

In praise of interdisciplinarity

Overspecialization in science is a bane of the times, but a meeting last week showed the benefits to be had from reversing the trend.

Keystone, Colorado. Whatever happened to the scientific generalist? Half a century ago, the physicist George Gamow felt able to include a discussion of modern cell biology and genetics in his popular book *One Two Three ... Infinity*; it would be a brave physicist who would make such an attempt today. Although general popularizers of science do exist (and are good at their job), they are not of the stature of Gamow. With few exceptions (such as semi-retired 'elder statesmen' or workers in explicitly interdisciplinary fields), our top-notch scientists seem to live in a more rarefied atmosphere — feeding, if not on a diet of pure Higgs bosons or synaptic vesicles, then at least on undiluted physical or biological science.

The reasons for this increasing specialization are apparent. First, as more people have been occupied in scientific research this century, and have been communicating more readily with one another, the accumulation of new understanding has proceeded ever more quickly. Although successful textbooks have always had several editions, in some fields there is now talk of updating university-level texts every year. Scientists who last studied biology twenty years ago no longer have even the appropriate vocabulary to understand many current advances in molecular biology — a problem with which this journal wrestles each week.

At the same time as scientific understanding has been advancing more rapidly, scientists have had less time to indulge in perceived luxuries such as keeping up with other fields. The pressures are familiar ones: more time spent on administration, on acquiring funding, and on helping students to survive in an increasingly competitive environment, to mention a few. Moreover, the easiest way to succeed in the competition for funding and university positions is to become expert in a single field of research; jacks (and jills) of all trades invariably lose out to masters of one.

Is specialization necessarily a bad thing? Surely it is more efficient for scientists to specialize, just as it makes sense for musicians to decide at an early age whether to be violinists or tuba players: the skills required are different in detail, and take years to develop. But an orchestra plays more beautifully if its members are sympathetic to each other's roles, and one can argue that, especially in times of reduced funding for research, a similar sympathy between practitioners is necessary for the scientific enterprise to flourish. Advocates of the Superconducting Super Collider project,

who failed to convince the US Congress to commit \$11 billion to the promise of finding "new physics" at energies in excess of 10^{13} electron volts, no doubt rue the fact that they were not first able to enlist the support of their fellow scientists — in some cases (though not in all) because the advocates were not able to explain themselves sufficiently well.

Against this background, the Keystone Center — a non-profit organization known to many readers of this journal for its symposia on molecular and cellular biology — inaugurated in 1991 an almost-annual series of unashamedly interdisciplinary meetings, known as the Scientist to Scientist colloquia. This year's colloquium, held last week in Keystone, treated about 70 scientists to talks on fields ranging from the molecular basis of memory to the detection of galactic 'dark matter', and from dinosaur behaviour to particle physics. With only fifteen 45-minute talks in four and a half days, there was plenty of time for discussion — which never ran dry. Scientists, young and old, who had evidently not had such concentrated exposure to ideas outside their own fields since their undergraduate days, grew visibly more excited as the week unfolded, as they rediscovered the pleasure of learning for its own sake. For as much as the colloquium series may have a pragmatic purpose — to give scientists the wherewithal to hang together (in the words of Benjamin Franklin), so as not to hang separately — its organizers are equally aware that the meetings provide participants with a less directed but equally tangible benefit: namely, the sheer inspiration of seeing how clever other people are.

Put another way, the meeting is simply great fun. For example, neuroscientists and astrophysicists alike seemed to delight in the mutual discovery that there are about as many neurons in the human brain ($\sim 10^{11}$) as there are stars in our Galaxy — not a profound realization, but one that gave each practitioner a better feeling for the other's work. At the same time, a computer scientist discovered, from a talk on synaptic transmission, that the most powerful computers are already matching the human brain in number of switching events per second — a graphic illustration that much remains to be learned about the efficient use of computational resources. And who is to say which is more wonderful: the fact that one can now record simultaneously the activity of 150 neurons in the hippocampus of a rat going about its business (and then apparently replaying the day's events during sleep, for

the benefit of the neocortex), or the existence of a Cretaceous fossil from Mongolia, which shows a *Velociraptor* using its arms to grasp the skull of a *Protoceratops*, while its killing claws are buried in the hapless victim's chest? Indeed, the participants' respect for their peers' resourcefulness in prising out nature's secrets was surpassed only by their wonder at the character of the natural world thus revealed.

Do meetings of this type yield more than a week of delight for 70 scientists? This is a pressing question for the meeting's organizers, who have had some trouble in finding sponsors for the series. Judging from this year's example, however, there are certainly benefits to be had beyond the re-energizing of the immediate participants (which is itself of some value). Although governments these days may be less universally keen to avail themselves of scientific advice than once was the case, leading scientists are still expected to be able to offer advice on technical matters, often outside the scientist's own field. As some of this advice will concern the relative importance of research in different fields, it would seem essential for the advisers to expose themselves to the kind of continuing education offered by the Keystone colloquia. In this regard, it is to be welcomed that two of the participants in previous colloquia have successfully replicated the Keystone model in their own universities. It is also a shame that only a very few university administrators and funding-agency officials have accepted invitations to Keystone.

Another important product of the colloquia, wholeheartedly welcomed by this journal, is a growing collection of scientists who are able to communicate the interest and excitement of their work in an accessible fashion. The meeting's organizers make a great effort to choose speakers who eschew jargon, and the audience is encouraged to request clarification on the spot where necessary. (This year a particle physicist interrupted a biological chemist with "What's a pi-orbital?") It is a tribute to the spirit of the meeting that the onus was on the speaker to explain, rather than on the physicist to have been better informed.) If the Scientist to Scientist colloquia manage to attain the prestige that they deserve, we may hope to see the day when leading scientists compete with one another for clarity of expression, rather than simply for intellectual attainment within their chosen field. That is a consummation devoutly to be wished.

Laura Garwin