

## Science's Ruthless but Correct Power to Judge

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In 1956, I traveled as a budding scientist from Prosser, Washington to Cincinnati, where I was to attend my second annual meeting of the American Phytopathological Society, the first, in which I was to present a short talk. In the meeting's brochure I had found a list of hotels and, had unthinkingly reserved a room in the cheapest hotel listed, despite its greater distance from the meeting's venue than all others. I had second thoughts, however, when I found the hotel to be located in a rather dilapidated neighborhood and, when I was received with utter consternation, my concern deepened. Only hesitatingly was I shown a room—accessible only after climbing long stairs and passing by a corridor with piles of clothing and bed linens that even by my modest standards were shockingly unacceptable. Suddenly, it dawned on me that this was, during the still reigning era of Jim Crow, a hotel frequented only by African-Americans, who still were not accepted in "white" hotels. I beat a retreat as diplomatically as possible, grabbed my bag, and walked back to the headquarter hotel, where I met Earl Blodgett, my Prosser boss. After learning of my problem, he graciously offered to have me stay in his sofa-bed equipped room. Thus, once again, I was sharing a room with Earl but, thankfully, not the same bed this time!

My short talk was well received; it even triggered an animated discussion, primarily with members of Dr. Samuel G. Wildman's then renowned UC Los Angeles research team (some of whom I had met earlier during a visit to their lab). I felt much honored when Dr. Wildman himself expressed interest in my results,

pronounced my artificial production of disease symptoms a significant achievement, and encouraged me to further pursue what he called my imaginative research.

I greatly enjoyed visiting with scientists I already knew and meeting new ones. Most memorable was a plenary session dedicated mostly to discussion of the then exciting and now classical experiments of Drs. Heinz Fraenkel-Conrat and Robley Williams [1] who had succeeded in disaggregating tobacco mosaic virus particles into biologically inactive protein and RNA of very low infectivity and, under narrowly specified conditions, to reassemble these mixtures into fully infectious virus particles.

To everybody's surprise, Fraenkel-Conrat's exciting lecture was followed by one presented by George W. Cochran, a Utah biochemist, whom I had met at a previous meeting, and whose seemingly revolutionary results had become a matter of intense controversy. Cochran claimed to have not only confirmed Fraenkel-Conrat's results, that is, the *in vitro* reconstitution of biologically active virus in a mixture of TMV protein and almost inactive RNA, but also to have achieved the *in vitro* synthesis of active TMV rods in a cell-free system containing, aside from TMV RNA, only a mixture of amino acids, but no TMV protein -- with the RNA presumably serving as template ensuring the correct alignment of amino acids to produce the sequence of TMV protein. Because these spectacular results, if correct, would have advanced knowledge far beyond what was known at the time, Cochran's claims were subjected to intense scrutiny during the following discussion, particularly,

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of course, by Fraenkel-Conrat, whose results seemingly had been eclipsed by Cochran's results.

To those of us familiar with the methodologies involved, it became rapidly evident that Cochran was unable to provide convincing evidence to buttress his revolutionary claims. Cochran's futile attempts to answer his critics' probing questions soon reduced him to a pitiful figure. Fraenkel-Conrat himself provided the coup de grace by proclaiming that "Dr. Cochran not only doesn't know how to reconstitute TMV, he doesn't even want to learn."

During the following break, I fetched a cup of coffee and, to soak up some of the brilliant winter sunshine, lowered myself into a comfortable deck chair beside the hotel's outdoor swimming pool. I was still trying to sort out my reaction to what I had just experienced — the brutal, irretrievable, yet fully justified, utter destruction of what had appeared to be a promising scientific career — when I saw George Cochran himself approaching me and sit down beside me. For once I was bereft of words---but didn't need to talk. In a defiant tone, Cochran immediately began: "You know, Ted, they may attack me now as much as they wish but, eventually, they will have to get over their envies and petty jealousies and accept my work!" With that, he stood up and, without giving me as much as another glance, disappeared in the crowd by the swimming pool -- leaving me completely bewildered. How, I asked myself, after having been fatally humiliated in front of a large audience of fellow scientists, could he maintain his composure and continue to assume the self-image of the proverbial unrecognized genius, victimized by lesser lights, who ganged up on him? In his position I surely would have drowned myself in the swimming pool!

This, then, I learned, is how science takes care of its pretenders and charlatans: by a slow, but ruthlessly effective, evidence-based, and self-correcting process -- unique to science and colloquially referred to as "the scientific method", which, for the first time in history, has resulted in the creation of a cumulative body of verified and universally accepted knowledge of nature---in stark contrast to older branches of intellectual activity, such as theology or philosophy -- which similarly endeavor to answer fundamental, existential questions,

but are founded, not on observation of nature and experimentation, but on pure thinking, with or without support derived from supernatural revelation. Neither has ever achieved bodies of universally accepted knowledge.

Thus, theology, despite efforts spanning thousands of years -- while filling libraries with its countless "learned" discourses and while resulting in numerous, mutually incompatible belief systems -- has still not been able to unequivocally prove the very existence of its study subject. Philosophy, similarly, has resulted in many schools of thought, with older ones followed by, but not displaced by, newer ones and without creating a body of generally accepted knowledge.

Few people realize that scientific knowledge differs from all other "knowledge" in three all-important, fundamental properties:

1. Once independently confirmed, scientific knowledge has universal validity; it is accepted worldwide by all thinking and unprejudiced human beings:
2. Scientific knowledge has innumerable practical consequences, which, applied by technology, have totally transformed our world, rendering our lives healthier, far longer lasting, and more comfortable.
3. Anti-science propagandists cannot deny that science "works," but illogically question whether science is "true." What could better prove science's "truth" than its innumerable beneficial applications?

What has happened to the two pseudo-scientists whom I had personally encountered? Regrettably, I don't know. I was told that both eventually lost their US Navy "gold mines." A search in PubMed for Cochran GW yields a total of 12 authored publications, starting in 1947 and ending in 1969; whereas Lindner RG authored 11 publications from 1940 to 1968. Evidently, the scientific careers of both had ended sometime late in the 1960s, but what caused their end I don't know, although I suspect that some astute scientists had finally exposed them for what they were: impostors and charlatans.

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[1] Dr. Fraenkel-Conrat arguably was the most glaringly overlooked of several other plant workers, whose discoveries, while originally identified in plants, are now known to be of basic biology-wide importance-----presumably victims of the common anthropomorphic bias among medical luminaries in charge.