Species Sleuths: Amateur Naturalists Spark a New Wave of Discovery

Scientists have not kept pace with the work of discovering new species. Now, a growing number of committed hobbyists – ranging from a Belgian bus driver to a California cybersecurity expert – are out in the field, igniting a boom in documenting the world's biodiversity.

BY JESSICA LEBER **YALE360** MARCH 12, 2019
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When mushroom hunter Terri Clements found a unique specimen near her home in Arizona, she couldn't be certain by its appearance that she'd stumbled across a new species. She tracked down a commercial lab that would process DNA from samples she collected and studied the resulting sequences. Only later did she cold email a mycological scientist, who confirmed her work. As a result, this December, she became part of a team publishing a scientific paper describing her new mushroom species, *Morchella kaibabensis*, along with three others.

A former restauranteur and real estate executive who retired in 2012, Clements has no formal scientific training beyond her college microbiology minor. But using a combination of traditional taxonomy — the science of describing, naming, and classifying life on earth — and increasingly accessible DNA classification tools, she's now hooked on documenting fungi either previously unknown in her region, or, just as often, new to science. "I spend hours and hours on it," she says. "It's like a full-time job for which I don't get paid."

Her work puts her in the ranks of an increasingly vibrant group of hobbyists busy documenting unexplored species on the planet, ranging from a chemical engineer in France, to a cybersecurity specialist in California, to retirees like Clements. Many study organisms from specific groups of fungi, insects, and other invertebrates that are less charismatic and surveyed than the orchids, birds, and butterflies that have long attracted the public's interest.

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Through close study of niche areas, some of these so-called amateurs amass decades of expertise rivaling or exceeding that of traditional taxonomic experts. Others are more typical collectors who dabble in discovery, with the help of online information and collaboration. Either way, in a poorly-funded academic field in the throes of a long-recognized workforce crisis, career scientists are increasingly welcoming to these enthusiastic volunteers.

Amateur contributions to taxonomy are far from new — “Darwin wasn’t a professional,” notes David Pearson, an Arizona State University ecologist and beetle expert — but this work became the more exclusive domain of traditional academic and museum institutions in the 20th century. More recently, however, Pearson says the heyday of Darwin’s Victorian era — when amateur naturalists driven by their own curiosity helped dramatically expand the world’s biodiversity catalog — is having a comeback.

The data, though limited, support the trend. A 2012 study found new species of multicellular land and freshwater animals are being discovered at an “unprecedented rate” in supposedly well-explored Europe. Crucially, it found “non-professional” taxonomists were responsible for more than 60 percent of those new species descriptions from 1998 to 2007. In the ocean, it’s a similar story — 40 percent of first authors of recently identified marine mollusks have been so-called “amateurs.” Another paper by New Zealand researchers argued that because of these citizen scientists, as well as new tools to analyze species and online access to knowledge, “the field has never been stronger,” they write, despite a decline in funding for the formal profession.

“There are fewer students who want to be taxonomists, but I think there are more and more amateurs who are interested in this, because nowadays you can find information much more easily [online],” says Iva Njunjić, a cave biologist at the Naturalis Biodiversity Center in the Netherlands.

In some fields, the detail and accuracy of work done by diligent high-level hobbyists rival professional scientists, says Pearson. French National Museum of Natural History curator and marine mollusk expert Philippe Bouchet, who estimates he has a backlog of tens of thousands of undescribed species gathering dust, agrees, which is why he actively farms out material he collects on ocean expeditions or stores in museum drawers to a network of volunteer collaborators, including a bus driver in Belgium, Koen Fraussen, whom he calls "the world expert" on the Buccinidae family of sea snails, and a retired Long Island environmental consultant, Phil Fallon.

One of Bouchet's power workers is Emilio Rolán, who in the last decade has described more ocean species than anyone else by far — almost 5 percent, or 988, of all 21,000 new species published, according to the World Register of Marine Species. Rolán is a retired pediatrician and shell collector working from his home in Spain, sometimes using high-powered microscopes at a nearby university. Rolán discovered his first new species in 1980, a snail he named after his wife: *Conus josephinae*. Over the next decade, he ramped up his interest in taxonomy, traveling and learning techniques for how to study the specimens he found. He earned a PhD in 1992 while still working full-time as a pediatrician — his thesis was about the snails of the Cape Verde archipelago. After he retired from medicine in 1999, his publishing output became prolific, in part with the help of museums like Bouchet's and the Museo Nacional de Ciencias Naturales de Madrid that send him specimens to study. In total, Rolán has identified almost 1,500 new species since 1980. He gets no salary for his work.

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"He's doing his work in his free time and for fun, not for money," says his son, Emilio Rolán-Alvarez, an evolutionary biologist at the University of Vigo, who lives a short drive from his father. "He cannot just spend time sitting and watching TV."

Taxonomic hobbyists vary in specialization, location, and age. Michel Bertrand, a chemical engineer who works at a pharmaceutical company in France, devotes his spare time to lichen taxonomy. "Right now, I'm studying lichen in as close a manner as a professional, in my special office and laboratory at home," he says. Last year, after four years of work alongside co-

authors, he published his third new species identification, a lichen first found by a friend on the exposed rocky coast of northwestern France. Michael Kuo, a college English teacher in Illinois, has spent 25 years becoming an expert in North American mushrooms, and runs the website MushroomExpert.com, which has information on 1,100 species, including several new classifications published by Kuo.

John Shetterly, a 74-year-old Massachusetts-based lawyer, works half-time and pursues his life-long insect taxonomy hobby on the side. He regularly visits the nearby collection at Harvard University to boost his insect knowledge and travels to places like Mongolia and Mexico, work that has led to him publishing books on tiger beetles in Mexico and Guatemala, as well as classifications for several new species.

For most of these hobbyists, the publications and travel aren't the reason they do their work. "This is my greatest pleasure," says Fallon, the retired environmental consultant and one of Bouchet's collaborators on marine mollusks. "Sitting down, writing a description and experimenting with phrases and words to get it just right, that's where the enjoyment is. And of course, looking at something new and describing something that has never been described before."

Sometimes such research requires more technical skills or equipment than hobbyists possess. But even so, many hobbyists act as additional sets of eyes in the field, and work with researchers on their finds. Jim McClarin, a former New Hampshire state representative and carpenter who retired to Ecuador to study and photograph beetles, frequently posts his unusual finds to Facebook groups like London's Natural History Museum's page "Friends of Coleoptera," the scientific name for beetles.

When he discovers something he can't identify, he emails photos to academic entomologists he's in touch with. "I can determine if it's new to me, but I have to be told by an expert whether it's new to science. Very often, they say 'Yes, this is something we haven't seen before,'" he says. He estimates he's found new species numbering in the "high dozens."

In countries with an emerging middle class, the boom in amateur taxonomists is even more pronounced.

Many in this growing workforce of unpaid, self-motivated naturalists have the luxury of leisure time and disposable income to buy equipment, pay society memberships, or travel in search of novel species. In countries with an emerging middle class, the boom in amateur taxonomists is even more pronounced, says Pearson, citing, for example, a widely published hobbyist in China Wenxuan Bi, who also studies insects.

To fill a funding gap and tap growing popular interest, Njunjić, the cave biologist, has even revived a Victorian business model: patronage. She co-founded a company in the Netherlands, Taxon Expeditions, which takes paying participants on expeditions to explore biodiversity in relatively undocumented regions like Borneo.

"Participants pay, from that money we fund everything — the whole research and expedition, the sponsorship of students and local researchers," she says. Travelers learn and collaborate on writing and publishing new species descriptions of beetles, slugs, and snails ("You can be Darwin too!" says the company's website). "We discovered five species in 13 days," says Taly Eddington, a college student from California and trip participant who co-authored the publication of a new "semi-slug" species found on her trip.

For career-minded professionals, the lack of interest in formally pursuing taxonomy isn't only because of scarce funding. While there are heated debates about how many species on earth remain undiscovered — estimates vary widely from a few million to tens of millions — the painstaking work of species classification comes with little opportunity for accolades or big scientific questions that could yield a prestigious publication or, as Bouchet put it, "shake the tree of life."

Parsing the minute differences in the bulk of the world's unidentified animals and plants isn't likely to make headlines. After traipsing through the jungle to find insects or sampling the snails of a deep coral reef, the harder part of identifying species is often the unglamorous work of sifting through an

unwieldy mess of earlier literature to see if it's really new. For professional researchers, says Njunjić, genetic studies of biodiversity and evolution — rather than traditional descriptive naming — are now the sexier science and more likely to attract funding.

Yet Clements' experience in the field of mushroom taxonomy suggests that even DNA sequencing research will become more accessible. In fact, last year the North American Mycoflora Project began raising money to subsidize hobbyists' sequencing efforts at the dozens of mushroom clubs that dot the country. Because scientists don't have time do all that work, the project aims to have enthusiasts not only do the collecting and sending out samples for sequencing, but also teach them to properly preserve specimens, upload DNA to the right databases, and understand their sequence results.

At a time when ecosystems are trending toward rapid biodiversity loss, sorting and classifying the branches on the tree of life still matters, says Bill Sheehan, president of the project. "It all starts with understanding what a species is. All of biology, whether it's ecological or evolutionary or whatever, rests on solid species determinations." Practically — and often legally — it's impossible to protect a species, or even figure out if it's threatened, if it doesn't have a name and description. And as Victorians like Darwin found, taxonomical studies often point the way to important questions about how evolution works, says Rolán-Alvarez.

Meanwhile, his father, the marine snail enthusiast, is happy knowing he is making a contribution while pursuing a hobby he loves. "To know may always be useful," Rolán says.