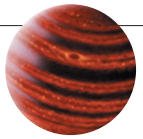
THIS WEEK

EDITORIALS

WORLD VIEW Vaccination programme urgently needed to tackle typhoid in Nepal **p.267**

ASTRONOMY Gas giant is lowest-mass exoplanet imaged directly **p.268**



NEUROSCIENCE Dreams spark visual activity in the brain **p.269**

Rise of the citizen scientist

From the oceans to the soil, technology is changing the part that amateurs can play in research. But this greater involvement raises concerns that must be addressed.

Science is not just for scientists these days. Going on a scuba-diving holiday this summer? Share the temperature data from your dive computer with researchers eager to plug holes in sparse records for inshore areas. Nervous about possible pollution from a nearby fracking project? Ease your concerns by helping to collect and analyse air samples as part of a monitoring project. Stuck at home as the rain pours down? Log on to the Internet and spend a couple of hours folding proteins and RNA to help university scientists work out how biology does it.

Citizen science has come a long way from the first distributed-computing projects that hoovered up spare processing power on home computers to perform calculations or search for alien signals. And it has progressed further still since the earliest public surveys of wildlife: it was way back in 1900 that the Audubon Society persuaded Americans to exchange their Christmas tradition of shooting birds for a more productive effort to count them instead.

Some professional scientists are sniffy about the role of amateurs, but as an increasing number of academic papers makes clear, the results can be valuable and can help both to generate data and to inform policy.

A paper in *Geoderma* entitled 'Can citizen science assist digital soil mapping?' (D. G. Rossiter *et al. Geoderma* **259–260,** 71–80; 2015) makes the case that, yes, non-specialists can help expert soil scientists to track quality, properties and types of soil. It goes further: these amateur soil researchers should be recruited to help with existing and future national surveys. Civil engineers and construction workers routinely view the subsoil, and digging foundations for buildings and trenches for pipelines offers a unique look at the spatial variability of different layers. An army of geocachers — twenty-first-century treasure hunters — visit harsh terrain and difficult-to-access places, and could collect soil data. And they routinely use satellite navigation to record their journeys.

Technology can make scientists of us all. Data churned out by the rapid spread of consumer gadgets equipped with satellite navigation, cameras and a suite of other sensors, and the ease of sharing the results digitally, are driving the boom in citizen science. Volunteers can already identify whale songs from recordings, report litter and invasive species, and send in the skeletons of fish they have caught and consumed. But there is more to being a scientist, of course, than collecting and sharing data — especially if the results are to be used to help determine policy.

Critics have raised concerns about data quality, and some studies do find that volunteers are less able to identify plant species than are academics and land managers. And there are issues around how to reward and recognize the contribution of volunteers, and around ensuring that data are shared or kept confidential as appropriate. But these problems seem relatively simple to address — not least because they reflect points — from authorship to data quality and access — that the professional scientific community is already wrestling with.

More troubling, perhaps, is the potential for conflicts of interest. One reason that some citizen scientists volunteer is to advance their political objectives. Opponents of fracking, for example, might help to track possible pollution because they want to gather evidence of harmful effects. When Australian scientists asked people who had volunteered to monitor koala populations how the animals should be managed, they found that the citizen scientists had strong views on protection that did not reflect broader public opinion.

Scientists and funders are right to encourage the shift from passive citizen science — number crunching — to more-active roles, including sample collection. But as increased scrutiny falls on the reliability of the work of professional scientists, full transparency about the motives and ambitions of amateurs is essential. ■

Portfolio boost

People who fund or manage many research projects could do it better with mindful analysis.

Imagine that you are in charge of a foundation funding a substantial range of research projects, or a university wanting to understand the broader benefits of its research. With a clear view of your institution's overarching mission, you seek good researchers. You might then conclude: as long as they deliver impactful research, your job is done.

But you could benefit from standing back and analysing the situation through different lenses. For example, you could check whether research projects display undesirable uniformity in their underlying assumptions. You could enable collaboration between research strands that happen to be converging on a particular social or technological outcome. Or you might find ways to diversify, maximizing the chances that something valuable (such as a diagnostic) will emerge even if the central goal (such as a vaccine) turns out not to be achievable.

Such are the virtues of research-portfolio analysis. Those intrigued by such mindfulness should turn to a study (M. L. Wallace and I. Rafols *Minerva* **53,** 89–115; 2015) that looks at relevant literature from recent decades, and highlights the benefits of inward-looking analysis that also creates opportunities for transparency and stakeholder engagement. The study highlights the limitations of corporate approaches to portfolio analysis that are geared to financial returns and well-defined markets — in contrast to the broader aims of government, philanthropic funders and universities.

In analysing how projects and themes can be mapped in ways that highlight "cognitive proximity", this work may help those who run research portfolios to get better bangs for their bucks. It might even help to make the world a better place. ■