The fifth category to be decided in the sixth edition of these awards

Paul R. Ehrlich wins the Frontiers of Knowledge Award for demonstrating that interaction between organisms is the main driver of biodiversity generation

- He was the first to describe a case of co-evolution – between butterflies and plants – and how it may contrive to generate biological diversity
- Among his seminal contributions was to explain the dynamics and importance of the metapopulations resulting from habitat fragmentation
- In a recent study, he proposes ways to "intervene" in key ecosystem processes to ensure the continuation of service provision, as opposed to seeking to restore individual species in order to return to a "pristine" state

Madrid, February 4, 2014.- The BBVA Foundation Frontiers of Knowledge Award in the Ecology and Conservation Biology category goes in this sixth edition to entomologist Paul Ehrlich, Professor of Biology at Stanford University (United States), for having "contributed key conceptual advances in the science of ecology and conservation biology, with a long-standing influence in other academic disciplines," in the words of the jury's citation.

"His fundamental contributions to the field of ecology," the jury continues, "include pathbreaking concepts such as coevolution, metapopulation dynamics, ecosystem services, and the role of humans in ecological sustainability." These achievements draw equally on theoretical explorations and experimental results: "I am a biologist with a keen interest in theory, or a theorist who likes testing his theories by experimentation," remarked Ehrlich after hearing of the award.

The work of Paul R. Ehrlich (Philadelphia, United States, 1932) has been vital in addressing one of the key questions in ecology: why does our planet harbor so many different species? Ehrlich unlocked part of the secret in 1964, in a paper co-authored with Peter Raven and published in the journal *Evolution*. In it, they concluded that coevolution – the interactions occurring between different types of organisms without genetic exchange – is one of the main reasons for the

diversity of life on Earth, and proposed the mechanism whereby this process might lead to the immense variety of plant and insect species.

As the jury puts it: "Professor Ehrlich advanced the seminal idea that interactions of plants and herbivores coevolve and shape the evolutionary history of species, as an engine for species diversity."

Ehrlich's vocation was born at the age of ten chasing butterflies at summer camp. His growing interest for wildlife led him to study zoology at the University of Pennsylvania (1953) and, from there, to obtain a PhD at the University of Kansas with the famed U.S. entomologist Charles Duncan Michener. During his time at Kansas, he took part in insect surveys on the Bering Sea and in the Arctic circle. And it was there he met a young biologist, Anne Fitzhugh Howland, who became his wife in 1954.

After earning his doctorate, Ehrlich joined the faculty at Stanford University, where he was appointed Professor of Biological Sciences in 1966. It was at this stage that butterflies re-entered his life. On the way back from a field trip, he remarked to a colleague, Peter Raven, how surprised he was at the diet patterns of the species they were both studying. "From that point on, it was a matter of brainstorming between two evolutionists, one with much experience in butterflies and the other with plants," Ehrlich recalls.

This coffee-table conversation was the seed of an article titled *Butterflies and Plants: A Study in Coevolution*, which discussed, for the first time, the "huge importance of plant-herbivore interactions in the generation of terrestrial diversity." Long considered one of the most influential texts in evolutionary ecology, it has spawned dozens of books and thousands of papers over the intervening decades. The ecological weight of coevolution was until then literally an unknown quantity.

"We did the work with a rising sense of excitement, as we suspected that coevolution was generally an underrated process (…). I believe that our paper has been so widely cited because it provided for the first time a detailed discussion of the evolutionary relationships between two large, ecologically intimate groups of organisms," the new laureate reflects.

What they came up with was the first description of coevolution in action: how butterflies generate enzymes that allow them to digest the toxins defensively produced by plants.

The search for the origins of biodiversity in coevolution was framed by a wider-ranging research enterprise as part of which Ehrlich, back in the 1960s, had set up a series of experimental installations in Stanford's biology preserve at Jasper Ridge – installations that still operate today, and have supported one of the world's longest-running ecological studies. The jury emphasized the novel, pioneering nature of this long-term data gathering methodology, and the value of its findings.

Ehrlich's own data gathering on checkerspot butterflies also showed how populations react on becoming fragmented into the smaller but still connected groups known as metapopulations: looking, for instance, at whether gene flows are conserved, whether species become more vulnerable to changes in their environment, or suffer an increased risk of extinction. One of his conclusions is that "metapopulations make species more resilient, because if one group dies out, another can colonize the space left vacant."

This information is vital to understand how ecosystems respond to the increasingly present threat of habitat fragmentation, with implications in such diverse areas as the control of insect plagues, prediction of climate change responses, and the optimal design of nature reserves.

Ehrlich, the citation adds, "used experimental, long-term studies to document wide-ranging patterns of population dynamics and genetic structure, and the factors regulating them. Working with butterflies as model organisms, he disentangled the role of climate and ecological interactions as drivers of population dynamics. This study was pathbreaking for research on metapopulation dynamics, extinction risk, and colonization-extinction dynamics."

The Ecology and Conservation Biology laureate explains why this concept is so central: "It shows that the focus of research into biodiversity decline should be population loss rather than species loss, since it is populations that deliver ecosystem services." The jury, in effect, singles out Ehrlich's role in developing the concept of ecosystem services, which makes explicit society's reliance on natural processes that provide us with direct or indirect benefits – crop pollination by insects, water purification, protection against erosion, food supply, etc.

His research has also been instrumental in quantifying the impact on nature of human activity, and refining the concept of sustainability. One of his most cited papers, published in *BioScience* in 1986, was the first to analyze what proportion of net primary productivity is destroyed or coopted by humanity. Primary productivity is the biomass generated by photosynthesizing organisms, the only ones capable of adding energy to the Earth's life cycle by converting sunlight and carbon dioxide into organic matter. Research done by Ehrlich and his team reveals that human beings consume around 40% of this resource.

The award citation remarks in this regard; "His work revealed the unexpectedly large proportion of net primary productivity and Earth's freshwater supply being destroyed or used by humanity."

Pedro Jordano, the jury secretary, singles out a recent contribution in a 2011 paper, where Ehrlich advocates intervention ecology in place of the ecology of restoration: "Rather than focusing on recovering a particular species, the idea is to understand and then leverage interaction processes that allow to maintain the species and ecological functions essential for ecosystem survival."

Ehrlich enlarges on the argument: "Restoration is still being used and that's fine for specific cases like for example, the aftermath of a fire, where the goal is to turn the clock back to just before it happened. In general, though, when we intervene

in an ecosystem, we should decide what point in the past we want to return to, and not try to recreate a pristine state." The solution, he contends, is to decide what ecosystem services we are aiming for, and only then go on to decide the form of the intervention.

The BBVA Foundation Frontiers of Knowledge Awards

The BBVA Foundation promotes, funds and disseminates world-class scientific research and artistic creation, in the conviction that science, culture and knowledge in its broadest sense hold the key to a better future for people. The Foundation designs and implements its programs in partnership with leading scientific and cultural organizations in Spain and abroad, seeking to identify and prioritize those projects with the power to move forward the frontiers of the known world.

The Foundation established its Frontiers of Knowledge Awards in 2008 to recognize the authors of outstanding contributions and radical advances in a broad range of scientific and technological areas congruent with the knowledge map of the late 20th and 21st centuries, and others that address central challenges, such as climate change and development cooperation, deserving of greater visibility and recognition. Their **eight categories** include classical areas like *Basic Sciences (Physics, Chemistry and Mathematics)* and *Biomedicine*, and other, more recent areas characteristic of our time, ranging from *Information and Communication Technologies*, *Ecology and Conservation Biology, Climate Change* and *Economics, Finance and Management* to *Development Cooperation* and the innovative realm of artistic creation that is *Contemporary Music*.

The **juries** in each category are made up of leading international experts in their respective fields, whose involvement endorses the rigor of the awards and has indeed been instrumental in consolidating their prestige. The BBVA Foundation is aided in the organization of the awards by the **Spanish National Research Council (CSIC)**, the country's premier multidisciplinary research organization. As well as proposing each jury chair, the CSIC is responsible for appointing the Technical Evaluation Committees that undertake an initial assessment of candidates and draw up a reasoned shortlist for the consideration of the juries.

In the Ecology and Conservation Biology category, Committee members were Xavier Querol, CSIC research professor in the Institute of Environmental Assessment and Water Research; Rafael Simó, CSIC research scientist in the Institute of Marine Sciences; Fernando Valladares, CSIC research professor in the National Museum of Natural Sciences; and Daniel Oró de Rivas, CSIC research professor in the Mediterranean Institute for Advanced Studies (IMEDEA), a joint center of CSIC and the University of the Balearic Islands.

Ecology and Conservation Biology jury

The jury in this category was chaired by **Daniel Pauly,** Professor of Fisheries at the University of British Columbia Fisheries Centre (Canada) and Principal Investigator on the *Sea Around Us* project, with **Pedro Jordano,** research professor in the Integrative Ecology Department at Estación Biológica de Doñana, CSIC (Sevilla, Spain), acting as secretary. Remaining members were **Joanna Burger,** Distinguished Professor of Biology at Rutgers University (United States); **Jordi Bascompte**, research professor in the Integrative Ecology Department of Estación Biológica de Doñana (CSIC); and **Gerardo Ceballos,** professor in the Wildlife Ecology and Conservation Laboratory of the Instituto de Ecología, Universidad Nacional Autónoma de México (Mexico).

Previous laureates

Last year's winner in this category was **Jane Lubchenco**, "for her leadership in establishing marine reserves based on solid principles of ecological science." The award in the fourth edition went to **Daniel H. Janzen** "for his pioneering work in tropical ecology and the conservation of tropical ecosystems." Preceding him were **Edward O. Wilson**, who took the award "for coining and popularizing the term biodiversity," and, in the second edition, **Peter Reich** of the University of Minnesota (United States) "for work that radically improves our understanding of and ability to predict terrestrial ecosystem compositional and functional responses to global environmental change, including climate change (…) and biodiversity loss." Finally, the award in the inaugural edition was shared by biologists **Thomas Lovejoy** and **William Laurance** of the Smithsonian Institute (United States), whose studies showed that the degradation of the Amazon rainforest is advancing much faster than predicted.

UPCOMING AWARD ANNOUNCEMENTS

CATEGORY	DATE
Contemporary Music	February 11, 2014
Economics, Finance and Management	February 18, 2014
Development Cooperation	February 25, 2014

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For more information, contact the BBVA Foundation Communications Department (+34 91 374 5210/+34 91 537 3769, comunicacion@fbbva.es) or visit www.fbbva.es