RARE SPECIMENS

A handful of plant collectors has shaped the field of botany. Now they are disappearing, and there are no clear successors.

BY JOHN WHITFIELD

John Wood has had malaria twice, and Dengue fever once. He has shaved leeches off his legs with a machete in southeast Asia — "you're supposed to use a lit cigarette, but I don't smoke" — had his car stolen in Bolivia and lain face down in the Yemeni desert while local tribes exchanged gunfire over his head.

He encountered such inconveniences in the process of collecting more than 30,000 plant specimens over 40 years of travelling the globe, mostly as a hobbyist. More than 100 of his finds have become type specimens, from which new species are described. Those numbers elevate him to the ranks of a star collector — the top 2% of botanical gatherers, who have accumulated more than half of the type specimens in some of the world's most important collections[1].

These elite field workers have probably numbered fewer than 500 people throughout history. But they have contributed much of what scientists know about plant diversity, ecology and evolution, and have been crucial in the race to document the world's plants before they are lost to deforestation, development, invasive species and climate change.

Many botanists, however, believe that the era of the superstar collector is drawing to a close, at least in the 200-year-old form of a man (or occasionally woman) setting out from Europe or North America to see what the tropics hold. As botany has moved away from taxonomy and towards molecular studies, few of the jobs available allow researchers to spend long periods in the field gaining an encyclopaedic knowledge of plants. Tropical countries have also imposed restrictions on foreign researchers and are developing their own botanical expertise among home-grown scientists. "It's possible that the days of the non-native plant collector are virtually at an end, and people like myself are the last examples," says Wood.

As the star collectors disappear, botanists are debating how to fill the gap. Some researchers, including Wood, are training botanists in tropical countries, the presumed home of most undiscovered plants. But others think that it might be more efficient to recruit a large group of less-skilled collectors, aided by technology and crowdsourcing techniques. "The real question is, can we exchange a few elite collectors for an army of enthusiastic less-experienced collectors?" asks Cam Webb, a Harvard University plant scientist based in Indonesian Borneo.

The iris *Mastigostyla woodii* is named after its discoverer, John Wood.

J. R. I. WOOD

That is a tall order, given the seminal part that top collectors continue to play. "The most interesting results are produced mostly by people who know what the plants look like, and what to expect in a certain area, and that's why they can pick out what's unexpected," says Henk Beentje, a specialist in tropical palms at Kew Gardens in London. "They're worth more than their weight in gold."

BUDDING INTEREST

Like many elite collectors, Wood started early. As a child, he accumulated stamps, rocks, butterflies and as many flowers as he could. As a teenager, he contributed to a project to record all the plant species living in his home county of Essex, UK. When he moved to Saudi Arabia in 1970 to teach English, botany provided him with an excuse to travel to wild and remote places. A contact in the British embassy put him in touch with a researcher at the Natural History Museum in London who was interested in receiving Arabian plants, and Wood sent his first specimens back in the diplomatic pouch.

In 1974, Wood moved to North Yemen, where he spent six years working in educational development, volunteering to inspect remote schools so that he could visit the places with the most interesting plants. Gradually, he began to try to identify and understand plants himself, driven by the thrill of finding something new, or something that had last been collected two centuries ago. He also became interested in broader questions of plant ecology — his first paper, published in 1979, discussed whether Yemen had once been forested[2].

He went on to collect in Colombia, Bhutan and Bolivia. Since 2001,

HERMES JUSTINIANO

John Wood, seen here examining the tree bromeliad *Aechmea bromeliifolia* in Bolivia this month, has collected tens of thousands of plant specimens.

he has been a professional botanist, spending half the year in plant taxonomist Robert Scotland's lab at the University of Oxford, UK, and the other half in Bolivia, doing fieldwork and training local scientists. Together with Scotland and others, Wood is finishing a monograph on *Strobilanthes*, a tropical genus of several hundred species.

It was Scotland who led the study that revealed the influence of the elite collectors. Along with Wood and an international team of botanists and ecologists, he scoured databases to find out who had collected each of 103,000 type specimens in four of the world's largest herbaria — at the Natural History Museum in London, the Royal Botanic Garden Edinburgh, UK, the Missouri Botanical Garden in St Louis and the Royal Botanic Gardens in Melbourne, Australia.

The analysis showed that a small group of what the team calls big hitters has been hugely and disproportionately effective at finding species over the past two centuries. It also showed that most big hitters are wide-ranging, in both where and what they collect — Wood, for example, has combined regular intercontinental relocations with an omnivorous collecting habit that takes in half a dozen plant families, including large groups such as the grasses and daisies. This breadth seems to underpin the ability to find lots of new species.

Broad experience helps a collector to know what to sample, and what to ignore. If a plant looks new, collectors try to get as many parts — flowers, leaves, root and fruit — as possible. (When sampling a tree, this often involves climbing it.) In the tropics, they have to race to get specimens into a press or preserved in alcohol before the plants start to decay. Drying and mounting plants so that they display their diagnostic features, and yield high-quality DNA samples, requires skill and practice.

That craftmanship must be allied to innate gifts in pattern recognition, says Quentin Luke, a botanist affiliated with the East African Herbarium in Nairobi. "People with a natural ability to distinguish plants from each other are few and far between," he says. Identifying plants that aren't in flower — which will be most of them in a tropical forest with no set flowering season — is particularly challenging. It requires knowledge of subtle features of leaf morphology or bark, or even the smell of wood or the taste of leaves.

A prodigious visual memory also helps. Alwyn Gentry of the Missouri Botanical Garden, one of the leading botanists of the twentieth century, claimed to remember every plant he had ever collected, amounting at his death to more than 80,000 specimens[3].

FIELD TESTED

For elite plant collectors, experience and ability reinforce one another: field botanists find the largest number of new species per year at the end of their careers. But they can't get that far without a cast-iron constitution and a certain sangfroid. Tom Croat of the Missouri Botanical Garden — who, with more than 100,000 specimens from 37 countries, is probably the most prolific living plant collector — once had a Costa Rican road collapse beneath him, causing his camper van, containing a custom-built plant drier, his wife and two young children, to roll down a mountain and into a river. And Beentje once had to talk down a lynch mob on Madagascar. "They thought I was abducting virgins and stealing their blood. We got out by the skin of our teeth."

Some botanists die at work. Gentry was killed in 1993, aged 48, when a plane taking him on a collecting trip in the mountain forests of Ecuador crashed. And in 2010, Leonard Co, one of the Philippines' top plant researchers, was shot dead while working in the forest, either in crossfire between government forces and communist insurgents, or because the army mistook him for a guerrilla.

There is no shortage of adventurous and skilful young botanists willing to embrace such a life, say senior collectors. And there is plenty of work left to do: estimates suggest that there are 70,000 plant species left to discover[4], mostly in equatorial Latin America and Indonesia, to add to the 350,000 or so already known. For the

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past few decades, about 2,000 new species have been described each year, with no sign of a slowdown.

There are, however, few places employing plant collectors. The first wave of globe-trotting botanists, in the late eighteenth and early nineteenth centuries, carried out surveys on behalf of the European empires; later, horticultural companies paid top collectors to bring back new products. Now, nearly all the serious collectors work for major botanic gardens and museums.

Yet even there, general botanists are no longer in such demand. The modern botanist tends to focus on one plant group and uses DNA sequences to decode evolutionary history and relationships. "We'll see fewer collections per individual because people are becoming so specialized. Just collecting a lot of specimens isn't something people have much respect for," says Robbin Moran, who studies ferns at the New York Botanical Garden. The shifts in botany have had costs, he says. "The really big collectors have been tremendous generalists, and that's something that's being lost."

Croat especially laments the waning opportunities to practise floristic taxonomy — describing all the plants in a location. He earned his spurs putting a name to every plant species on Barro Colorado Island[5], a research station in the Panama Canal run by the Smithsonian Institution in Washington DC. "Floristic studies give knowledge of all groups of plants," he says. "Without that, the average student has no idea what to work on. Most of the graduate students today wouldn't be able to find the forest, let alone find anything in it."

Plant collectors are also facing a growing number of bureaucratic hurdles. Tropical countries, seeking to protect potentially lucrative sources of drugs and crops, have tightened their regulation of plant collecting. India is among those that ban the export of plant specimens altogether; other countries demand that botanists specify what groups they will collect, hindering broad floristic work.

"Each time I go back to Bolivia there's more paperwork and more restrictions," says Wood. That makes it harder for botanists to gain international experience, he says. "There's a disincentive to start in another country, because it means starting your permits and contacts from scratch." The top collectors of the future are likely to be born in, or migrate to, tropical countries, he says.

This shift is already happening, with local collectors and herbaria compensating for the decline of the big-hitting Westerner, says Gerrit Davidse, of the Missouri Botanical Garden, a co-author of the collector analysis. "In the past, you could mostly ignore local collections in places such as Mexico and Brazil," he says. "Now you ignore them at your peril."

The tight regulations do not spare native collectors. "We have many problems applying for permits," says Alfredo Fuentes, a botanist at the National Herbarium of Bolivia in La Paz. "It is very difficult to explain why we collect, and that the collections are not for commercial purposes. We spend a lot of time on this." In Kenya, says Luke, it is "a huge song and dance" for local botanists to send specimens abroad to be identified, which is usually necessary for the most interesting finds.

Old Man Banksia (*Banksia serrata*) is one of the many plants that Joseph Banks collected.

NATURAL HISTORY MUSEUM, LONDON/SPL

"It's possible that the days of the non-native plant collector are virtually at an end."

And developing-world botany still requires the support of rich nations. "In Bolivia, the government support for botany is almost non-existent," says Fuentes. "This major shortcoming is largely filled by foreign institutions and researchers who strongly support the training of new botanists."

The changing botanical landscape, and the many threats to plant diversity, have led Webb to advocate a different approach to discovery[6]. Western collectors have always employed local naturalists and students, to gather and process specimens. Now, technology could allow this approach to be scaled up, says Webb. In a few years, he predicts, volunteers will be armed with a tablet computer bearing the world's botanical information in one hand and a pocket DNA sequencer that identifies species in the other. His team is working on software that will allow anyone to help identify specimens online, by pairing up images of known and unknown plants. "Perhaps it doesn't matter which is better, the elite few or the excited rabble," says Webb. "But I am optimistic that the latter could actually be made to be highly selective and effective via good training, augmented with the best of tech."

Others are sceptical that this approach will bear fruit. DNA-based identification has so far yielded little for plants, says Scotland. "We're still trying to work out what the markers are, even though it's been talked about for a decade." And although volunteers can collect huge amounts of material — botanists call it hay baling — they often bring back the weedy and introduced, rather than the rare and interesting. Supporting a new generation of experts might be more productive, Scotland says. "Fewer people over a longer period of time might give more rewards than lots of unfocused people collecting lots of the same thing."

Wherever the collectors of the future hail from, they will have to be content with a long wait for recognition. Herbaria are filled with unidentified specimens, and the gap between a species being collected and being described averages about 36 years[4]. This means that any analysis of collectors' achievements will underestimate the contribution of contemporary botanists. It also suggests that at least half of the 70,000 unidentified plant species are already in a cupboard somewhere.

The bottleneck means that star collectors of the past remain a force in present-day botany. Today's researchers spend their days with plants collected by botanists going back to the eighteenth-century days of Joseph Banks, and speak of their forebears with the same familiarity as they do of their contemporaries. As Wood puts it: "Collectors have a sense of their place in history." ■

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