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EDITORIAL

The loneliness of the scientific discoverer

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There is a story about a biology class in school when the teacher asks the students to look into the microscope and observe some microbes. So, the students one by one look into the eyepiece, record their observations in their diaries, and yield to the next student. Then, one of the students, the ninth in the row, tells the teacher that he sees only darkness. The teacher is first annoyed, but finds that he had forgotten to remove the cap over the objective lens. It took some courage from the ninth student to differ from the preceding eight. I wonder if I would have had the courage to do so. The story came from a regimented European school rather than from a liberally minded American one.

The scientist who makes a truly seminal discovery often must break with generally accepted previous notions. This may happen to earthshaking discoveries as well as to lesser achievements. When Jacobus Henricus van 't Hoff and Joseph Achille Le Bel came out with the suggestion of the tetrahedral bond configuration of the carbon atom in 1873–1874, it was met not only with disbelief, but also with ridicule. A famous organic chemist [1] of the time accused them of invoking "fanciful nonsense" and using "supernatural explanations" when their knowledge failed them. Today, it seems hard to believe, but then, to many chemists it was utterly alien to extend structural considerations into the third dimension.

Max Planck himself found it difficult to accept his own discovery, when he came to the conclusion of the quantum. However, he had the strength to overcome his own reservations and the courage to come out with his shattering new theory. Perhaps, judging by his reaction to his own discovery, Planck was not very optimistic with respect to others accepting his theory. He noted: "An important scientific innovation rarely makes its way by gradually winning over and converting its opponents. . . . What does happen is that its opponents gradually die out, and that the growing generation is familiarized with the ideas from the beginning" [2].

When Oswald Avery and his two young coworkers reported that, as they called it, the "transforming principle" is DNA [3], very few scientists took notice. There were others, rather vocal ones, who managed to plant the seeds of doubt in changing the generally and for long accepted notion that proteins are the substance of heredity. Avery had every confidence in the correctness of their careful experiments, but he was not prone to publicity and he believed the results should speak for themselves. They did—eventually.

If one looks at the numbers in Erwin Chargaff's chromatographic analyses of DNA from different organisms, and sees the scatter of measurements, the notion is that he needed determination and self-confidence to pronounce the observation about the ratio of 1:1 of purine and pyrimidine bases. The scatter was around 10%, and it took Chargaff some foresight to see the pattern beyond those numbers [4].

When F. Sherwood Rowland and his postdoctoral associate, Mario Molina first determined and communicated that chlorofluorocarbons may be responsible for the depletion of the ozone layer, they were met with more than ridicule. There were accusations by the industries involved in the production

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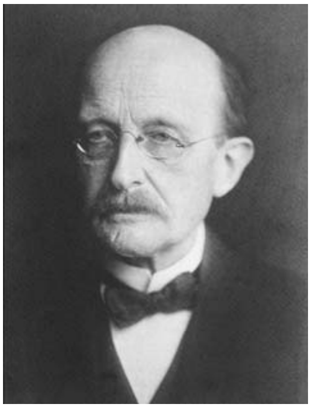
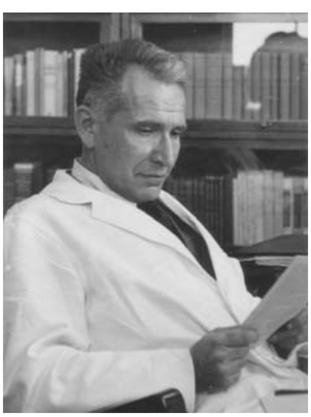


Max Planck (courtesy of the Oesper Collection and William Jensen, University of Cincinnati).

Oswald Avery (courtesy of the late Maclyn McCarty, New York City).



Erwin Chargaff (courtesy of Tom Chargaff, Surry, Maine).

F. Sherwood Rowland (photo by the author).

Dan Shechtman (photo by the author).

Alan G. MacDiarmid (photo by the author).

and application of chlorofluorocarbons, and there was virtual boycott by some of Rowland's colleagues finding expression in noninvitations for giving seminars and not sending him graduate students [5].

Being a student of the solid-state, Dan Shechtman had to prove in one of his exams that fivefold symmetry is forbidden in crystallography. It was an irony of fate then that he was the first who observed and reported extended regular structures with fivefold symmetry and no periodicity. Thus, he became the discoverer of the so-called quasicrystals. People warned him that if he insisted on his claims, he would risk his scientific reputation, and Linus Pauling remained their vocal opponent to the end of his life. Shechtman remained alone with his discovery for two painful years [6].

A physicist colleague of Alan McDiarmid also warned him not to risk his scientific reputation when McDiarmid suggested cooperation in understanding the electronic structure of conducting polymers. To the luck of McDiarmid and a whole new future industry, he succeeded in finding another physicist to help him [7]. But the road was bumpy because the idea of such substances was entirely new.

Today, research is often carried out in large groups and sometimes a dozen or more and in certain areas even hundreds of coauthors share the glory and the responsibility represented by research reports. Seminal ideas and observations, however, still belong to individuals. They, more often than not, have to bear the weight of bringing down dogmas or opening entirely new vistas in science. At some point, they must be feeling very lonely out there.

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