real impact of publications. This requires that: (1) the impact of a paper is expressed by citations and the citation impact is positively correlated with the quality and/or relevance of the paper; (2) most cited and citing journals are considered (easily possible if Bradford's law of scattering applies to a field, as most cited papers are published in a few core journals); and (3) a paper gets most of its citations in the first few years after publication. These requirements are not met by taxonomy, for the following reasons.

First, the number of taxonomists is declining. Consequently, taxonomy does not follow the 'exponential curve' of most sciences. The old literature is not overwhelmed by an avalanche of new papers. The peak of species descriptions (a rough surrogate for relevant publications) was before 1900 for most groups, so the average age of references in taxonomic publications is much greater than those in other scientific disciplines.

I have analysed 2,091 references from seven randomly chosen, comprehensive taxonomic papers. The mean age of the references is 61 years, the median 36 years (details available direct from F.-T. K.), with 98.5% of cited papers being more than two years old. In shorter taxonomic journal papers, F. Köhler[4] found the average age of citations to be 46.7 years (s.d. 30.5 yr) and 41.8 years (s.d. 22.7 yr). It is therefore pointless to judge taxonomists according to the ISI method of analysing citations over the preceding two years.

Second, the relevance of descriptive publications in this field remains the same over time; original descriptions have to be referred to for ever, independent of the paper's quality. Outside taxonomy, referring to original descriptions becomes superfluous with time and/or revisions. Einstein's papers are not always cited for his theory, unlike the original descriptions of, say, *Escherichia coli* or *Drosophila melanogaster*. This obsolescence underestimates impact only for authors of well-studied species[5]. However, in taxonomy this obsolescence effect is negligible.

Third, for any group of organisms there are at best a handful of (or frequently no) extant specialists. Therefore the chance to become cited by colleagues is relatively rare compared with other fields. The number of taxonomists and consequently the number of publications is this low for one reason, which has nothing to do with need or quality: decision-makers are generally more enthusiastic about other fields. For these reasons, taxonomic papers have a long-term impact. Sometimes taxonomists have to wait a generation to be heavily cited. The number of citations of their empirical taxonomic publications depends on the number of taxonomists working on the same field and whether these colleagues publish in the few taxonomic journals covered by the *Science Citation Index* (*SCI*). These things are a matter of luck.

Fourth, there are no core journals for general taxonomy. These exist for cladistics, biogeography, chemical systematics, and so on, but not for species descriptions, revisions of genera, identification keys or inventories. Where to publish depends on which museum the material is in; which institute or learned society the taxonomist is affiliated to; or which serial has the funding to accept long monographs. Only 27 (42%) of the 64 entomological journals covered by the *SCI Expanded* publish taxonomic papers, whereas 898 (82%) of the 1,100 serials held by the entomology library of the Natural History Museum in London probably contain taxonomic information. Because of the less-developed relevance hierarchy of taxonomic journals, the low proportion covered by the ISI puts taxonomy at a disadvantage.

Finally, the most important impact of taxonomy is the usage of identification keys which enable non-taxonomists to identify and work with a group of organisms. The use of such keys is generally not documented in reference lists, hence a crucial impact of taxonomy is missed by citation analysis.

Consequently, taxonomy has no citation classics which the ISI would uncover. E. O. Wilson's citation classics aren't his taxonomic works, and R. Sokal's treatises on biometry and on the method of numerical taxonomy (not an empirical taxonomic work, but a methodological textbook on classification) have far more citations than his taxonomic work. The *SCI* is not an appropriate means to judge taxonomy because taxonomy does not meet its requirements for a meaningful judgement.

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1. Krell, F.-T. *Nature* **405,** 507–508 (2000).
2. Garfield, E. *Nature* **413,** 107 (2001).
3. Adam, D. *Nature* **415,** 726–729 (2002).
4. Köhler, F. *Amateurwissenschaft: Entwicklung, Beschreibung und wissenschaftssoziologische Analyse am Beispiel der Koleopterologie* p. 195 (Diploma thesis: Sociology, Univ. Köln, 1988).
5. van der Velde, G. *Nature* **414,** 148 (2001).

Physics gets physical

Sir — The readable and entertaining Words article "Coming to Terms" by J. L. Heilbron (*Nature* **415,** 585; 2002) on scientific nomenclature is amusing, but potentially misleading as far as it concerns high-energy physics. It may be true that the first flippant names such as 'quark' and 'gluon' were bestowed by US researchers, but they have monopolized neither the discoveries nor the follies.

The inspirationally named gluon — the elementary particle carrying the force that 'glues' quarks together — was discovered at Germany's high-energy accelerator centre, DESY, in Hamburg in 1979, and the more prosaically named 'intermediate boson' was discovered at CERN, the European laboratory for particle physics, in Geneva in 1983.

Less seriously, I plead guilty to coining TOE as a non-anatomical acronym for Theory of Everything in an article that appeared in *Nature* (**323,** 595–598; 1986). As for Grand Unified Theories or GUTs, the term was coined by my CERN collaborators Andrzej Buras (Polish/German), Mary K. Gaillard (American/French), Dimitri Nanopoulos (Greek) and myself (British). But we did not have the 'guts' to put the acronym in our paper on this subject (*Nucl. Phys. B* **135,** 66; 1978) — instead, we weaselled out and used the equally non-anatomical GUM for Grand Unification Mass. To the best of my knowledge, GUTs were first spilled, metaphorically, by Dimitri Nanopoulos in a paper (*Harvard Preprint HUTP-78/A062*) published later in 1978.

As well as making discoveries, we Europeans can be just as facetious, jocular and capricious as our US friends.

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