Peer review and science

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If you are in or interested in scientific research, it is likely that peer review and peer reviewed journals are important for you.

My first article that appeared in a scientific journal was in the area of 'phyto remediation' and in fact this term was not in existence those days. I joined Zawar mines, Hindustan Zinc Ltd (HZL) as an Ore Dressing Engineer in 1979, in the mill department. At that point of time, the land where the waste [tailings] was being disposed off since about 50 years, contained high levels of Pb, Zn and Fe all in their sulphide forms. We eventually developed vegetation on that toxic land by ameliorating the soil with farm yard manure and transplanting hard weeds that generally grow in any inhospitable environment. I posted my article on these studies to a journal in UK. The editor replied saying that his journal publishes pollution related articles in the area of chemical pollution and that he had forwarded (instead of returning) the article to C. G. Down who was the editor of *Minerals and Environment*, also from UK. Within a few days, Down informed me that he found the article suitable for publication if mandatory editorial corrections are allowed. That was my first science article, that too in a subject which I never studied in my regular courses. It was published[1]. Decades later, I found lush green forest like vegetation on that abandoned tailings site instead of the sparse trial vegetation which we started. My initiating effort was voluntary and was neither a part of my official duty nor was it funded by HZL. Pollution control laws in India were not as stringent those days.

Sphalerite activation by heavy metal ions is a darling subject to many scientists working in the area of surface chemistry applied to flotation process. The activation by Tl and Sn ions is described as anomalous as they do not obey the idea that the sulphide form of the activator ion must be more insoluble than zinc sulphide. We proposed a theory to overcome this anomalous observation, proposing that a metal ion's ability to activate sphalerite is directly proportional to the insolubility of the sulphide of the activator ion and the size of the ion, and inversely proportional to the electric charge of the ion. Further, we suggested that activation causes breaking of the structure of liquid water near the site of adsorption of the activator ion. The paper[2] was published. And then to my horror, I noted that hydrophobicity should cause enhancement (structure making) of water structure and not structure breaking! A great misunderstanding! I ran to my guide Rama Shankar and he agreed that there is a problem. We started reading published work on the effect of non-polar solutes on the structure of liquid water at ordinary temperatures, which itself is a controversial area. After carefully going through some articles published in the area of the structure of liquid water, we found[3] that the two-state model of E. Grunwald may be used in our context but with a minor adjustment of the model. I wrote a letter, a hand written one, to Grunwald. He replied in four lines which read, 'I greatly enjoyed your thoughtful letter. You may well be right'. With this development, we offered an explanation in the form of a follow-up article to the transactions of the Indian Institute of Metals. The paper was promptly rejected by the peer reviewer. I pleaded with the Editor, K. A. Natarajan to allow me to discuss with the reviewer. The paper was sent to another reviewer who not only rejected the paper but also chided me alleging that: (i) I might be copying material from Siva Reddy and Konda Reddy from their paper published in *Mineral Processing and Extractive Metallurgy Review* which I cited and that[2] he had never heard about a journal '*Mineral Processing and Extractive Metallurgy Reviews*' (*MPEMR*). I dared to send the follow-up article to K. N. Han who was the then editor of MPEMR, with a request for a specific comment on the crux of the paper. 'It is suggested that the activator ions polarize at the sphalerite surface such that there is a drift of charge towards sphalerite leaving the other part of the ion facing the aqueous phase non polar.' The reviewer said that the idea is valid and the same can be explained in 8 pages instead of 15 pages and also suggested how to re-size the article. The paper[3] was published as a short note in MPEMR! It is worth mentioning here that it is the experimental research work of J. M. Pratt of South Africa that prompted us to take up this theoretical work.

One of the requirements for ISO certification is analysing the data of the process and operations using statistical process control techniques. It is expected that the data on a parameter (a variable) follows the normal distribution. We noted that the concentrate grades of samples taken shift-wise were not obeying the normal distribution. The consultant, a mechanical engineer, insisted that the data should follow the normal distribution or otherwise it may be understood that the data is manipulated or tampered with. I requested the consultant to check with an expert from the Indian Statistical Institute, Calcutta to find out if there can be exceptions. The expert apparently said that there cannot be exceptions. I went to Zawar mines, from where I started my career to see if the grade of the zinc concentrate follows the normal distribution. We noted that the data on the lead-zinc concentrator was also not obeying the normal distribution. I made a technical note and gave it to our consultant to show it to the expert. The expert rejected the contents of the technical note and also refrained from confirming his rejection in writing. I sent that note to the editor of the *Indian Chemical Engineer* for favour of publication. For almost two years, there was no response despite my repeated requests for confirmation if the note was rejected. Then one day, I received a letter from R. K. Saha who had just taken over as editor of the *Indian Chemical Engineer*. He informed me that his predecessor had got the note reviewed twice and both the times the note was found unsuitable for publication by the peers. He suggested that I should resubmit the note. That note was published[4] after resubmission.

While testing rock phosphate concentrate of Jhamarkotra for direct application as P fertilizer, we noted that the rock with farm yard manure works as efficiently as di-ammonium phosphate. This questions the well established, 160-yearold chemical phosphatic fertilizer technology. We sent the results for favour of publication to *Current Science*. Initially, we were asked to name some experts in the area. We did propose a few names. Then we got a reply that the subject was highly specialized and hence cannot be published in *Current Science*. I wrote a letter to *Current Science*, drawing the attention of the editor, explaining the importance of the work. That paper eventually appeared[5] in *Current Science* as Scientific Correspondence. Today we have a PROM (phosphate rich organic manure) Society that is working for large scale implementation of this technique.

The majority of flotation researchers believe that flotation is a first order rate process, which is not true! My correspondence in minerals engineering with G. E. Agar, to resolve the dispute, is now history.

In my opinion, peer review is an unavoidable and painful process for young scientists till they publish ten articles in peer reviewed journals. After that, one will find that peers may be as ignorant.

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How much should a nation spend on academic research?

Gangan Prathap

How is India performing on the world stage in academic research? To put this in proper perspective, one needs an indicator that provides a rational estimate for R&D activity, and then normalize this for size. Recent studies[1–3] show that a single indicator with energy-like properties can effectively combine size and quality of scientific output. The proxy for the exergy (a more accurate thermodynamic definition of the energy-like term expressed by the formula that follows) of ideas turns out to be $E = iC = i^2P$, where P is measured in the unit in which ideas are conveyed (here, the number of papers) and i is a measure of the rate at which ideas are transmitted as citations C (here, $i = C/P$ is a proxy for quality, while C itself is a proxy for size or quantity of output). When this exergy audit is applied to the data on leading countries in research in all fields published by Essential Science Indicators of Thomson-Reuters for 1998–2008, Table 1 emerges. On a per capita basis, Switzerland produces 1108 times the academic research activity that India does. The average for the 28 countries listed in Table 1 is 82 times what India does. The exergy performance can also be displayed on a two-dimensional contour map as shown in Figure 1. The 'BRIC' countries cluster right at the bottom of the hill.

To understand Table 1 and Figure 1, one must go into the economics of R&D activity. Marburger III[4] asked, among other questions pertinent to the emerging discipline called 'science of science policy': 'How much should a nation spend on science?'. An attempt to answer some of these questions was made recently by Leydesdorff and Wagner[5]. The idea is to come up with relevant macro-level benchmarks which can be used to compare the efforts made by different nations in R&D. Many countries appear on the radar in Leydesdorff and Wagner[5], but not India! This article is devoted to see how India fares in the company of some of the leading players in global R&D, using the indicators and benchmarks that best serve to throw reasonable light on these activities[5].

Table 2 is a precursor to Figure 2. It computes the total R&D expenditure as a percentage of Gross Domestic Product (GDP), 2006 (selected nations)[6]. The data is sorted using the indicator (R&D Exp/GDP)/(FTER/population) as a

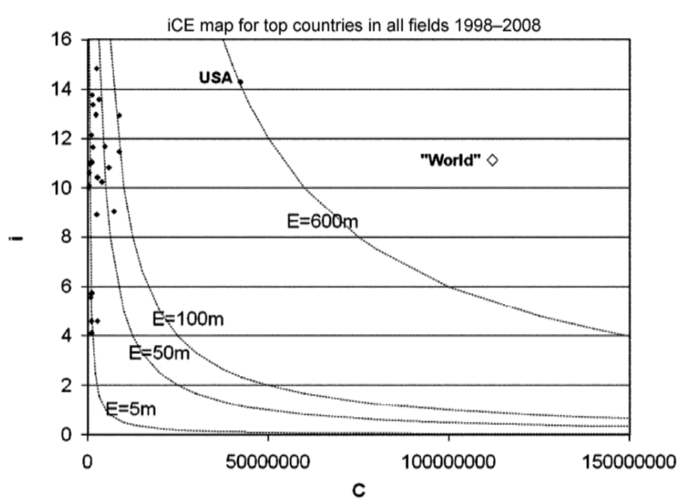

Figure 1. Exergy performance on a two-dimensional contour map.