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Observational natural history and morphological taxonomy are indispensable for future challenges in biodiversity and conservation

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Global biodiversity is rapidly declining, leading inevitably to a loss of ecosystem functionality when species and their associated life-history traits vanish. Unfortunately, even in the 21st century, a large proportion of Earth's species are yet unknown and also for most described species science lacks a deeper understanding of the functional role of species and thus of ecosystems. In this Addendum we use the recent discovery of a new spider wasp with a unique natural history as an example to emphasize the importance to conduct basic observational natural history and traditional taxonomic research. We aim to encourage such 'old-fashioned' research and biologists from various research fields to report the many fascinating phenomena holding valuable natural history information they may encounter. Such detailed knowledge on species, their life-history traits, and their trophic interactions will be crucial to reliably address the challenges global change brings to the persistence of ecosystems.

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Biodiversity on Earth is facing numerous threats, most prominently by a large-scale exploitation of natural habitats to fulfill the resource demands of an exponentially growing human population.[1] Species extinction rates have reached alarming levels and this situation is predicted to persist throughout the 21st century.[2,3] As ecosystem functioning is closely intertwined with biodiversity,[4,5] the impact of such extinction rates are even more dreadful. While species extinctions should be avoided for ethical reasons alone, the loss of species also increases the risk of losing morphological and behavioral trait characteristics of communities, thus affecting the functionality of ecosystems.

Unfortunately, the most endangered ecosystems which are under the highest land-use pressure harbor globally the highest number of undescribed species.[6,7] As there is evidence that a sixth mass extinction on is already under way,[8] it is inevitable that species have gone and will go extinct together with their unique trait characteristics, some of them even before they are known to science. Famous examples for this are the Moa, an order of large flightless birds that vanished very shortly after the arrival of the first humans on New Zealand.[9] However, extinction before scientific recognition is certainly not restricted to conspicuous megafauna.[10]

Fortunately, we are living in the age of biodiversity discovery and never before in the history of science have new species been described at higher rates.[11] These findings contradict the widespread claims of a current 'taxonomy crisis' (see e.g. ref. [12]). Despite the 'dusty' reputation[13] and the, in some parts of the scientific community, low valuation of natural history and taxonomy research (see ref. [14]), there have been approximately 20,000 new species descriptions per year since 2009, raising the number of formally described species to almost 2 million.[15] DNA-based approaches, including DNA taxonomy,[16] DNA barcoding,[17] and integrative taxonomy[18,19] complement and speed up the discovery rates of new species.

In a recent paper,[20] we described a new species of spider wasp which shows a striking nesting behavior: *Deuteragenia* *ossarium* Ohl, 2014, protects uniquely in the entire animal kingdom its own progeny by a nest-closing chamber filled with dead ants. This discovery was fascinating but totally unexpected; actually we were, as part of a large Chinese-German research cooperation (www.bef-china.de, see ref. [21]), conducting a study to disentangle the effects of tree diversity on insect communities. Doing so, we collected solitary cavity-nesting Hymenoptera with trap nests,[22] in which we found the new species among several other, mostly described bee and wasp species. Thus we see our study as an example for the importance to report on-the-side observations that may frequently occur during larger studies. We urge biologists, in particular graduate students who usually do most of the basic research, to share and publish the intriguing phenomena they may encounter. Otherwise many fascinating aspects of species' biology will never get publicly known.

We would also like to highlight that *D. ossarium* and its unique life-history were only discovered by conducting a detailed observational study. Even in the 21st century, in the time of high-technology science, for most plant and animal species barely more than the name and the type locality is known, showing the urgent need for basic natural history studies. Moreover, many new species are described without knowing any associated information and most of them only decades after the initial collection.[23] In our case, crucial aspects of the life-history of *D. ossarium*, namely the very low susceptibility to parasitism and that the species, despite being a spider-hunting wasp, is possibly a significant predator of the most abundant ant species in its range, would have stayed unnoticed if we had only detected the species by molecular methods or if we had only described the species morphologically. Our discovery demonstrates that molecular methods to identify new species can, if part of an integrative holistic taxonomic approach,[18,19] complement but not displace classical observations, as the complete natural history of a species will only be caught by detailed observational and experimental research.[13,24]

We realize and understand that, due to the limited availability of funding and manpower, it will only for a minority of species be possible to conduct natural history studies. For most species, the life-history, the functional roles in an ecosystem, and the trophic interactions will likely ever stay unknown or obscure. This is particularly true for invertebrates, which account for the largest part of animal biodiversity and biomass[25] and which are indispensable for ecosystem functioning and services.[26,27] We are convinced that there are very many functionally important life-history traits yet unknown across the tree of life, both in already known species and in species awaiting discovery and description. Knowledge on these species and their traits will be necessary to reliably assess the functionality of single species and consequently of the ecosystems the species life in. Accurate and holistic data on species, traits, and communities will be vitally important to predict responses of species and ecosystems to global change,[28] to develop effective conservation schemes, and to preserve critical ecosystem functions that depend to a high degree on biodiversity.[4,5] We emphasize that our proposal for taxonomy and natural history studies is not restricted to pristine habitats. Our discovery[20] has been made in South-East China, a region where the original species-rich subtropical forests are under high land-use pressure and have largely been converted to agricultural land or forestry monocultures.[29,30] Thus it is very likely that in this region several species have gone extinct together with their unique life history, behavior and morphology long before they were observed, recognized or analyzed.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

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