

In praise of the 'brain drain'

Countries and professions that export skilled staff do not always lose out.

Governments and scientists are often heard expressing angst about the malign impact on their countries of the 'brain drain', the flow of skilled individuals to foreign climes. The brain drain worries people everywhere, with the possible exception of California. It is a policy fixation in European science, a concern for at least three-quarters of American states, and, most of all, a major strategic headache for developing countries.

In South Africa, for example, the government has demonized institutions that train doctors and nurses who leave for employment elsewhere. It has taken steps to penalize those state-trained health professionals who choose to leave.

But South Africa is wrong. Its perception of the brain drain — as a simple transaction in which the recipient gains and the donor loses — is, at best, incomplete. Conventional wisdom holds that the movement of trained healthcare personnel from Africa is creating a crisis in public health. But is that really what is happening?

Michael Clemens, an economist at the non-partisan Center for Global Development in Washington DC, doesn't think so. He reported his findings at the meeting of the American Association for the Advancement of Science in San Francisco last month (see www.cgdev.org/content/publications/detail/13123). There is a clear correlation between emigration and the state of the public healthcare system, but not the one you might expect. The higher the proportion of an African nation's nurses and doctors who have moved abroad, the better shape its healthcare is likely to be in.

This is not so strange, when you think about it. Countries and professions with more openness and greater mobility of personnel are more likely to be in touch with global trends — and more likely to attract able trainees in the first place. The worst public healthcare

systems, Clemens says, are in French-speaking West Africa, where staff are least likely to emigrate, as France won't let them.

The tendency of perhaps half of today's emigrants to return home later on in their careers is another factor. So is remuneration and the large amounts of cash that migrants send back home. These changes make the old model of immigrant 'donor' societies obsolescent. Communities can benefit, financially and intellectually, from those who have left. It is the degree to which these benefits counteract the unquestionable initial loss that is open to question.

Similar observations could be made regarding emigration flows between wealthy nations. According to the World Bank, Britain has more professional émigrés than any nation on Earth. But it doesn't seem to be hurting. California's research labs may be crawling with Brits, yet UK science has gone from strength to strength. According to surveys of citations against expenditure, Britain has one of the most productive research systems in the world. How can this be?

Well, say the revisionists, science departments at British universities may actually benefit from the ambition to depart, and, to a lesser degree, from their connections with those who have done so. Perish the thought, but some of these mobile researchers may even do the best work of their lives at Salford, say, only to take their foot ever-so-slightly off the gas when they 'arrive' at Stanford.

Woody Allen once observed that the sole cultural advantage of California (over his native New York, presumably) was its law permitting you to turn right at a red light. To be fair, science and industry in the Golden State have clearly benefited to a massive degree from immigrant talent gleaned from every corner of the planet. But the notion that other places have necessarily suffered a corresponding loss — or that emigration is a zero-sum game — is misplaced. ■

The legacy of Linnaeus

Taxonomy in an age of transformation.

Every plant and animal has a mitochondrial cytochrome oxidase I gene, and its sequence helps researchers assign that plant or animal to a given species, with some degree of certainty. The precise degree of the certainty obtained using this 'barcode' sequence is a matter of some debate, but such sequences are clearly useful to both taxonomists and those who use applied taxonomy. And the industrial-scale sequencing that allowed Craig Venter's ocean-metagenomics consortium to deposit billions of letters of sequence from hundreds of thousands of microbe genes into the GenBank database this week opens up even more possibilities.

The ability to peer into living things and inspect the evolutionary scorecard encoded in their genes has transformed the whole of biology, but few fields have had their core assumptions challenged



as deeply as taxonomy. From the time of Carl Linnaeus, born 300 years ago this May, taxonomy has relied on the observation and comparison of physical forms. Now it is supplemented by access to what would once have been seen not as form, but as essence.

Linnaeus himself sought a universal classification of all creation, animal, vegetable and mineral. His categorizations were not uniformly valuable, but his systematic spirit, his stress on the concept of species, and the formal but adaptable conventions of nomenclature he introduced have endured. *Nature* is glad to celebrate his legacy in this special issue.

DNA sequencing is a gift that Linnaeus would surely have made great use of, but it brings its own problems. It is not always easily reconciled with the careful description, annotation and curation that have been the duty and delight of the taxonomists who carried the linnaean programme forward. The availability of DNA sequences

invites both pure scientists (see page 247) and conservationists in the field (see page 250) to change their ways of working.

The classical world in which Linnaeus worked may seem, at first glance, to contrast with our present age of change. Linnaeus believed in fixed species of knowable number created by God and observable by men, in a world more like the lawns and flowerbeds of a formal garden than Darwin's dynamic "tangled bank".

Yet Linnaeus's classification was itself a response to a changing world — a world in which Europe's growing hegemony was bringing new species into the realm at headlong speed. Linnaeus's own experience of it was bounded by France to the south and Lapland to the north, but the 'apostles' who carried forth his words and sent back samples and descriptions sailed out from Sweden to Arabia, the Americas north and south, China, Japan and the Pacific. Two sailed with Captain Cook, sending back samples from the parts of the Pacific now being sieved for genes.

The various inventories that Linnaeus produced grew ever longer. But while today's world continues to expand in many ways, in some, including those most important to taxonomy, it is shrinking. The

creationist Linnaeus was able to assert that "we can count as many species now as were created at the beginning," but today's taxonomists suspect with near certainty that species are being irretrievably lost to science at an ever-quickening rate.

This whittling away of the bark and marrow of life is not necessarily, in itself, catastrophic. Not every lost species represents a depletion of ecosystem services or other human amenity, and although that is not the only yardstick by which to measure such things, it is in some ways the most important.

Linnaeus would no doubt find much to admire in today's scientific world: its scholarship; its ability to assemble data from around the world in minutes; its tools for examining essences. He would hopefully come round to evolutionary theory — and see the error of the racial categorizations he applied to humans.

The fact that so much of life can be seen in a few buckets of sea water might reconcile him to the fact that swallows do not, as he insisted, wait out the winter in lake-bottom mud. But the realization that the second edition of his dreamed-of universal catalogue would be slimmer than its first would surely strike him as a melancholy one. ■

Open for business

California's stem-cell institute is already transparent enough.

Twenty-eight months after California's electorate voted to spend \$3 billion on an institute dedicated to stem-cell research, the California Institute for Regenerative Medicine (CIRM) is finally up and running.

Last month, it gave 72 labs SEED (Scientific Excellence through Exploration and Development) grants for innovative approaches to stem-cell work. Tomorrow they will be joined by up to 25 more, under the institute's first tranche of mainstream investigator grants.

Details of how these grants will be executed — often in the same labs as other research funded by the federal government, and therefore subject to the Bush administration's tight constraints on stem-cell research — have yet to be fully worked out (see page 238).

However, it is already clear that the CIRM has established a robust grant-review mechanism that should satisfy the critics who said the institute would be secretive, biased towards particular organizations that had lobbied for its creation, or overly deferential to scientists. Indeed, the scrutiny to which the CIRM was initially subjected has resulted in a system for grant evaluation that is in some respects more transparent than that of any other research agency.

For example, the CIRM publishes a large amount of information about every grant application on its website (www.cirm.ca.gov), including anonymous reviewers' comments, review scores and the reviewers' recommendations to grant or withhold funding. Successful grant applicants are named on the site, but those who fail remain thankfully anonymous.

The reviewers' comments are frank and potentially embarrassing. One review summary opined that a successful applicant's proposal "lacks focus" and "is not well put together", and some reviewers said

they were sceptical about the rigour of another successful applicant's prior publication record.

This openness derives from the CIRM's unusual beginnings. In its short existence, the agency has engaged in constant and often productive dialogue with watchdog groups such as the Foundation for Taxpayer and Consumer Rights, based in Santa Monica, and members of the California legislature in Sacramento. The CIRM's oversight procedures and structure have come under close scrutiny through lawsuits in the California courts.

But as the first grants are awarded, the CIRM is under pressure to open up its review processes still further. The taxpayer-rights group now wants the agency to identify not only those who win awards, but also those who lose out. That would be akin to the state of California publicly releasing information on all the job applications it receives, complete with adverse comments made during the hiring process.

It is impossible to see how such a move will benefit California's taxpayers. Publicly identifying, and sometimes humiliating, those who fail to win awards serves no useful purpose. On the contrary, it is likely to deter scientists from submitting risky proposals that might draw flak from reviewers, and may well curtail reviewers' honesty.

Watchdog groups have also suggested that more financial information should be disclosed about members of the grant-review working group itself. The group is recruited from outside California, and is already screened for potential professional and financial conflicts of interest. The proposal for yet more disclosure, if implemented, would make the CIRM's external review process more onerous, without adding useful information on potential conflicts.

The CIRM is now functioning well, and its dialogue with the public has played a significant role in its progress. Calls for yet more openness may be well intentioned, but they threaten to override the element of confidentiality that is inherent to fair peer review, and to undercut the agency's mission of supporting cutting-edge research from the best Californian scientists. There comes a point at which yet more sunshine leads to sunburn. ■