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EDITORIAL

Biodiversity data: The importance of access and the challenges regarding benefit sharing

Global consensus that biodiversity is essential to humanity's productivity, health, and even survival has not translated into nearly enough conservation action to reverse, or in many cases even to slow its loss over several decades (Díaz et al., 2020; IPBES, 2019). A recent review of the 20 Aichi Biodiversity Targets of the Convention on Biological Diversity (CBD)—crafted to envision necessary progress between 2010 and 2020—found that none of the Targets had been met, and only six had been partially achieved (Convention on Biological Diversity, 2020).

What explains this existential disconnect between success on priority setting, and failure on action?

Among the reasons for meager progress is continued disagreement around profits and other benefits gained through the use of biodiversity, including how and with whom these benefits are distributed. While fair and equitable sharing of the benefits arising out of the use of genetic resources represents one of the three pillars of the CBD, alongside the conservation and sustainable use of biodiversity (Convention on Biological Diversity, 1992), it is clearly the most contentious. Its emphasis arose in part in response to perceived disparities in the distribution and use of plant, animal, bacterial, and other genetic resources, as well as concern over the increasing potential for their privatization (Khoury et al., 2021). As a form of leverage, access to biodiversity has been linked with benefit sharing (forming the commonly-used term "Access and Benefit Sharing" [ABS]).

Several international treaties ensconce ABS as a key principle. This "ABS regime complex" (**Aubry et al., 2021**) consists of various independent and specialized instruments: the Nagoya Protocol broadly covering ABS in the CBD (Convention on Biological Diversity, 2011); the Multilateral System of the International Treaty on Plant Genetic Resources for Food and Agriculture (Food and Agriculture Organization of the United Nations, 2002), also referred to as the Plant Treaty) regulating some crop genetic resources; the Pandemic Influenza Preparedness (PIP) framework; the Antarctic Treaty (AT); and the Biodiversity Beyond National Jurisdiction negotiations under the auspices of the United Nations Convention on the Law of the Sea (UNCLOS), among others.

These instruments and the negotiations that led to them are complex. Their varied interpretations and implementation across the world create confusion for practitioners and policy makers alike, including regarding who is subject to their conditions, how ABS can be bilaterally negotiated, and how biodiversity outside of the time-frame of the instruments is governed.

Further complicating matters is the potential that information generated through research important to the use of genetic resources, such as genotypic or phenotypic data, may soon come to be subject to ABS conditions alongside the physical genetic resources. The generation, storage, exchange, and use of these data have all advanced rapidly over recent decades, but ABS mechanisms have not kept pace with these changes. A concern has begun to be voiced that without updating ABS mechanisms, the increasing efficiency of this information will diminish the power of frameworks governing only physical biodiversity resources. This has now come to a head, with the CBD, Plant Treaty, and other agreements actively discussing ABS for biodiversity data. These negotiations have been tense over the past 5 years (**Rohden & Scholz, 2021**; Wynberg et al., 2021). Further critical negotiations will take place at the Conference of the Parties (COP) of the CBD in October 2021 and May 2022.

We are glad to offer this timely special collection of research, review, and opinion articles regarding ABS of biodiversity data, with, apropos to *Plants*, *People*, *Planet*, particular focus on data relevant to plant genetic resources. The collection provides a range of evidence and viewpoints contributing context to these negotiations and the underlying scientific issues involved. The articles provide opportunities for those first engaging with this important topic to understand the main concepts and complexities, as well as useful material for those interested in digging more deeply into the nuances. From these articles, a few major themes emerge.

1. There is a lack of clarity about the definition of biodiversity data and thus its scope and ABS obligations. A placeholder term—'Digital Sequence Information' (DSI)—has been in use in the CBD and other venues for various years, despite its inadequacy in clarifying the boundaries around the range of sequence data (DNA, RNA, proteins, etc.), phenotypic and morphological information, passport (provenance) data, and other information potentially included.

Clarity on the scope of biodiversity data subject to ABS is critically needed for any future progress.

2. Rapid exchange of biodiversity data has provided enormous societal benefits. Perhaps the most visible recent example is the development and sharing of SARS-CoV-2 sequences (Maxmen, 2021).
3. Due to the importance of sharing biodiversity data and the lack of clarity around definitions and scope of this data and possible ABS obligations, many authors project that significant constraints to exchange will be untenable.
4. Multilateral or fully open systems of exchange of biodiversity data are preferable for scientists and researchers and for managers of associated physical resources (genebanks, botanic gardens, etc.).
5. Current use of biodiversity data around the world is unequal and further benefit sharing, including through capacity building and other efforts are needed for benefits to be more widely realized. Several articles provide useful examples of capacity building and other benefit sharing activities.

An article by **Rohden and Scholz (2021)** provides an overview and update on ABS political processes (focused on the CBD) for researchers and scientists who need to be more aware and more active in decisions very likely to affect their work. **Sirakaya (2021)**, meanwhile, explores whether the Nagoya Protocol is effective for conserving biodiversity. Although the overarching intent of the CBD has been conservation, aspects of the Protocol may discourage research contributing to conservation of plant genetic resources, including for crop wild relatives.

Rourke (2021) looks at biodiversity data from a "bioparts" perspective, based on synthetic biology. Through looking at the "chassis" on which an improved variety or a synthetic organism might be built, this article highlights the difficulty of assigning a country of origin to the different biological parts. When distinct "bioparts" cannot be assigned an origin, current ABS schemes become untenable.

Aubry et al. (2021) advocate for a multistakeholder committee on biodiversity data to assess its role in the ABS regime. This committee would be an important step toward representing a range of viewpoints and would be relatively straightforward to assemble. As tense negotiations continue internationally, such a committee may help lower tensions and assist with outreach to diverse communities impacted by these negotiations.

Vogel et al. (2021) provide an economic argument for "bounded openness," a nuanced alternative concept of a multilateral system for genetic resources and associated information. They argue that bilateral agreements are unlikely to ever generate the shared benefits needed to maintain the international ABS regime. An effective multilateral system, on the other hand, could generate benefit sharing and facilitate increased conservation and access to crop genetic resources.

Moving to more specific plant data contexts, **Brink and van Hintum (2021)** provide practical explanations of how biodiversity data is managed in relation to genetic resources maintained in genebanks, and how various potential ABS obligations on data will directly affect ex situ repository activities.

Rouard et al. (2021) provide a useful example of a well-designed data information resource highly connected to banana germplasm. While this resource is openly available, the authors note potential inequities based on internet access and capacity to use the data. **Awada et al. (2021)** provide insights on current sharing of data across a large crop phenotyping program in Canada. In their view, current sharing between actors and fields is not ideal; they suggest stronger legal and data quality mechanisms and suggest that this will help contribute to ABS more widely as well as serve as a good example of transdisciplinary data management. **De Jonge et al. (2021)**, meanwhile, examine how emerging breeding technologies and the data they generate and utilize may impact farmer-breeders.

Cowell et al. (2021) provide perspectives on biodiversity data and research from the botanic garden community. They provide examples of data generated and shared for conservation and food security impacts, as well as successful negotiations of Nagoya obligations. They argue for clarity on terms and scope, and a multilateral solution to ABS.

Iob and Botigue (2021) examine unique aspects of how ABS and biodiversity data apply to archeogenomic data. As a field of genomics that harnesses rare samples requiring particularly specialized equipment and approaches, the challenges of ABS are acute. With little direct financial gain to be expected from sequencing preserved samples, the authors argue for an exemption in agreements for this basic research.

The importance of accessible data is the strongest thread connecting the contributions to this special collection. Since the agreements of the 1970s and 1980s that created large scale, open access platforms for sequence data, many scientists have been trained in an intellectual environment with abundant accessible data. Such platforms for genomic information (e.g. Benson et al., 2018; Sayers et al., 2019), and the spirit of open science behind them (e.g., Molloy, 2011; Woelfle et al., 2011), have in many ways powered the genomics revolution, and have arguably led to fairer and more open access (e.g., Gallagher et al., 2020; Piwowar et al., 2011). Substantial work is certainly still needed to make these resources accessible to all and to build the global capacity to make use of them. But steps taken to limit these data will not only hinder access to useful information but also degrade the value of biodiversity science and its potential to contribute to living in harmony with nature. As this is a topic that will remain of critical importance, we at *Plants, People, Planet* welcome future submissions on these topics and aim to add to this collection as new works are published to create an evolving resource to benefit the community.

KEYWORDS

digital sequence information, food security, genetic resources, genomics, phenomics

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CONFLICT OF INTEREST

The authors declare no known conflicts of interest.

DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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REFERENCES

Benson, D. A., Cavanaugh, M., Clark, K., Karsch-Mizrachi, I., Ostell, J., Pruitt, K. D., & Sayers, E. W. (2018). GenBank. *Nucleic Acids Research*, *46*(D1), D41–D47. https://doi.org/10.1093/nar/gkx1094

Convention on Biological Diversity. (1992). [WWW document] https://www.cbd.int/convention/text/ [accessed 3 October 2021]

Convention on Biological Diversity. (2011). *Text of the Nagoya Protocol*. https://www.cbd.int/abs/text/. CBD.

Convention on Biological Diversity. (2020). *Global biodiversity outlook 5*. CBD. 2020

Díaz, S., Zafra-Calvo, N., Purvis, A., Verburg, P. H., Obura, D., Leadley, P., Chaplin-Kramer, R., De Meester, L., Dulloo, E., Martín-López, B., Shaw, M. R., Visconti, P., Broadgate, W., Bruford, M. W., Burgess, N. D., Cavender-Bares, J., DeClerck, F., Fernández-Palacios, J. M., Garibaldi, L. A., … Zanne, A. E. (2020). Set ambitious goals for biodiversity and sustainability. *Science*, *370*(6515), 411–413. https://doi.org/10.1126/science.abe1530

Food and Agriculture Organization of the United Nations. (2002). *The international treaty on plant genetic resources for food and agriculture*. Food and Agriculture Organization of the United Nations (FAO).

Gallagher, R. V., Falster, D. S., Maitner, B. S., Salguero-Gómez, R., Vandvik, V., Pearse, W. D., Schneider, F. D., Kattge, J., Poelen, J. H., Madin, J. S., & Ankenbrand, M. J. (2020). Open Science principles for accelerating trait-based science across the Tree of Life. *Nature Ecology & Evolution*, *4*(3), 294–303. https://doi.org/10.1038/s41559-020-1109-6

IPBES. (2019). In E. S. Brondizio, J. Settele, S. Díaz, & H. T. Ngo (Eds.), *Global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*. IPBES secretariat.

Khoury, C. K., Brush, S., Costich, D. E., Curry, H. A., de Haan, S., Engels, J., Guarino, L., Hoban, S., Mercer, K. L., Miller, A., Nabhan, G. P., Perales, H. R., Richards, C., Riggins, C., & Thormann, I. (2021). Crop genetic erosion: Understanding and responding to loss of crop diversity. Tansley review. *New Phytologist*. https://doi.org/10.1111/nph.17733

Maxmen, A. (2021). One million coronavirus sequences: popular genome site hits mega milestone. *Nature*, *593*(7857), 21–21. https://doi.org/10.1038/d41586-021-01069-w

Molloy, J. C. (2011). The open knowledge foundation: Open data means better science. *PLoS Biology*, *9*(12), e1001195. https://doi.org/10.1371/journal.pbio.1001195

Piwowar, H. A., Vision, T. J., & Whitlock, M. C. (2011). Data archiving is a good investment. *Nature*, *473*, 285. https://doi.org/10.1038/473285a

Sayers, E. W., Cavanaugh, M., Clark, K., Ostell, J., Pruitt, K. D., & Karsch-Mizrachi, I. (2019). GenBank. *Nucleic Acids Research*, *47*(D1), D94–D99. https://doi.org/10.1093/nar/gky989

Woelfle, M., Olliaro, P., & Todd, M. H. (2011). Open science is a research accelerator. *Nature Chemistry*, *3*(10), 745–748. https://doi.org/10.1038/nchem.1149

Wynberg, R., Andersen, R., Laird, S., Kusena, K., Prip, C., & Westengen, O. T. (2021). Farmers' rights and digital sequence information: Crisis or opportunity to reclaim stewardship over agrobiodiversity? *Frontiers in Plant Science*, *12*, 686728. https://doi.org/10.3389/fpls.2021.686728