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.

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. 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, 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 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...
osarium Ohl, 2014, protects uniquely in the entire animal kingdom its own prog- eny 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 disen- tangle the effects of tree diversity on insect communities. Doing so, we collected soli- tary 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 impor- tance 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 publi- cally known.

We would also like to highlight that D. osarium and its unique life-history were only discovered by conducting a detailed observational study. Even in the 21st cen- tury, in the time of high-technology sci- ence, 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 informa- tion and most of them only decades after the initial collection. 23 In our case, crucial aspects of the life-history of D. osarium, namely the very low susceptibility to para- sitism and that the species, despite being a predator of the most abundant ant species if part of an integrative holistic taxo- nomic 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-his- tory, the functional roles in an ecosystem, and the trophic interactions will likely ever stay unknown or obscure. This is par- ticularly true for invertebrates, which account for the largest part of animal bio- diversity and biomass 25 and which are indispensable for ecosystem functioning and services. 26,27 We are convinced that there are very many functionally impor- tant life-history traits yet unknown across the tree of life, both in already known spe- cies 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 bio- diversity. 4,5 We emphasize that our proposal for taxonomy and natural history studies is not restricted to pristine habi- tats. 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 spe- cies have gone extinct together with their unique life history, behavior and mor- phology long before they were observed, recognized or analyzed.

Disclosure of Potential Conflicts of Interest

No potential conflicts of interest were disclosed.

Acknowledgments

We thank the Editor in Chief, Franti- šek Baluška, for his invitation and encour- age ment to write this addendum. We also thank Tamar Marcus and David Walms- ley for stimulating discussions and for proof-reading an earlier version of the manuscript. The original work on which this addendum is based on was part of the ‘Biodiversity-Ecosystem Functioning China Project’ (BEF-China) funded by the German Research Foundation (DFG; grants FOR 891/2, KL 1849/6-1).

References

1. McKee JK, Sciulli PW, Foose CD, Waite TA. Forecasting global biodiversity threats associated with human population growth. Biol Conserv 2004; 115:161-4; http://dx.doi.org/10.1016/j.biocon.2003.09.009-5
2. Butchert SHM, Walpole M, Collen B, van Strien A, Schärmann JPW, Almond REA, Baille JEM, Bomb- hard B, Brown C, Bruno J, et al. Global biodiversity: Indicators of recent declines. Science 2010; 328: 1164-8; PMID:20430971; http://dx.doi.org/10.1126/ science.1187512
3. Pereira HM, Leadley PW, Proença V, Alkemade R, Schärmann JPW, Fernandez-Manjarrès JF, Araujo MB, Balvanera P, Biggs R, Cheung WY, et al. Scenarios for global biodiversity in the 21st century. Sci- ence 2010; 330:1496-501; PMID:20978282; http://dx. doi.org/10.1126/science.1196624
4. Balvanera P, Pfisterer AB, Buchmann N, He JS, Naka- shinzuka T, Raffaelli D, Schmid B. Quantifying the evi- dence for biodiversity effects on ecosystem functioning and services. Ecol Lett 2006; 9:1146-56; PMID:16972878; http://dx.doi.org/10.1111/j.1461- 2028.2006.00961.x
5. Cardinale BJ, Duffy JE, Gonzalez A, Hooper DU, Per- rings C, Venail P, Narwani A, Mace GM, Tilman D, Wardle DA, et al. Biodiversity loss and its impact on humanity. Nature 2012; 486:59-67; PMID:22678280; http://dx.doi.org/10.1038/nature11148
6. Joppa LN, Roberts DL, Myers N, Pimm SL. Biodiver- sity hotspots house most undiscovered plant species. Proc Natl Acad Sci U S A 2011; 108:13171-6; PMID:21730155; http://dx.doi.org/10.1073/pnas. 1109389108
7. Guénard B, Weiser MD, Dunn RR. Global models of ant diversity suggest regions where new discoveries are most likely are under disproportionate deforestation threats. Proc Natl Acad Sci U S A 2012; 109:7568-73; PMID:22522935; http://dx.doi.org/10.1073/pnas. 1113867109
8. Barnosky AD, Matzke N, Tomiya S, Wogan GO, Swartz B, Quental TB, Marshall C, McGuire JL, Lind- sey EL, Maguire KC, et al. Has the Earth’s sixth mass extinction already arrived? Nature 2011; 471:517-1; PMID:21366823; http://dx.doi.org/10.1038/ nature09678
9. Holdaway RN, Jacomb C. Rapid extinction of the Moa (Aves: Dinornithiformes): Model, test, and impli- cations. Science 2000; 287:2250-4; PMID:10751144; http://dx.doi.org/10.1126/science.287.5461.2250
10. Richling I, Boucher P. Extinct even before scientific rec- ognition: A remarkable radiation of heliconid snails (Heliconiidae) on the Gambier Islands, French Polynes- sia. Biodivers Conserv 2013; 22:2433-68; http://dx.doi. org/10.1007/s10531-013-0496-2
11. Costello MJ, May RM, Stork NE. Can we name Earth’s species before they go extinct? Science 2013; 339:613-6; PMID:23349283; http://dx.doi.org/10.1126/ science.1230181
12. Agnarsson I, Kunter N. Taxonomy in a changing world. Seeking solutions for a science in crisis. Syst Biol 2007; 56:531-9; PMID:17562477; http://dx.doi. org/10.1080/10635150701424546
13. Echir MC, Holderegger C. More taxonomy, not DNA barcoding. Bio Sci 2005; 55:822-3; http://dx.doi.org/10.14400/0066-3568(2005)055[0823:MTND8]2.0. CO2
14. Wägele H, Klaussmann-Kolb A, Kuhlmann M, Hasz- prunar G, Lindberg D, Koch A, Wägele JW. The taxon- onomist - an endangered race. A practical proposal for
15. ISEE. State of observed species. Tempe, AZ, U S A: International Institute for Species Exploration 2011; retrieved 22.09.2014; http://timgostony.com/iise temp/

16. Tautz D, Arctander P, Minelli A, Thomas RH, Vogler AP. A plea for DNA taxonomy. Trends Ecol Evol 2003; 18:70-4; http://dx.doi.org/10.1016/S0169-5347(02)00041-1

17. Hebert P DN, Cywinska A, Ball SL, DeWard JR. Biological identifications through DNA barcodes. Proc R Soc B 2003; 270:313-21; PMID:12614582; http://dx.doi.org/10.1098/rspb.2002.2218

18. Dayrat B. Towards integrative taxonomy. Biol J Linnean Soc 2005; 85:407-15; http://dx.doi.org/10.1111/j.1095-8312.2005.00503.x

19. Challenges for Taxonomic Research Working Group. Challenges for taxonomic research in the age of ‘omics’ technologies. Halle/Saale, Germany: Leopoldina National Akademie der Wissenschaften, 2014; retrieved 22.09.2014; http://www.leopoldina.org/en/policy-advice/working-groups/completed-working-groups/challenges-for-taxonomic-research/

20. Staab M, Ohl M, Zhu CD, Klein AM. A unique nest-protection strategy in a new species of spider wasp. PLoS One 2014; 9:e101592; PMID:24987876; http://dx.doi.org/10.1371/journal.pone.0101592

21. Bruehlside H, Böhneke M, Both S, Fang T, Assmann T, Barufollo M, Basalus J, Busch F, Chen W, Ding BY, et al. Community assembly during secondary forest succession in a Chinese subtropical forest. Ecol Monogr 2011; 81:25-41; http://dx.doi.org/10.1890/09-2172.1

22. Tischmäcker T, Gathmann A, Steffen-Dewenter I. Bioindication using trap-nesting bees and wasps and their natural enemies: community structure and interactions. J Appl Ecol 1998; 35:708-19; http://dx.doi.org/10.1046/j.1365-2664.1998.35343.x

23. Fontaine R, Ferrard A, Bouchet F. 21 years of shelf life between discovery and description of new species. Curr Biol 2012; 22:943-4; PMID:23174292; http://dx.doi.org/10.1016/j.cub.2012.10.029

24. Ebach MC, Holderegger R. DNA barcoding is no substitute for taxonomy. Nature 2005; 434:697; PMID:15815602; http://dx.doi.org/10.1038/434697b

25. Wilson EO. The little things that run the world. Conserv Biol 1987; 1:344-6; http://dx.doi.org/10.1111/j.1523-1739.1987.tb00055.x

26. Folgarait PJ. Ant biodiversity and its relationship to ecosystem functioning: a review. Biodivers Conserv 1998; 7:1221-44; http://dx.doi.org/10.1023/A:1008891901953

27. Losey JE, Vaughan M. The economic value of ecological services provided by insects. Bio Sci 2006; 56:311-23; http://dx.doi.org/10.1641/0006-3568(2006)56[311:teves]2.0.co;2

28. Calih AE, Aello-Lammens ME, Fisher-Reid MC, Hua X, Karazensky CJ, Ryu HY, Shigai GC, Spagnolo F, Waldron JR, Warsi O, et al. How does climate change cause extinction? Proc R Soc B 2013; 280:20121890; PMID:23075836; http://dx.doi.org/10.1098/rspb.2012.1890

29. Lopez-Pujol J, Zhang FM, Ge S. Plant biodiversity in China: Richly varied, endangered, and in need of conservation. Biodivers Conserv 2006; 15:3983-4026; http://dx.doi.org/10.1007/s10531-005-3015-2

30. Hansen MC, Potapov PV, Moore R, Hancher M, Turubanova SA, Tyukavina A, Thau D, Stehman SV, Goetz SJ, Loveland TR, et al. High-resolution global maps of 21st-century forest cover change. Science 2013; 342:850-3; PMID:24235722; http://dx.doi.org/10.1126/science.1244693