Letter From the Desk of David Challinor
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Scientific fraud is really no different from any other kind of fraud, in that innocent people are often harmed or humiliated when it is exposed. Most people basically trust others, a trait which undoubtedly works to the advantage of con artists who exploit such trusting souls. Scientific fraud, however, is hard to sustain because within scientific disciplines there is normally a vigorous exchange of information and an inherent skepticism of unexpected new discoveries. This month's letter is about some current and past scientific frauds; how they were unmasked; and the possible motives the perpetrators had for initiating them.

One of the best known hoaxes was the "Piltdown Man." In 1912, on Piltdown Common near Lewes, England, what was thought to be the remains of a fossil apeman was discovered, along with the bones of Pleistocene mammals and what appeared to be bone and flint tools. For 40 years these artifacts remained controversial, but by 1954 evidence had accumulated to show that the putative fossil apeman consisted of a skillfully disguised human cranium found next to part of an orangutan jaw. The fossil mammal bones were genuine but were not from animals that lived in Britain. To this day the instigator of the fraud remains unknown. Suspects even include Arthur Conan Doyle.

Another example of fraudulent behavior, also in England, in the 1940's was the continuous reports in botanical journals of the unexpected range extension of sedges and other small plants normally growing elsewhere, to the isle of Rum off the west coast of Scotland. The reports were the work of Professor J. Heslop Harrison, a well-known botanist who specialized in the flora of Rum, a privately owned island to which he controlled access by other botanists through his close friendship with the owners. Harrison's "discoveries" of never-before-seen plant species on Rum were met by other botanists with profound skepticism. The range extension of the plants he claimed to have found on Rum helped support his theory that Rum might have been part of a refugia (area not covered by ice) during the Pleistocene glaciation. John Raven, a Cambridge classics professor and also a respected amateur botanist, did not believe Harrison's reports. After considerable planning, he surreptitiously landed on Rum to check the existence of the species that Harrison had claimed were growing there. Raven found none.

Conjecture abounds on why Harrison, a Professor and Fellow of the Royal Society, would stoop to perpetrate such fraud in his reports, claiming to find both plants and insects on Rum that he had clearly planted there himself. Evidently, he desperately wanted solid evidence to support his theory that there was an ice-free area on the land bridge that had originally connected the land masses (Hebrides and Ireland) west of Britain. Thus, these plants and insects he claimed to have found could have survived the glaciation around them (from 12,000 years ago) and have populated Rum and its adjacent

islands in the Hebrides, when the ice melted and the sea rose once again. Few others agreed with Harrison's theory and his intransigent behavior may best be explained by his overwhelming ambition to be recognized by his peers as the foremost botanist of his time. Sadly, that plague of English culture—class— probably played a role. Harrison, although he preferred to be known and addressed as Heslop Harrison (no hyphen), was a Professor at Newcastle University (one of the so-called "brick Universities") and thus not on a par with "Oxbridge." Even his Fellowship in the Royal Society was not enough to salve his ego. Interestingly Raven, after he had a virtually airtight case against Harrison, failed to follow through out of concern for the emotional damage that such publicity might have on Harrison's children. Harrison himself was not well-liked, although his children were.

A somewhat parallel incident occurred also in England shortly after the Harrison fraud. For years scientists had been searching for an example in action of Darwin's theory of evolution through natural selection. The example of the peppered moth (*Biston betularia*) seemed to fit, as this moth has two color morphs. A light pepper-colored one and a dark (melanistic) one. As the British Industrial Revolution progressed, the rapid increase in coal burning darkened the trunks of many urban trees, thereby allowing the dark form of moth cryptic protection from bird predators. It seemed that the dark morphs survived in greater numbers when coal was so freely burned than its paler peppered kin, thus becoming the dominant color form in woods of dark barked trees. Although the peppered moth example of natural selection had been discussed since the late 1800's, it was never tested until Oxford Professor E. B. Ford in 1953 engaged an amateur lepidopterist, H.D.B. Kettlewell, M.D., to run experimental tests to find out what was happening. Kettlewell was delighted with the opportunity and abandoned his medical practice. For two years he bred moths in a laboratory and released them by the thousands to monitor their survival. As he expected, the pale moths were more prone to bird predation on dark-barked trees than dark moths and vice versa in unpolluted forests. The results soon appeared in evolution textbooks as a striking example of natural selection.

Kettlewell was evidently so convinced that his efforts did indeed show what he wanted to illustrate, that he was accused by some of his peers of doing sloppy research; many scientists simply did not accept his results. He was accused of placing laboratory-raised moths on the trees he chose, often at times when wild moths would not normally have been on those tree trunks. Poor Kettlewell, a field collector who truly knew his moths, wanted to please his mentor, Ford, but the collector never felt at ease with or even socially accepted by the University academics. The relationship between Kettlewell and his mentor was complicated and apparently exacerbated by the class divisions between established Oxford academics and those on the "outside." It is hard to understand why Ford did not oversee or at least approve of Kettlewell's experimental design. In any case, poor Kettlewell was hit by a series of painful illnesses and committed suicide in 1979 by overdosing on painkillers.

The standards of research protocol followed by Kettlewell in the 1950's were very different from those of today and most would agree that Kettlewell's work was not maliciously fraudulent. Unfortunately, the creationists tried to exploit his experimental shortcomings as evidence against natural selection. However, several subsequent and more carefully controlled experiments have shown more clearly how natural selection determines changes in moth color patterns within a species. Thus natural selection's role in peppered moths' variants is much stronger today than it was in Kettlewell's time. Industrial melanism was real and natural selection is a valid explanation, despite our still not knowing the actual agent for color morph selection.

My last example, about Jan Hendrik Schön, has been much in the current news. The reaction of the scientific community to this case is generally one of sadness: why would such a brilliant young scientist—he is now 32—fabricate his research results?

Schön received his Ph.D. in physics in 1997 from the University of Konstanze (Germany). He was popular and his research on semi-conductor systems was solid, which led him to a post doctoral position at the famous Bell Labs in New Jersey. He was so productive—writing a paper every eight days in 2001—that Bell Labs offered him a permanent position. When the Max Planck Society also sought to hire him for their Institute for Solid State Research in Stuttgart, it began its customary review process on his candidacy about a year and a half ago. Just as negotiations began on his employment contract, suspicions of fraud in his research began to surface—specifically his use of identical graphs to support different experiments. Bell Labs assembled an external review and last 25 September the report of the investigating panel was released. It found a "preponderance of evidence" that Schön had faked data in 16 of 24 cases considered by the panel, which involved 25 published research papers in the most prestigious scientific journals, i.e. Nature, Science, Applied Physics Letters, etc.

Schön was fired from Bell Labs just before the findings were released, but the outcome of the incident is far from resolved. The physics community is seeking to find out what went wrong with the system that is supposed to prevent such fraud. Furthermore, what is the status now of the 100 or more scientific papers Schön published since coming to Bell Labs in 1998? Schön, meanwhile, has admitted that he made mistakes but that he "never wanted to mislead anybody or to misuse anybody's trust." Such comments do not furnish much insight into why he published fraudulent results; deleted his raw data from his computer; or why his co-authors, who should have been better informed about the experiments, never checked the veracity of the papers they were signing with him. Further, other colleagues never witnessed his extraordinary discoveries.

Scientific fraud can be fraught with danger to the public in terms of bogus cures or treatments. Unsubstantiated "new discoveries" often lead to premature use of untested medicines or procedures by sufferers seeking relief from pain. The public and

particularly the scientific community that has been harmed by such behavior can only speculate on Schön's motives. It is almost impossible to reach inside another's mind. He must have known that he could not get away with publishing fraudulent results, yet he proceeded. Was it some kind of addictive "high" that made him continue regardless of the risk to his own career and indeed to those of his co-authors? We may never know precisely, but perhaps the one encouraging aspect of this sad story is that in science certainly, and usually in other disciplines as well, fraud eventually is discovered—most often by peers trying to replicate experiments. The system is far from perfect but there are, fortunately, self-correcting mechanisms to protect research integrity. The guilty are generally caught, even though their motives may never be truly understood.

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P.S. I recommend two recent books that consider the motives for fraud, real or alleged, and from which I have drawn material for this month's letter: Sabbagh, Karl, A Rum Affair - Farrar, Staus, and Giroux, New York (2000) and Hooper, Judith, Of Moths and Men, W.W. Norton and Co., New York (2002).