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OBITUARY

Looking to the future of soil biodiversity: the legacy of Diana Wall

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Diana Harrison Wall passed away on 25 March 2024 in Fort Collins, CO, USA, her home for more than 25 years and where she was the Director of the School of Global Environmental Sustainability (SoGES) and Distinguished Professor of Biology at Colorado State University (CSU) after having been faculty at the Natural Resource Ecology Laboratory (NREL) there for more than a decade. While Diana was to become respected globally for her work in soil ecology, soil biodiversity, and sustainability science, she began her career as a nematologist, receiving her PhD from the University of Kentucky-Lexington in plant pathology. When faced with the challenges of being a woman scientist in a male-dominated era, Diana blazed trails. Undoubtedly, her early-career years were formative. The meticulousness and focus she honed-in her science during these early years extended to the expectations she held for her mentees, and in her approach to leadership as she progressed in her career. Those of us who were mentored by Diana wish to honor her and her legacy by providing a glimpse of not only her research and achievements, but what lessons she left us, her mentees, to carry with us through our careers and lives. Those of us who were close collaborators and co-editors wish to honor Diana's exemplary approach to science, forward-looking approach, and impact on the science community as a whole.

Big thinking

To say that Diana was eminent is an understatement. Among the many honors for her work in the Antarctic, she received the Medal for Excellence in Antarctic Research by the Scientific Committee on Antarctic Research (SCAR) in 2012, the Tyler Prize for Environmental Achievement in 2013, the Ulysses Medal from University College Dublin, Ireland, in 2015, and she was elected as

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a member of the National Academy of Science (USA) in 2018. In 2005, Wall Valley, Antarctica (77°29°S, 160°51°E; Fig. 1) was named after her by the U.S and New Zealand Advisory Committees on Antarctic Names in honor of her work in the McMurdo Dry Valleys. She served as the President of numerous professional societies – the Ecological Society of America (1999), the Society of Nematologists (1983), and many more. She was the chair of the NAS Polar Research Board from 2020-2023 and served as a member of many advisory committees including, at the time of her passing, the German Centre for Integrative Biodiversity Research (iDiv) since 2019, the Revitalization of Informal Settlements and their Environments (RISE) at Monash University in Melbourne Australia. Since 2011, Diana was the Science Chair of the Global Soil Biodiversity Initiative (GSBI, www.globalsoilbiodiversity.org). Developed by her and a core group of colleagues including Richard Bardgett (University of Manchester, UK), Luca Montanarella (Joint Research Centre, ESDAC), Wim van der Putten (NIOO, The Netherlands), and Johan Six (ETH Zurich), among others, the GSBI promotes the importance of soil biodiversity science in policy development. The GSBI continues to unite researchers, educators, and policymakers in an effort to raise awareness of and protections for biodiversity in soil and the critical ecosystem functions driven by this largely unseen life. This influential effort has inspired and guided many other international organizations and groups including the Soil Biodiversity Observation Network (Soil BON; Guerra et al. 2021a, b) of GEOBON, the Society for Protection of Underground Networks (SPUN; Popkin 2022, Kiers & Tercek 2022), the UN-FAO Global Soil Partnership's Global Soil Biodiversity Observatory (GLOSOB) and its research body, the Global Soil Biodiversity Network (NETSOB), and the Global Initiative of Crop Microbiome and Sustainable Agriculture (Australia), to name a few. Many of these like-minded groups leaned on Diana for guidance through their development and operation.

As we reflect on our loss of Diana and the profound impact she had on us, while proud of her own accomplishments, Diana was always happier in hearing about the successes of her students and the early-career researchers pursuing 'hot' new soil biodiversity science than being lauded herself. She strove to acknowledge that work publicly and elevate emerging scientists. Diana knew the power of a formal thank you, both to genuinely acknowledge the work someone did, and to share directly with that person's supervisor. It was always her hope these communications showed-up in tenure and

Figure 1. Photograph of Wall Valley, Antarctica, 77°29°S, 160°51°E. Photo by Byron Adams, 2011. Made available under the Creative Commons Attribution-Share Alike 3.0 Unported license.

promotion packages. Some of Diana's greatest impact was as a mentor and career advocate across the globe.

Mentoring across the globe

Diana's achievements are only one aspect of her influence across the globe. She never let her achievements overshadow her focus on helping her students and mentees have opportunities to be successful in their own ways and specific interests. As a university professor with projects and grants apart from all her voluntary international ecology, soil biodiversity, and policy efforts, Diana also advised 23 postdoctoral researchers since 1991, 14 graduate students since 1996, and 7 undergraduates. For those of us who knew and worked with her, especially as postdocs, Diana inspired us to be something greater through her uncompromising vision, no-nonsense approach to our training, and commitment to sustainability and soil biodiversity science. Diana encouraged us to think bigger, refusing to be confined by borders, whether geographical or within disciplines. She had an infectious enthusiasm for science, exploring the unknown, pushing the envelope, and a particular love of nematodes that was impossible to ignore. This has influenced many of our careers as we set up our own labs, establish our research programs, and forge our own path.

Diana was a force in elevating junior scientists by welcoming and promoting their individual perspectives and talents. We often witnessed the extra prestige and influence brought in with each new high-profile achievement of hers being quickly and consciously set aside in her efforts to elevate the work and ideas of her early-career colleagues. To many of us, and particularly those coming from underrepresented groups in STEM (Science, Technology, Engineering, Mathematics), this meant an unfamiliar sense of belonging, intellectual assurance, and tremendous encouragement to pursue career pathways in science, even non-traditional ones.

Diana held herself to the same high standard to which she held her mentees. Among many other examples, Diana was meticulous in what many others would consider 'small things' in writing and, especially, online media communications. Fonts, font style, specific wording, images, links, visual balance, and diction were all things she scrutinized and taught us to become adept at. Proposals, manuscripts, biographies, newsletters, blogs - all examined and edited with a fastidious eye. There was always room for improving what you presented. It was high praise when she let slip that you were a good writer.

By example, Diana taught mentees to be generous with our students and the opportunities for them to grow. Diana was conscious about forwarding you as the expert when she was contacted about, for example, speaking about soil biodiversity, writing a report, or with the GSBI. She sought opportunities for mentees to have formal training in 'soft skills' and presenting science in media and policy forums. Diana spoke about how she was not taught those skills in her early career and that participating in the Leopold Leadership Program at The Stanford Woods Institute for the Environment trained her to develop the skills to speak about science to non-scientists with an eye on policy. It was her vision for others to gain those skills early in their career. She did this at Colorado State University by developing the Sustainability Leadership Fellows program organized though the School of Global Environmental Sustainability, where she was Director. The program leveraged experts in science communication, journalism, policy, grant-writing, time management, and collaboration to build graduate students and postdocs into well-rounded experts who could bring their work, and maybe their careers, out of the proverbial Ivory Tower. It was real foresight on her part to see the value in bringing early-career academics from different disciplines together through these trainings to also develop cross-disciplinary communication and networks. For these Fellows, this training is noticed by current colleagues who see the difference in not only how we do our work, but in how we share that work. She not only stimulated mentees to consider the potential impact of jobs and career pathways beyond the traditional boundaries of academia, but also actively equipped us to achieve them. Some of us have fresh memories of the 1:1 annual review meetings where the order of business was to critically assess our CVs, find gaps in training and professional experiences, and develop a workplan to fill those in and clear the path to our dream jobs.

Her influence on us came from her ability to think big about the research and its scope, but also to see the importance of everyday actions and interactions such as collegial relationships, consistency in words and deeds, and believing in oneself. For us, Diana's legacy is the experience and skills she gave us the opportunity to acquire. More than this, Diana mentored with a unique brand of worldview – one of creating connections and how to communicate and conduct yourself in that world – a world of working to provide equal opportunity and diversity in representation.

A vision for sustainability – an aspiration for soil biodiversity

Diana was renowned by the international scientific community for her work in science policy and soil

biodiversity (Fig. 2). Toward the end of her career, Diana was excited and proud to be a part of the research of her students – in particular, drought effects on soil biodiversity, soils in the aerobiome, and climate change effects on sustainability in soil health were held high in her mind. As the Director of SoGES, she fought for and maintained a seat at the table in the Colorado political community as well as at CSU. Under her leadership, the community of faculty funded through the Resident Fellows program grew and allowed for collaborative, transdisciplinary research between faculty across CSU to solve issues of sustainability. Her personal research in Antarctica highlighted the issues of climate change happening across the globe, emphasizing the impact at the poles. Those that were fortunate enough to spend time with her in Antarctica, saw Diana in her element in the field and lab, working with long-time colleagues who were pioneers in studying climate change in the McMurdo Dry Valleys and training the next generation scientists.

Internationally, Diana collaborated with others who were examining the influence of increased weather extremes on soils, agriculture, and human health, yet had little voice or proof of all the changes occurring in soils and with soil life, hence the establishment of the GSBI. Diana knew from the beginning that the strength of the GSBI was from its members and began a global effort to recruit members from any discipline, region, nationality, profession, and gender to join in the flight to put solid science in front of policy makers, government officials, and international organizations to show how much humans rely on the life in soil for survival.

Diana and the GSBI Executive Director encouraged the soil biodiversity science community to be a community of communicators who published and presented everywhere in the world highlighting that the crisis of biodiversity loss was a crisis of soil biodiversity loss as well. In addition to the regular online communication in GSBI (e.g. talks, discussions, newsletters, calls), the GSBI conference emerged as one of the 'must-attend'

Figure 2. (**A**) Diana Wall speaking at the 20th World Congress of Soil Science in S. Korea in 2014. Photo credit Kelly Ramirez. (**B**) Diana with colleagues at the World Biodiversity Forum in Davos, Switzerland, 2022; l. to r. Franciska DeVries, Marcel G. A. Van der Heijden, S. Franz Bender, Anton Potapov, Wall, Stefan Geisen, Carlos A. Guerra, and Nico Eisenhauer. Photo credit Nico Eisenhauer. (**C**) Diana with some of the founding members of the Global Soil Biodiversity Initiative (GBSI) at the Third Global Soil Biodiversity Conference in Dublin, Ireland in March 2023; l. to r. Fredrick O. Ayuke, Wim van der Putten, Wall, Ciro Gardi, Richard Bardgett. Photo credit Monica Farfan. (**D**) Diana speaking at the World Biodiversity Forum in Davos, Switzerland, 2022. Photo credit Nico Eisenhauer.

events in soil ecology. Many have communicated over the years that they assumed that the GSBI inhabited a large building with a medium-sized staff based on the omnipresence and communication level of the GSBI secretariat. This was all an outcome of the enthusiasm and unrelenting dedication to forwarding the science in environmental policy. Diana was staunch in her resolve that the GSBI remains independent from any other organization over the years who may have wished to provide funding, realizing that this compromised the efforts of the GSBI as an independent, scientific body that provides information and forwards experts unburdened from outside influence.

One project that deserves special attention as a subject of pride for Diana is the leadership and involvement of her lab in the global monitoring effort, the Soil Biodiversity Observation Network (Soil BON). As a co-leader, with Carlos Guerra (University of Coimbra, Portugal) and Nico Eisenhauer (iDiv and Leipzig University, Germany) of the project until her passing, Diana helped to grow the involvement of researchers in the United States and to serve in an advisory capacity as well as help implement certain protocols related to soil organisms. Diana's commitment to Soil BON was the result of her dedication to the idea of global monitoring as the key to inclusion in soil biodiversity science and to providing policy makers with the information about the decline of soil health and the life in soil to develop effective environmental policy. Until her passing, the involvement of the Wall Lab as a partner in the nematode community analysis for Soil BON was a priority for her and continues to be a legacy of her influence on the global community involved in this first major monitoring effort. In addition to such lab and coordination work, Diana also contributed as a key ambassador of Soil BON's idea in political and scientific events.

'I want to hear from you all.'

Diana never lost sight of what she thought was critical: creating change by promoting soil biodiversity science; 'thinking big' to influence policy and those who develop it; and encouraging and including early-career researchers from lesser-represented regions and backgrounds.

In preparing our reflections, we thought it important to consider what Diana herself would be excited to read about; what we learned from her and what we learned about ourselves in the process. To do this, we went back to a personal recording one of us made of Diana's last talk to a global audience, her speech at the Third Global Soil Biodiversity Conference held in Dublin, Ireland in March 2023. Always cognizant of the audience members new to the messages of the GSBI, she emphasized the need for an independent, scientific effort dedicated solely to advancing ideas from innovative and ground-breaking soil biodiversity research. She spoke of maintaining a hard-fought 'seat at the table' with international organizations and intergovernmental bodies to have soil health recognized as a component of sustainable development and soil biodiversity recognized as worthy of protection.

At the end of her speech, Diana tells the audience, 'Now, we want to hear from you all.' Her excitement about new scientific collaborations, new techniques, and new ways of examining the ecological impacts of soil life was ever-growing. It is this excitement that drove Diana's work – it is this energy and ground-breaking consideration of soil biodiversity as a critical resource for humans and the environment that we, her students, mentees, postdocs, and colleagues seek to honor and continue. Along with all her awards and career accomplishments, one of her greatest legacies will be what she left behind in all of us.

Diana at Soil Organisms

Along with her versatile contributions to soil biodiversity science and policy, we are grateful Diana also chose to be a member of the editorial board and a scientific and strategic advisor of Soil Organisms. The idea of fair open-access publishing without any publication fees facilitating the contributions and participation of soil ecologists from around the world (Eisenhauer & Xylander 2019, Potapov et al. 2023) reflected Diana's approach to inclusivity in science and her commitment to forming a global research community. The journal now wishes to honor and celebrate Diana's legacy in soil biodiversity research and policy by introducing a new paper format specifically dedicated to broad and forward-looking perspectives: the Wall Review. Wall Reviews are commissioned by the Editors-in-Chief, but we also welcome ideas and pre-submission inquiries. In contrast to normal Reviews, Wall Reviews should focus on promising ideas, novel hypotheses, future research frontiers in soil ecology, or respective policy implications. We encourage diverse contributions from around the world and from all disciplines related to soil ecology, emphasizing contributions led by those underrepresented in science, especially women. In Diana's memory at Soil Organisms, we now say: '*We want to hear from you all.*'

For more words from Diana, please see Wall (2007), Wall et al. (2015), and Sala et al. (2000), and her messages in social and news media:

- American Association for the Advancement of Science Tyler Prize Laureate video (2013): https://www.youtube.com/watch?v=noC_Ad3i9EQ&list=PLoER7znK1z4CFzfR_6j4rgES4HFm4B0No&index=5.
- American Association for the Advancement of Science Tyler Prize Laureate Lecture (2013): https://www.youtube.com/watch?v=ANirtOohabs&list=PLoER7znK1z4CFzfR_6j4rgES4HFm4B0No&index=2.
- UN-FAO (2020): 'Keep Soils Alive, Protect Soil Biodiversity'. https://www.youtube.com/watch?v=9Ro-1TiJy2A&t=67s.
- The Global Soil Biodiversity Initiative (2023): 'International Day for Biodiversity 2023. From Agreement to Action: Build Back Biodiversity'. https://www.youtube.com/watch?v=2db8ppzFOsE.

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