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OPINION

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The corollary of scientific research: "Publish or be damned"

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The scientific method starts with an initial hypothesis proposed by the researcher, which takes into account his (her) own previous experience and the available information concerning the matter under study. This hypothesis must be supported or rejected through observations and/or the performance of relevant experimental work. Once the results become unequivocal, they are presented to the scientific community as specialised monographs, usually termed scientific papers. The continuous and consistent accumulation of evidence providing support for the original idea leads to the postulation of general principles or theories, although only very few theories reach the category of laws endowed with universal significance.

Hence, the publication of new scientific results and any concomitant conclusions is the epilogue of a long process devoted to obtaining, checking and analysing individual data and observations. Throughout history, outstanding scientists have reported their main contributions using a variety of procedures such as notes edited by themselves, letters to scientific societies, articles in well-established journals or even demonstrations before the members of learned academies. Since World War II, the USA has emerged as the predominant power, playing a decisive role in political and social events worldwide. This influence also extends to the field of scientific research and has caused a revolution in the way that science is conducted and communicated. Journals published in the USA where, of course, the main language of communication is English, are beginning to dominate the scientific press while those published in Europe, often long standing and of great repute, are beginning to lose their importance.

When the results of an investigation are ready to be made public, they usually adopt the form of short papers written in English following a predefined format. They are submitted to specialised journals, which accept them for publication after a careful and rigorous process of revision carried out by anonymous referees, who are specialised in the relevant field of investigation. This process is designed to ensure confidence in the true value of the contents. Such a peer-review system is generally accepted to be the best available, since it guarantees that only the contributions important for making new progress in science are presented to the scientific community. In addition, false or erroneous data as well as discussions of little interest are removed. Furthermore, the anonymous peer-review method also introduces the necessary controls to prevent any interference by interested scientists during the revision.

The quality and number of publications—at least those concerning basic research—have become the essential indicators that define scientific activity. There has been a proliferation of new journals and a significant increase in the number of articles published by each particular journal. The evolution of science has replaced the archetypal figure of the solitary genius by the research group. This group is usually organised as a hierarchical pyramid, headed by the group leader, followed by a staff of several postdoctoral researchers, each with ample experience, and finally predoctoral students, who are charged with the bulk of the experimental work.

Apart from contributing to the advancement of knowledge, publications provide a highly valuable record of work, or "curriculum", both for individual scientists looking to their future careers and for the research group itself. The viability of a research group largely depends on the funding it can obtain from research projects, grants, fellowships, donations etc. The decision whether or not to fund a research group is usually based on its scientific trajectory. For this reason, large interdisciplinary research teams, which are able to produce many papers, possess an initial advantage when it comes to competing for ever scarcer financial backing.

Recent years have seen a new element introduced, which distinguishes between the number and the quality of published papers. Now it is not so important how much a particular group or individual publishes, but where it appears. Articles accepted in a few "top" journals, which theoretically apply a policy of maximum rigour in choosing only "landmark" papers at the cutting edge of science, are the most highly appreciated. Such reputed journals are endowed with greater credibility and enjoy a greater "Impact Factor" than others. For an individual or a research group, a certain added merit is achieved when they succeed in getting an article published by one of these top journals. Nevertheless, this does not necessarily mean that the

authors are infallible or that a journal lower down in the list of merit cannot publish a scientific breakthrough. Although the peer-review evaluation is well established and well regarded, it may not necessarily be the best. However, given the present-day organisation of scientific research, it seems very unlikely that any alternative system be proposed.

Some drawbacks in the rush for publishing are evident: the number of papers published is disproportionate with the advances actually made in science, and articles are often a mere continuation or repetition of evidence previously reported. It is very difficult for scientists to keep themselves informed about the new discoveries recorded in their own field of work, and in many cases the explosion of new titles makes this task more difficult. There is great pressure on research groups to produce new results, and research lines are frequently planned to enable publication rather than actual discovery. Among distinct groups in the same area, there is strong competition to publish first and thus gain prestige. A frequent complaint is that powerful groups "phagocyte" original ideas from other groups, complete the research, and often publish the results without citing the original report or minimizing its importance. They become the "parents of the new creature". (Let's not forget the controversy surrounding Salvador Moncada and the Nobel Prize for Physiology or Medicine in 1998, presented for essential studies into the physiological role of nitric oxide.) Moreover, the peer review of a paper is not a totally anonymous process. The reviewer will know the authors' names and might somehow be swayed towards acceptance because of this.

If we assume that a research group may be considered to be prestigious and scientifically sound when it publishes many excellent papers, should those groups which do not publish much be done away with? Not necessarily. For instance Frederick Sanger, whose name does not customarily appear in the scientific literature, has been awarded twice the Nobel Prize (Chemistry, 1958 and 1980) for his novel methods for proteins and nucleic acids sequencing.

The current trend in publication provides few opportunities to those visionary researchers who propose audacious or apparently crazy hypotheses, condemned to failure or not, simply because they do not produce short-term publishable results. However, history abounds with these kinds of outstanding scientist, whose views were frequently underestimated and mocked by official science. Their theories and revolutionary discoveries, rejected at the time, constitute the fertile substrate of our present day knowledge.

So, after carefully reading the above reflections, perhaps a better title for this modest opinion would be "How can you become a good scientist if you publish little or nothing?"