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EDITORIAL

Sharing and Reporting Benefits from Biodiversity Research

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The most remarkable feature of our planet is the diversity of its life forms, ranging from viruses and nanobacteria to blue whales and giant sequoias to satanic leaf-

tailed geckos and leafy seadragons (look them up!). Life is found in essentially all environments on earth, and the number of species living on our planet is many times greater than we could have imagined a century ago. A well-regarded estimate pegs the number of eukaryotic species on earth at 8.7 million (± 1.3 million), of which fewer than 15% are currently described (Mora et al., 2011). The diversity of prokaryotes is less clear (and highly controversial), but an analysis of 1.6 billion 16S ribosomal RNA sequences estimated that 0.8–1.6 million prokaryotic operational taxonomic units exist globally (Louca et al., 2019).

While we do not know how many species are currently extant, or have existed in the past, we do know that this biodiversity is valuable, providing food, fibre and medicine, furnishing ecosystem services such as water and air purification, nutrient cycling, pollination, and carbon uptake, and contributing to technological innovations ranging from biotechnology to robotics to material science. Moreover, biodiversity underlies the cultural identity of human populations and is important to human health and well-being.

Geographically, species richness increases from the Polar Regions to the tropics in terrestrial and surface marine ecosystems. Thus, some countries, especially those in tropical and subtropical regions, are endowed with much greater biodiversity than others. Unfortunately, benefits arising from the access and utilization of this biodiversity have been unequally shared, with (paradoxically) biodiversity-poor countries often accruing the lion's share of economic gains. There can be imbalances within countries as well, wherein some segments of the population obtain greater economic benefits from biodiversity and associated traditional knowledge than indigenous peoples.

The "Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization," which came into force in 2014, is an international agreement designed to ensure that the benefits arising from biodiversity are shared equitably (https://www.cbd.int/abs/). However, few

scientific journals require compliance with the Nagoya Protocol or the reporting of benefits from biodiversity research. In this editorial, we (the editors of *Molecular Ecology* and *Molecular Ecology Resources*) express support for the Nagoya Protocol and the principle of benefit sharing. We believe that scientific journals publishing research on biodiversity can play an important role in implementing the Nagoya Protocol and in reporting on benefits generated from such research. Below we provide background on the Nagoya Protocol, discuss the kinds of benefits that may arise from biodiversity research, describe the rationale for reporting on these benefits, and introduce changes to the journals' Data Accessibility Statements to incorporate the requirements and goals of the Nagoya Protocol.

Background on Nagoya Protocol

The Nagoya Protocol amends the Convention on Biological Diversity and was negotiated to clarify the Convention's requirement that signatory countries engage in "fair and equitable sharing of the benefits arising out of the use of genetic resources." This is commonly known as the benefit-sharing requirement. Under the Nagoya Protocol benefit-sharing must be directed to the provider of access to genetic resources as agreed in "Prior Informed Consent" of "Mutually Agreed Terms." To date, the Nagoya Protocol has been ratified by 127 countries (as of August 21, 2020). These countries are known as "Parties" to the Nagoya Protocol.

Parties to the Nagoya Protocol must enact domestic legislation to create legal guidelines about the operation of benefit-sharing obligations for those seeking to access and utilize genetic resources for research and development, including with respect to indigenous and local communities and governments. The aim of the Nagoya Protocol is that through the adoption of effective access measures such as a requirement for collection permits and benefit-sharing agreements, provider Parties (i.e. countries or indigenous and local communities) can capture benefits that result from utilization of genetic resources over which they have sovereign rights. The Nagoya Protocol states that "utilization of genetic resources," means "to conduct

research and development on the genetic and/or biochemical composition of genetic resources, including through the application of biotechnology." "Biotechnology," in turn is defined as "any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use." The Nagoya Protocol provides that benefits shared from utilization of genetic resources can be monetary or non-monetary, with the conservation of biological diversity being of paramount concern.

Parties to the Nagoya protocol have, or are in the process of developing, laws that interpret and implement these terms. This process is proceeding slowly, and has been criticized for not sufficiently acknowledging the rights and interests of indigenous communities. The European Union and some of the mega-diverse countries from Asia, Africa and Latin America have implemented such laws. Notably, Canada and the United States are not yet Parties to the Nagoya Protocol. The status of individual countries and national laws of Parties can be found at https://absch.cbd.int/countries/status/party. While the Nagoya Protocol lacks "teeth" to ensure fair and equitable benefit sharing within borders, we (and others) believe that researchers have responsibilities to indigenous communities, including sovereign nations, that lie within member states of the United Nations.

Sharing Benefits from Biodiversity Research

We acknowledge that implementation of the Nagoya Protocol is ongoing and complex. In some instances, for example with respect to historical collections, it is difficult to assess when and where materials were accessed in order to determine whether there are benefit sharing obligations (Sherman, 2020). Moreover, the concept of utilization has been interpreted differently by different Parties and there remain ongoing and contentious debates about whether the Nagoya Protocol and implementing domestic legislation does, or should, also address use of genomic data and information. In some cases, these debates have led Parties to enact restrictions

on access and use of genetic resources in a manner that may impede ongoing scientific inquiry (Marden, 2018).

We take the position that the benefit-sharing principles contained in the Nagoya Protocol are important and should be acknowledged, even where there is a lack of legal clarity. The range of benefits identified in the Nagoya Protocol (Box 1) include many of the practices already adopted by research groups to leverage research outputs and enhance the community of practitioners. These include, for example, the sharing of sequence data and other information, research collaboration and cooperation, education and capacity building, and research on high priority issues such as conservation and sustainable use of biodiversity. At present, there is little awareness that scientific researchers regularly incorporate benefit sharing into their research. We believe that identification of benefits generated will help the general public, policymakers, and influencers better understand current practices in the research community. Providing information about benefit sharing in a transparent and consistent manner may be important in demonstrating the broad value of such research to the country providing the biodiversity resources, thereby influencing international policy discussions. Such reporting may also promote further research and research support, setting into motion a "virtuous circle" between scientists and policy makers that enhances biodiversity research and conservation. For these reasons, we strongly encourage authors to identify benefit-sharing outputs in manuscripts submitted for review.

Data Accessibility and Benefit-Sharing Statement

To comply with the Nagoya Protocol and to encourage transparency regarding benefits generated in a manner commensurate with the Nagoya Protocol, we are revising the Data Accessibility Statements (https://onlinelibrary.wiley.com/page/journal/1365294x/homepage/forauthors.html#Ed_policy) for *Molecular Ecology* and *Molecular Ecology Resources* to incorporate the requirements and goals of the Nagoya Protocol. The additions, including an

expanded title (i.e. Data Accessibility **and** Benefit-Sharing Statement), are as follows:

> *Molecular Ecology* and *Molecular Ecology Resources* require, as a condition for publication, that the research described in the publication complies with relevant national laws implementing the Convention on Biological Diversity and Nagoya Protocol agreements. Authors will be required to make an affirmative statement during the submission process as to compliance with national laws, if applicable.
>
> *Molecular Ecology* and *Molecular Ecology Resources* also encourage authors to disclose benefits generated commensurate with the Nagoya Protocol. Further information on the scope of benefits recognized under the Nagoya Protocol, see the link to the Nagoya Protocol Annex at https://www.cbd.int/abs/text/articles/?sec=abs-37.

We recognize in some cases the Nagoya Protocol is not applicable or that there are no benefits to report, which is why the reporting of benefits is not mandatory.

Example Statements

"Benefits Generated: A research collaboration was developed with scientists from the countries providing genetic samples, all collaborators are included as co-authors, the results of research have been shared with the provider communities and the broader scientific community (see above), and the research addresses a priority concern, in this case the conservation of organisms being studied. More broadly, our group is committed to international scientific partnerships, as well as institutional capacity building.

"Benefits Generated: We consulted with the indigenous community providing the biodiversity resources and hired members of a local Hunters and Trappers Association to help with biodiversity assessments, including collections of canid fecal samples for diet analysis based on DNA metabarcoding, and local knowledge

concerning changes in prey communities over time. The contributions of all individuals to the research, including indigenous hunters, are described in the METHODS and ACKNOWLEDGEMENTS, and a research report has been provided to the relevant indigenous community council, as well as to the territorial government. The research addresses a priority concern regarding an apparent shift in the prey of canids from wild to domesticated animals. Lastly, as described above, all data have been shared with the broader public via appropriate biological databases."

"Benefits Generated: Benefits from this research accrue from the sharing of our data and results on public databases as described above."

Conclusions

We acknowledge the importance of benefit-sharing as it relates to the access and utilization of genetic resources. By amending the *Molecular Ecology* and *Molecular Ecology Resources* Data Accessibility and Benefit-Sharing Statement, we aim to not only encourage compliance with the Nagoya Protocol, but also to communicate the significant benefits already generated and shared by the research community. We believe that providing this information will enhance discussion in the international arena about the important role research plays supporting and sharing benefits arising from biodiversity.

REFERENCES

Louca, S., Mazel, F., Doebeli. M., & Parfrey, L. W. (2019). A census-based estimate of Earth's bacterial and archaeal diversity. *PLoS Biology* 17, e3000106. https://doi.org/10.1371/journal.pbio.3000106

Marden, E. (2018). International agreements may impact genomic technologies. *Nature Plants* 4, 2–4. https://doi.org/10.1038/s41477-017-0087-4

Mora, C., Tittensor, D. P., Adl, S., Simpson, A. G. B., & Worm, B. (2011). How many species are there on Earth and in the ocean? PLoS Biology 9, e1001127. https://doi.org/10.1371/journal.pbio.1001127

Sherman, B., Henry, R. J. (2020). The Nagoya Protocol and historical collections of plants. *Nature Plants* **6,** 430–432. https://doi.org/10.1038/s41477-020-0657-8

Nagoya Protocol Annex

Non-monetary benefits may include, but not be limited to:

(a) Sharing of research and development results;
(b) Collaboration, cooperation and contribution in scientific research and development programmes, particularly biotechnological research activities, where possible in the Party providing genetic resources;
(c) Participation in product development;
(d) Collaboration, cooperation and contribution in education and training;
(e) Admittance to ex situ facilities of genetic resources and to databases;
(f) Transfer to the provider of the genetic resources of knowledge and technology under fair and most favourable terms, including on concessional and preferential terms where agreed, in particular, knowledge and technology that make use of genetic resources, including biotechnology, or that are relevant to the conservation and sustainable utilization of biological diversity;
(g) Strengthening capacities for technology transfer;
(h) Institutional capacity-building;
(i) Human and material resources to strengthen the capacities for the administration and enforcement of access regulations;
(j) Training related to genetic resources with the full participation of countries providing genetic resources, and where possible, in such countries;
(k) Access to scientific information relevant to conservation and sustainable use of biological diversity, including biological inventories and taxonomic studies;
(l) Contributions to the local economy;
(m) Research directed towards priority needs, such as health and food security, taking into account domestic uses of genetic resources in the Party providing genetic resources;

Box 1. Non-monetary benefits under the Nagoya Protocol.