Ensuring scientific integrity

SIR—Recent articles in *Nature*¹⁻⁵ have drawn attention to the problems that have been created by scientific fraud, suggesting that fraud is a disease that could even now be afflicting identifiable groups of scientists.

As with other infections, I should like to know where it originated, the causative agent and methods for its detection, treatment and prevention. Just because the cases reported in *Nature* have all been from the United States does not necessarily mean that fraud is of North American provenance — our colleagues there may simply be better at diagnosing the disease in the world's largest population of scientists. Stewart and Feder⁴ believe that the causative agent is the pressure to publish, but Braunwald⁵ feels that an underlying psychiatric problem could often be responsible.

There appears to be some disagreement on the best methods of detection, but the analysis of one case indicates that a sound knowledge of statistics is helpful². (Ironically, widespread statistical expertise could also render detection more difficult.) Published accounts suggest that detection depends heavily on delation and hindsight for success. It is clear that diagnosis is not straightforward^{4,5}. Automatic ostracism of the culprit from the scientific body seems to be the longstanding therapy.

Serious consideration needs to be given to prophylaxis. First, I suggest that thorough training of young scientists in careful and critical reading of research papers would help. An excellent means to this end is an active journals club, where each member regularly discusses a paper in depth. Second, in the special case of university scientists, the perception that output of publications is virtually the sole criterion for promotion needs to be modified, while promotions committees should put increasing weight on the teaching dossier and administrative competence; teaching and administrative duties require as much skill and time as laboratory research, and although they reduce research output they do not detract from its quality. Third, grant-making bodies should pay attention to modification of the role of the progress report as a step towards preventing the spread of this new disease.

NOEL J. DAWSON

Department of Physiology,
University of Auckland,
Private Bag,
Auckland,
New Zealand

1. Collins, E. *Nature* 324, 197 (1986).

2. Locke, R. *Nature* 324, 401 (1986).

3. *Nature* 325, 181–182 (1987).

4. Stewart, W.W. & Feder, N. *Nature* 325, 207–214 (1987).

5. Braunwald, E. *Nature* 325, 215–216 (1987).

SIR—The commentaries by Stewart and Feder and by Braunwald (*Nature* 325, 207–216; 1987) have drawn attention to an increasingly painful issue in science. Darsee's apparently fraudulent work is not an isolated case.

The integrity of science has always rested on two pillars: the honesty of the individual scientist, and the reproducibility of the research findings. This attitude has served science well in the past, partly because the number of researchers were few and because they published only when substantial data had accumulated.

In the postwar era, the increased infusion of funds into the scientific establishment and the training of large numbers of scientists may have overwhelmed this old-fashioned system. The products of science have also entered the consumer market and, as a result, have become big business. The scientific entrepreneur is now competing with major industries in raising money for his ventures. Science has also become part of government legislation. The environmental concerns of the 1960s have spawned a major industry devoted entirely to the evaluation of new and old chemicals. The complexity of the technologies involved in all aspects of this 'new' science has resulted in multiple investigators pooling resources to answer questions that were previously unanswerable or were only partly answered because no individual had all the skills required to deal with these complex problems. Finally, with the large number of trained researchers competing for funds that wax and wane with political fortunes in Washington, the pressure to publish in order to succeed has increased.

A hundred years ago, it would have seemed impossible for a researcher to publish 50 papers per year, and yet today many scientists are not only capable of maintaining this pace year after year but also of exceeding it. Who can possibly replicate the flood of papers published by the journals which, having become part of the science business, encourage an ever greater pace?

It is not surprising that under these circumstances more and more cases of fraud are discovered. The pressures are simply too great, and the temptation to become a sharer of this \$100,000 million yearly enterprise irresistible. Are we to assume that the revealed cases of fraud represent the fringes of science, or do they represent the tip of the iceberg? Can we go on assuming that trusting the integrity of the individual scientist is sufficient to police our ranks and prevent fraud in the future? It is hard to believe that with so much money at stake, any other profession would act on trust alone.

This historical development of science

could be compared with the developments in many other fields during the same period. Thus over the years banking has evolved from a state where transactions were conducted between people who knew each other in small communities, and with a handshake sealed a contract. Business deals were agreed upon in a similar way. As communities grew larger, it became necessary to commit contracts to paper and eventually a complex set of rules has evolved governing these transactions.

One consequence of this evolution is the necessity to ensure that ethical procedures are followed in the transaction of the business. The mechanism ensuring this is the auditing of books by independent professionals who are trusted by the business community to provide an unbiased evaluation of the business practices of the parties involved in the transaction. This has become an accepted practice because, without it, the same temptations that we are beginning to see in science would destroy the credibility of business and bankers alike.

Before science loses its credibility and scientists become regarded as untrustworthy members of society not meriting the financial support needed to carry out research, it is necessary to establish data-auditing procedures that will ensure that fraudulent practices are minimized and revealed early. The procedures for data auditing will have to be non-obtrusive so that scientists can carry out their work without fear of unnecessary interruptions. In fact, an entirely new field of science data-audit will have to be developed in order to make the supervision of the vast research enterprise possible. This may be perceived as yet another unnecessary piece of bureaucracy, but we feel that without such a safeguard scientists will not be able to maintain their reputation for honesty and integrity in the face of ever increasing fraudulent practices by a minority that cannot be weeded out before its entry into the field.

In the long run, just as the banks accept auditing as part of their normal activities and because of this safeguard have earned a reputation as trustworthy institutions, scientists will have to accept data-auditing as a normal procedure, and will use data auditing techniques to reassure the funding agencies and society in general that they have learned to police their ranks in a mature and professional manner.

ADIL SHAMOO

Department of Biological Chemistry,
University of Maryland,
School of Medicine,
660 West Redwood Street,
Baltimore, Maryland 21201, USA

ZOLTAN ANNAU

Department of Environmental Sciences,
Johns Hopkins University,
Baltimore, Maryland 21205, USA