Press release

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The BBVA Foundation recognizes Sandra Díaz, Sandra Lavorel and Mark Westoby for cataloguing plant traits and their functions in ecosystems worldwide

- **The three winners** in the Ecology and Conservation Biology category linked plant ecosystem function to their physical characteristics, such as height, leaf type or seed size, and described how these broad traits relate together at global level

- **The catalogue** of these functional traits is now a vast database with information on some 200,000 plant species that is added to and used by researchers around the world for such purposes as modelling the impact of climate change on ecosystems and identifying mitigation measures

- **The "trait ecology"** championed by the three scientists is improving the design and effectiveness of studies to identify and quantify the ecosystem services that benefit humanity, and of biodiversity conservation efforts

- **The committee** concludes for these reasons that the awardees have made "outstanding efforts to describe and sustain the complexity of life on Earth"

The BBVA Foundation Frontiers of Knowledge Award in the Ecology and Conservation Biology category has gone in this thirteenth edition to ecologists Sandra Díaz (Universidad Nacional de Córdoba, Argentina, and Argentine National Research Council, CONICET), Sandra Lavorel (Laboratoire d'Ecologie Alpine [LECA], Grenoble, France, and Landcare Research, Lincoln, New Zealand) and Mark Westoby (Macquarie University, Sydney, Australia), for "expanding the concept of biodiversity," through "their pioneering work to discover, describe and coordinate the measurement of plant functional traits."

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Independently and collaboratively, the awardees focused their research on arranging each plant's ecosystem function along dimensions of measurable physical traits, such as height, leaf type or seed size, enabling them to locate patterns in the functional diversity of species at a global level. The catalogue of these functional traits has now become a vast database, added to and used by researchers around the world for such purposes as modelling the impact of global change on ecosystems, and identifying mitigation measures.

"The increasingly massive and coordinated trait databases that have been developed [on plant functional traits] are fundamentally changing our ability to predict the consequences of climate change for both the diversity and the function of our ecosystems," in the words of the award committee appointed jointly by the BBVA Foundation and the Spanish National Research Council (CSIC). The "trait ecology" that the co-laureates championed "is improving the design and efficacy of both biodiversity conservation efforts and predictive ecosystem models and theory."

Díaz, Lavorel and Westoby, the citation concludes, have made "outstanding efforts to describe and sustain the complexity of life on Earth."

Form as function

Not all plants can convert sunlight into organic matter with the same efficiency, or reproduce themselves as quickly, or consume the same quantity of water. These different abilities depend on measurable physical traits, and have a major impact on overall ecosystem functioning. This concept of functional biodiversity was already "in the air" by the 1990s, recalls Sandra Díaz in a video interview after hearing of the award. Yet it was not until the new millennium that its study got systematically under way.

Díaz herself wrote in a paper published in 2001: "There is a growing consensus that functional diversity, or the value and range of species traits, rather than species numbers *per se*, strongly determines ecosystem functioning. But despite its importance, functional diversity has been studied in relatively few cases."

By then, the three had met at various international conferences, each traveling from a distinct corner of the globe. "We really connected," says Díaz, "and had a great time talking together about the relationship between biodiversity and function." It was from these conversations that the idea

took shape to create a global database of shared knowledge, something "quite rare at the time in this field of research," remarked Sandra Lavorel, speaking from New Zealand, where she is currently on a research stay at the Landcare Research Center in Lincoln. The three explained the project to their initially reticent colleagues, who decided to sign up, says Díaz, "basically because they trusted us."

This was how they came to play what the committee calls "critical roles in formalizing the study of plant traits, inspiring their colleagues across the planet to share in the effort to measure the functional diversity of plants within and across ecosystems."

A database of 200,000 plant species

The success of the initiative exceeded all expectations. At the time of writing, the TRY database – its name a nod to the hard task they knew would lie ahead – contains 12 million entries, documenting the functional trait diversity of some 200,000 plant species.

The committee was at pains to stress the value of this tool, stating that "trait ecology has allowed ecologists to make common and standardized measurements of plant function in every ecosystem on Earth."

Plants perform vital ecosystem functions, like carbon fixation, nutrient acquisition and the accumulation of living biomass. Now, thanks to the TRY database, researchers can project how efficient a plant will be at these or other tasks on the basis of its physical traits.

A milestone in their collaboration was the 2016 paper "The global spectrum of plant form and function," published in *Nature*, which marked the first attempt to classify functional biodiversity by reference to six physical traits. These traits have to do primarily with the size of plants and their components, such as seeds, and the workings of the "leaf economy." Westoby elaborates on this last concept, explaining that "some leaves capture light very 'cheaply', that is, capturing a lot of light for the level of resources they invest, but at the cost of being relatively short-lived. At the other end of the spectrum you have relatively 'expensive' leaves with a low rate of return, but that last for a long time."

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For Díaz, the great global catalogue of forms and functions set out in 2016 is "the first snapshot of the functional diversity of the Earth's vascular plants." Behind it is the ambition to understand the mechanisms that drive the functioning of each ecosystem. Westoby continues with the analogy: "Ecosystems are a machine where the cogs and the levers and the connecting rods are species. And so being able to understand how those pieces of machinery work is a prerequisite for being able to forecast the consequences of any kind of change in the environment, including those due to stressors of human origin."

Mounting a better response to climate change

The kind of knowledge provided by the functional approach, and a database like TRY, is already being applied in the design of models to improve ecosystem adaptation to climate change. Lavorel explains that it has been shown, for instance, that slower growing plants are more resistant to drought, a phenomenon set to increase with global warming in regions like the Mediterranean. But at the same time, slower growing crops capture less carbon, so it is important to factor both variables into future adaptation plans.

Another research strand is the relationship between plants' functional traits and the production of foods. And one of the connecting threads is pollination: "A large proportion of the world's crops are pollinated by insects," says Lavorel, "and the traits of the flowers of these plants determine which insects will be able to pollinate them, which will ultimately influence their levels of production."

In short, understanding each plant's function allows to model how the ecosystem will change in response to environmental changes, providing a key input to conservation planning. "Species are not disappearing randomly," says Díaz. "Some organisms are systematically more affected than others, because they have traits that make them differentially vulnerable. Our work helps generalize which are those vulnerable organisms, and what we lose in terms of ecosystem properties and benefits to people when those species disappear. In this sense, what we do highlights how inextricable are our connections with the rest of living nature."

The need to act urgently

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Asked about today's dramatic rates of biodiversity loss, the co-laureates concur in the necessity of urgent action. "What is at threat is the functioning of the tapestry of life on Earth, of which we all form part, and we cannot expect a reasonable future without it," Díaz warns. "It is not too late to act, but the window of opportunity is rapidly closing. What we do in the next few decades will be decisive."

Westoby, for his part, sees species as a precious legacy of the evolution of life on our planet which we must fight to preserve: "On average a species will have a million years of history; through all that time, each one has been solving problems that are somehow unique to it, so when you lose species it's like burning libraries or bulldozing important monuments. It's all of those things, only I would say more severe, because we're talking about the deep history of life on Earth. And we stand to lose really large proportions of species over the next 100 years."

Sandra Lavorel too likens biodiversity to "a library of life" that has come gravely under threat before we have even fully understood it: "We all know now that it is absolutely urgent that we reverse the current trend if we don't want to sink the boat that is our current Noah's Ark."

Laureate bio notes

Sandra Díaz (Bell Ville, Argentina, 1961) obtained her PhD from the Universidad Nacional de Córdoba (UNC), Argentina in 1984. In 1993, she joined the Instituto Multidisciplinario de Biología Vegetal (IMBIV), a joint center of the Argentine National Research Council (CONICET) and the Universidad Nacional de Córdoba, where she has risen to the top academic rank of Investigador Superior. She is also Professor of Community and Ecosystem Ecology at UNC, as well as holding a visiting professorship in the School of Geography and the Environment at the University of Oxford, and heading the international initiative Núcleo DiverSus on Diversity and Sustainability. Author of almost 200 scientific publications and nine books and reports, she is Associate Editor of *Proceedings of the Royal Society B*, and sits on the Board of Reviewing Editors of *Science* and the editorial boards of other scholarly journals. She has served in leading positions in international projects including the Intergovernmental Panel on Climate Change (IPCC), the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) and the UN's Millennium Ecosystem Assessment. In 2019, the magazine *Nature* chose her for the "Nature's 10" list of the people who helped shape science in that year.

Sandra Lavorel (Lyon, France, 1965) holds a degree in agronomic and biological sciences from

the Institut National Agronomique Paris-Grignon and a PhD in Ecology and Evolutionary Biology from the University of Montpellier (France). After completing a postdoctoral fellowship at the Australian National University, in 1994 she joined the French Centre National de la Recherche Scientifique (CNRS), where she is currently a Senior Research Scientist, leading a research group on "Dynamics of socio-ecosystems in a changing world" at the Laboratoire d'Ecologie Alpine (LECA) in Grenoble (France). She has contributed some 20 chapters to edited books, and published over 225 papers in international journals – notably "Plant Functional Types: Are We Getting Any Closer to the Holy Grail?" (2007) – as well as two authored books. Lavorel has been closely involved in numerous international initiatives, including the UN's Millennium Ecosystem Assessment and the European Commission's MAES/MESEU project for the assessment of ecosystem services across Europe's member states. Since 2013 she has chaired the Scientific Committee of the French National Ecosystems and Ecosystem Services Assessment, and in 2018 was elected onto the Multidisciplinary Expert Panel of the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).

Mark Westoby (Hayes, Middlesex, United Kingdom, 1947) earned a BSc in Ecological Sciences from the University of Edinburgh in 1970, before going on to complete a PhD in Wildlife Ecology at Utah State University (United States) in 1973. From 1970 to 1974, he worked first as a research assistant with the US/IBP Desert Biome Modelling Group then as a research associate at Cornell University. In 1975, he began his long association with Macquarie University (Australia), where he was appointed Emeritus Professor in 2017. From 2005 to 2016, he promoted and led the Macquarie University Genes to Geoscience Research Centre, working to develop a fusion between genomics, ecology, paleobiology and earth systems. Among his other distinctions, he was elected an honorary foreign member of the American Academy of Arts and Sciences in 2017, and named Scientist of the Year by the New South Wales Government in 2014. He has served actively on boards and committees, most recently as chair of the National Committee for Ecology, Evolution and Conservation of the Australian Academy of Sciences from 2013 to 2015. He is author of 317 published articles in international journals.

Ecology and Conservation Biology committee and evaluation support panel

The jury in this category was chaired by **Emily Bernhardt**, James B. Duke Professor in the Department of Biology at Duke University (United States). The secretary was **Pedro Jordano**,

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Research Professor in the Department of Integrative Ecology at the Estación Biológica de Doñana, CSIC (Spain). Remaining members were **Paul Brakefield**, Professor of Zoology and Emeritus Director of the University Museum of Zoology at the University of Cambridge (United Kingdom); **Anna-Liisa Laine**, Professor of Ecology in the Department of Evolutionary Biology and Environmental Studies at the University of Zurich (Switzerland); **Joanna Lambert**, Professor of Environmental Studies, Ecology and Evolutionary Biology at the University of Colorado Boulder (United States); and **Rik Leemans**, Professor in Environmental Systems Analysis at Wageningen University (the Netherlands).

The **evaluation support panel** of the **Spanish National Research Council (CSIC)** was coordinated by **M. Victoria Moreno**, Deputy Vice President for Scientific and Technical Areas, and formed by: **Xavier Bellés Ros**, research professor at the Institute of Evolutionary Biology (IBE); **Marta Coll Monton**, tenured scientist at the Institute of Marine Sciences (ICM); **Dolores González Pacanowska**, Coordinator of the Global Life Area and research professor at the López Neyra Institute of Parasitology and Biomedicine (IPBLN); **Anna Traveset Vilaginés**, research professor at the Mediterranean Institute for Advanced Studies (IMEDEA), and **Blas Valero Garcés**, Deputy Coordinator of the Global Life Area and research professor at the Pyrenean Institute of Ecology (IPE).

About the BBVA Foundation Frontiers of Knowledge Awards

The BBVA Foundation centers its activity on the promotion of world-class scientific research and cultural creation, and the encouragement of talent.

The BBVA Foundation Frontiers of Knowledge Awards, funded with 400,000 euros in each of their eight categories, recognize and reward contributions of singular impact in science, technology, social sciences and the humanities, privileging those that significantly expand the frontiers of the known world, open up new fields, or emerge from the interaction of various disciplinary areas. The goal of the awards, established in 2008, is to celebrate and promote the value of knowledge as a public good without frontiers, the best instrument at our command to take on the great global challenges of our time for the benefit of all humanity. Their eight categories are congruent with the knowledge map of the 21st century, ranging from basic science to key challenges for the natural environment by way of domains characterized by the overlap of disciplines – Biology and Medicine; Economics, Finance and Management – or the supremely creative realms of music and the opera.

www.frontiersofknowledgeawards-fbbva.es

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The BBVA Foundation has been aided in the evaluation of the 59 nominees for the Frontiers Award in Ecology and Conservation Biology by the Spanish National Research Council (CSIC), the country's premier public research organization. CSIC appoints evaluation support panels made up of leading experts in the corresponding knowledge area, who are charged with undertaking an initial assessment of the candidates proposed by numerous institutions across the world, and drawing up a reasoned shortlist for the consideration of the award committees. CSIC is also responsible for designating each committee's chair and participates in the selection of its members, thus helping to ensure objectivity in the recognition of innovation and scientific excellence.

Calendar of forthcoming announcement events

Information and Communication Technologies (ITC)	Wednesday, 10 February, 2021
Basic Sciences	Wednesday, 24 February, 2021
Economics, Finance and Management	Thursday, 4 March, 2021
Music and Opera	Wednesday, 10 March, 2021
Humanities and Social Sciences	Wednesday, 17 March, 2021

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