Check for updates

Received: 18 January 2021 | Revised: 8 October 2021 | Accepted: 8 October 2021

DOI: 10.1002/ppp3.10239

OPINION

WILEY

Bounded openness: A robust modality of access to genetic resources and the sharing of benefits

Joseph Henry Vogel[1] | Manuel Ruiz Muller[2] | Klaus Angerer[3] | Dino Delgado-Gutiérrez[4] | Alfredo Gálvez Ballón[4]

[1]Departamento de Economía, Universidad de Puerto Rico-Río Piedras, San Juan, Puerto Rico

[2]Researcher & Consultant, Sociedad Peruana de Derecho Ambiental (SPDA), Lima, Peru

[3]Centre Responsible Digitality (ZEVEDI), Technische Universität Darmstadt, Darmstadt, Germany

[4]Programa de Biodiversidad y Pueblos Indígenas, SPDA, Lima, Peru

Correspondence
Joseph Henry Vogel, Departamento de Economía, Universidad de Puerto Rico-Río Piedras, San Juan 00931-3345, Puerto Rico.
Email: josephvogel@usa.net

Societal Impact Statement

The Fourth Industrial Revolution is underway. Controversy surrounds the choice of modality for access to genetic resources and the fair and equitable sharing of benefits arising from their utilization, as established in the third objective of the Convention on Biological Diversity. The modality chosen by the Conference of the Parties should promote conservation and sustainable use of genetic resources, which are the first and second objectives of the convention. "Bounded openness over natural information" achieves all three objectives by aligning incentives between users and Providers. With philanthropic support, the modality can also be applied to unpublished traditional knowledge, which would enhance food security.

Summary

Several international agreements have provisions for "access to genetic resources" and "fair and equitable sharing of benefits arising from [their] utilization" (ABS). The optimal modality has proven elusive for the United Nations Convention on Biological Diversity (CBD) and Nagoya Protocol (NP). Such failure need not be so. We embrace reductionism and partition genetic resources into tangible and intangible attributes and classify the latter as natural or artificial information. The economics of information justifies "rents," which is the difference between what is paid and what would have been paid in a competitive market. Fairness and equity imply protection for natural information equal to that of artificial information. Bilateralism eliminates rents through competition and renders royalties infinitesimal, thus defeating ABS. The proposed Global Multilateral Benefit-Sharing Mechanism (GMBSM) could capture rents and distribute royalty income proportional to habitat for terrestrial species, and to CO_2 reductions for marine species and wild relatives of crops. Alignment of incentives for conservation would facilitate transition to half-Earth. Domesticated species require stronger incentives for conservation than do nondomesticated species. The Multilateral System (MLS) of The International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) should be expanded. Enclosure of traditional knowledge not yet in public domain through a benefit-sharing mechanism could incentivize communities to deposit samples into the CGIAR Genebanks and resume seed

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.
© 2021 The Authors. *Plants, People, Planet* published by John Wiley & Sons Ltd on behalf of New Phytologist Foundation.

exchange, which is essential for food security. A robust modality of ABS for the CBD, NP, ITPGRFA and other agreements is "bounded openness."

KEYWORDS
bounded openness over natural information, economic rent, economics of information, genetic resources, Global Multilateral Benefit-sharing Mechanism, half-Earth

1 | INTRODUCTION

International agreements that concern genetic resources should be interpreted in light of other agreements with the same concerns. Sensitivity to interconnectedness is necessary to achieve the diverse objectives of the agreements and prevent adverse outcomes. In the spirit of mutual supportiveness, we adopt a panoramic perspective for this special issue on access to crop digital sequence information and the sharing of benefits derived from its use (von Wettberg & Khoury, 2020). The implications for crops is possible once connective elements among the agreements are identified and harmonized. We begin with reduction of "genetic resource" to its essence and then consider the objectives of conservation and sustainable use. We address, in the present tense, the question raised by Clive Stannard (2013): "Could the multilateral system have been constructed in another way?" Inasmuch as the agreements on "access to genetic resources" and the "fair and equitable sharing of benefits" (ABS) are framework treaties, alternative constructions are always possible.

Any system for ABS must rest on solid foundations. We believe that they exist in an economic literature that has been ignored by Parties and stakeholders to the Conference of the Parties (COP) to the 1992 United Nations Convention on Biological Diversity. Inasmuch as many institutional details have already been worked out over a span of 30 years, reform could occur quickly should a handful of delegations recognize the fallacy of "sunk costs" and assume leadership. The problem is largely one of volition.

2 | PANORAMA

Reductionism "was and is the virtually unchallenged linchpin of the natural sciences." So writes E.O. Wilson (1994) in his autobiography *The Naturalist*. The claim seems at odds with the holism that Wilson (1986) expressed about conservation just a few years earlier: "In the end, I suspect that it will all come down to a question of ethics---how we value the natural worlds in which we evolved and now, increasingly, how we regard our status as individuals." For the conservation and sustainable use of genetic resources, can reductionism lever holism?

An answer can be gleaned from *Half-Earth* (Wilson, 2016). Wilson invokes a land ethic and reduces conservation to 50% of the planet's surface. But policymaking demands detail. One book review was titled "Half-Earth or Half Solution?" (Rotkin, 2018). How do we go from the current onslaught of degradative land use to restoration of lands already degraded? And how do we tackle the acidification of the oceans and the collapse of marine life? Our thesis is that ABS can ease the transition to half-Earth, by offsetting the opportunity costs of conservation. ABS stands for "access to genetic resources" and the "fair and equitable sharing of benefits arising from [their] utilization" (UNCBD, 1992, Article 1). We agree with Wilson that reductionism is the linchpin.

Several international agreements include provisions for ABS. The scope in the agreements range from all nonhuman life to one pathogenic species that afflicts humans. Correspondences among them suggest that reduction could be robust:

1. The United Nations Convention on Biological Diversity (1992) (CBD);
2. The supplementary Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity (2010) (NP);
3. The International legally Binding Instrument under the United Nations Convention on the Law of the Sea on the Conservation and Sustainable Use of Marine Biological Diversity of Areas Beyond National Jurisdiction (2020, 4th Session) (BBNJ) under The United Nations Convention on the Law of the Sea (1984) (UNCLOS);
4. Antarctic Treaty (1959) (AT);
5. The International Treaty on Plant Genetic Resources for Food and Agriculture (2001) (ITPGRFA);
6. Pandemic Influenza Preparedness Framework for the Sharing of Influenza Viruses and Access to Vaccines and Other Benefits (2001) (PIP).

Scale matters for the objectives of each agreement. Biotechnology is expected to top one trillion dollars in global annual sales by 2027 (Reports & Data, 2020). Almost all of it enjoys some form of protection through the 1994 Agreement on Trade Related Intellectual Property Rights of the World Trade Organization. Sufficient financial potential exists for the conservation of biodiversity, and more could exist if the ABS modality truly "facilitate[d] access" for Research and Development (UNCBD, 1992, Article 15.2). The Fourth Industrial Revolution is a "fusion of technologies across the physical, digital and biological worlds" (Schwab, 2016). Given the magnitude of revenues, a sharing of benefits could align incentives between the utilization of genetic resources and relief of the pressures which drive extinction.

Those drivers are Habitat loss, Invasive species, Pollution, Population growth and Over-harvesting, which give rise to the mnemonic HIPPO (Natural Resource Defense Council, 2008). For terrestrial species, the chief driver is changes in land use (H); for marine, CO_2 pollution (P) (Kolbert, 2014).

3 | THE ECONOMICS OF BILATERAL MODALITIES AND INFINITESIMAL ROYALTIES

Compliance with benefit-sharing obligations is a necessary but not a sufficient condition for the alignment of incentives to conserve genetic resources. Parties to the respective agreements must design a modality of ABS which also facilitates access. Two approaches exist: the bilateral and the multilateral.

The bilateral modality allows one user and one Provider to negotiate; multilateralism means agreement on a set of rules in lieu of bilateral negotiation. To date, the CBD and NP have adopted bilateralism and the PIP, a bilateralism that simulates multilateralism. The ITPGRFA has adopted multilateralism, but for only 64 of the most important crop and forage genera. The modalities of the AT and the BBNJ of UNCLOS are under negotiation. Because all nonhuman genetic resources are within the scope of the CBD, whose COP is the largest and meets the most frequently, the COP to the CBD should assume leadership in the pursuit of harmony on ABS.

The economic implications of bilateralism are opposite to those of multilateralism. This sentence cannot be stressed sufficiently. ABS between one user and one Provider induces competition through "jurisdiction shop[ping]" (Sociedad Peruana de Derecho Ambiental [SPDA], 2015, SPDA, 2017). That the USA has not ratified the CBD is most significant. Within its jurisdiction, genetic resources are *res nullius*, that is, property of no one. Cost minimization dictates that users first attempt access there. Success is likely: the USA is a mega-diverse country, home to vast collections and rich databases. If not available *in situ*, *ex situ* or *in silico* within US jurisdiction, logic then suggests that users shop around, unleashing a bidding war in reverse. In the race to the bottom, the most mega-diverse Party on Earth seems to have already won. The Brazilian ABS Legislation allows royalties as low as 0.1% (Brazil Law No. 13.123, 2015). Any record, however, has a way of being broken.

Policy options for ABS from the WiLDSI Project of the German Collection of Microorganisms and Cell Cultures GmbH contemplate a percentage which is an order of magnitude below that of Brazil (Scholz et al., 2020). Parties and stakeholders should take stock. A royalty of 0.01% means that a blockbuster invention, often understood as a product with annual sales of USD 1 billion, would generate a paltry USD 100,000. And blockbusters are rare. ABS under the WiLDSI Project or even under the Brazilian ABS Legislation, is uneconomic. The transaction costs outstrip the expected benefits. Bilateral ABS—why bother? This unwelcome question has been voiced in COP after COP. Studied ignorance is the nonresponse and engenders cynicism (Oduardo-Sierra et al., 2012; Vogel et al., 2011). Satire understandably ensues. The Captain Hook Awards for Biopiracy of the early COPs have given way to song—even karaoke—about biofraud and nonfeasance (ETC Group, 2016).

The mega-diverse countries of Africa suffer no delusions about bilateralism. At COP9 they called for mandatory minimum standards for the sharing of benefits (UNCBD, 2010). To reach consensus, COP10 opened the door to multilateralism (Buck & Hamilton, 2011). Article 10 of the Nagoya Protocol reads that Parties "shall consider" a Global Multilateral Benefit-Sharing Mechanism (GMBSM) (2010). "Shall consider" may seem like weak tea but is not. Good faith is obligatory in the performance of agreements under the Vienna Convention (1969). For the CBD and NP, bad faith occurs whenever Parties, stakeholders or the UNCBD Secretariat intone sovereignty to end consideration of the GMBSM. The Vienna Convention is incontrovertible: *multilateralism is just as much an expression of sovereignty as is bilateralism*.

Defenders of the bilateral approach are not fazed. Rather than argue the logic and evidence for the *status quo*, they turn to homilies. One will hear that "the train has left the station," "the boat has sailed" or "the die is cast." Even advocates of multilateralism partake in feel-good metaphors: "[T]he bilateral architecture of ABS under the CBD and NP is already baked in..." (du Plessis, 2021). Our response is in kind. "No matter how long you have gone down the wrong road, turn back" (Ruiz Muller, 2015). The legal doctrine of *stare decisis*—stand by things decided—does not hold when the errors are foundational (Seidman, 2012) (see Box 1).

Box 1: Is adherence to bilateral ABS *stare decisis*, path dependency or neither?

Rhetoric sways. Advocates of bilateral ABS find resonance in endearing language synonymous with *stare decisis*. Should the positive homilies and metaphors not resonate, negatives ones just might. Delegates will also hear that the COP is *stuck* with bilateralism, much as half the world is stuck with driving on the left (or the right), the QWERTY layout of the keyboard or English as the international language. Adherence to bilateral ABS is attributed to "path dependency" (Winands-Kalkuhl & Holm-Müller, 2015).

Essential for such classification is that the suboptimal standard work. Investments which have adopted the wrong standard constitute a barrier for switching to the right one. Note well: bilateral ABS never worked. Fairness and equity were impossible due to competition among Providers. The agreements were declared "successes" simply because they were concluded. Adherence to bilateral ABS is not path dependency but system failure, made resilient through the fallacy of sunk costs.

4 | THE ECONOMICS OF MULTILATERAL MODALITIES AND THE ALIGNMENT OF INCENTIVES

Most Parties, stakeholders and the UNCBD Secretariat deem bilateralism as bedrock to the CBD. What error is so egregious as to warrant establishment of a GMBSM? We believe that the negotiators of the CBD misidentified the object of access in 1992. Our answer may seem like a bridge too far. Wilson (1998) is fond of quoting the Chinese saying that "the first step to wisdom is getting things by their right names." What then do we suggest is the right name?

The negotiators of the CBD defined "genetic resources" as "genetic material of actual or potential value," where "genetic material" is "any material of plant, animal, microbial or other origin containing functional units of heredity" (1992, Article 2). "Genetic material" was defined using a word of the term to be defined. Is "material" just the tangible? Or is it the tangible and the intangible? The ambiguity was probably not intended. "[T]he text is sloppy" chided the legal advisor to the US delegation in a scathing law journal article (Chandler, 1993). The bridge too far need not be crossed. The Vienna Convention obliges Parties to interpret a treaty "in accordance with the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose" (1969, Article 31.1). An interpretation of "material" as inclusive of information is the first step toward ensuring that benefits not be infinitesimal. Only such interpretation accords with the objectives of the CBD.

Economics justifies "rents" for information, where "rent" is the difference between what is actually paid and what would have been paid in a competitive market (Samuelson & Nordhaus, 2010). Intellectual property rights (IPRs) suspend competition and afford rents, as evidenced by the difference in price before and after the expiry of the intellectual property protection. Rents-through-royalties allow recovery of the fixed costs of innovation as well as an incentive to assume the risk of failure. The previous sentence is the economic justification for the limited-in-time monopolies of intellectual property. Fairness and equity in the sharing of benefits demand protection for genetic resources equal to that of IPRs. Such treatment means the ability to negotiate rents from a position equal to that of a holder of an IPR. Limited-in-time oligopoly ABS is the homolog to limited-in-time monopoly IPRs. Whereas the latter facilitates innovation, the former, continued existence.

5 | THE OBJECT OF ACCESS

To interpret "material" in the definition of "genetic material" as inclusive of information would include that which is human made. Such an interpretation is too broad. Discrimination is necessary (Vogel, 1991, 1994). Information must be modified with the adjective "natural" or "artificial":

> Natural Information: Any unintentional distinction, non-uniformity or difference extracted from matter that is living or was once alive
> Artificial Information: Any human-made distinction, non-uniformity or difference that is intentional. (SPDA, 2021)

The above definitions have illustrious antecedents. Charles Darwin (1859) used "natural" and "artificial" to modify "selection" in *On the Origin of Species*. "Natural information" is also reminiscent of "genetic information" in "The Central Dogma of Molecular Biology" (Crick, 1970), which was inspired by the "code-scripts" of "What is Life?" (Schrödinger, 1944). Nevertheless, "natural information" has been taboo in multiple studies commissioned by the COP (Vogel, 2019a, 2019b, 2019c, 2020). We recommend that COP15 break this taboo. Parties should replace "digital sequence information" (DSI) with "natural information." We note that the Ad Hoc Technical Group on Digital Sequence Information on Genetic Resources reached consensus that DSI was "not the appropriate term" (UNCBD Secretariat, 2018). We believe that "natural information" is without doubt the relevant attribute of the object of access, which enables fairness and equity in the sharing of benefits.

Abstractions can be visualized. A Venn Diagram allows conceptualization of alternative terms to replace DSI (Figure 1). Natural information (biotic) captures what should fall within the scope of CBD while excluding information that is artificial or natural but abiotic.

Inclusion of information in the interpretation of "material" requires partitioning "genetic material" into attributes that are intangible or tangible. The multilateral approach would apply to the intangible attribute, be it natural or artificial information, and the bilateral approach, to the tangible. Access to tangible genetic resources requires a Material Transfer Agreements (MTA), which transfers possession of the medium but not the title. As such the MTA is a bailment. Associated information is the subject of licensing provisions (Garner & Black, 2019). Under the multilateral approach, new MTAs would no longer possess licensing provisions. For MTAs concluded before the 1993 ratification of the CBD, the COP would have to strike a bargain for participation of the collections in the royalty income of the GMBSM (SPDA, 2021). Otherwise, the GMBSM would compete with the collections.

6 | ITPGRFA: SCOPE OF ARTIFICIAL INFORMATION

The preceding four sections are the panorama in which the ITPGRFA is embedded. What is the essence of its object of access? The ITPGRFA defines "plant genetic resources for food and agriculture" as "any genetic material of plant origin of actual or potential value for food and agriculture," where "'genetic material' means any material

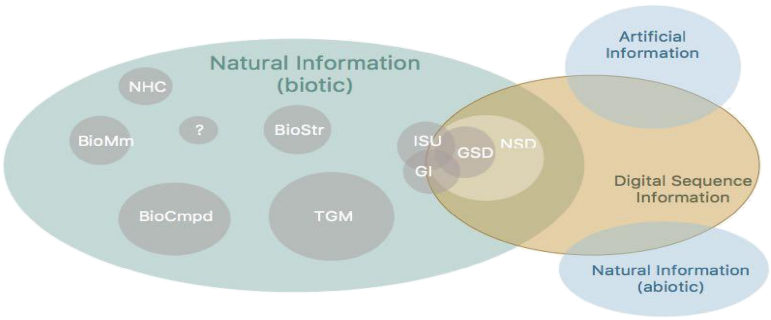

FIGURE 1 The Phenom
Source: Adapted from Vogel (2019a)

KEY
Natural Information (biotic) = Any unintentional distinction, non-uniformity or difference extracted from matter that is living or was once alive.
Natural Information (abiotic) = Complement of Natural Information (biotic) with respect to that which is not living and was never alive.
Artificial Information = Any human-made distinction, non-uniformity or difference that is intentional.
Digital Sequence Information = Placeholder for the "Phenom"
NHC = Non-human cultures
BioStr = Biomolecular structures
BioMm = Biomimicry
BioCmpd = Formula of biochemical compounds
TGM = Tangible genetic material
GI = Genetic information
GSD = Genetic sequence data
ISU = *In silico* utilization (of genetic resources)
NSD = Nucleotide Sequence Data
? = Unidentified natural information (biotic)

Image Credit: Valeria M. Berríos-Arroyo

of plant origin, including reproductive and vegetative propagating material, containing functional units of heredity" (2004, Article 2). Thinking reductively, the object of access for food and crops in the ITPGRFA is artificial information. The interpretation owes to domestication being an intentional human-made distinction, nonuniformity or difference.

The economist deduces that Parties and stakeholders to the CBD based its modality on an equivocation and that those to the ITPGRFA, on an implicit discounting of the future benefits from accessions, exchange and re-exchange. The negotiators of the CBD mistook natural information for the biological medium and allowed bilateralism, which eliminates rents and thereby incentives. The negotiators of the Multilateral System for ITPGRFA (MLS) did not address rents in the 64 crops and forages of Annex I, and thereby discounted the future value of artificial information previously afforded by the "common heritage of mankind" through seed exchange and re-exchange.

Rather than looking to the past, Providers in both the CBD and the ITPGRFA looked to the future. Mega-diverse countries were anticipating the role of genetic resources in the Fourth Industrial Revolution. Biotechnology would augment the value of those resources, just as the steam engine had done with coal in the nineteenth century and nuclear reactors, with uranium in the twentieth. Alas, intrinsic differences upend any such analogy. Unlike coal or uranium, the valuable attribute in the object of access in genetic resources is intangible. Whereas Providers correctly appreciated the rising use value of genetic resources, they wrongly understood the dynamic of exchange value for the intangible attribute, viz., the race to the bottom. The delusion that a Provider could capture use value impacted collections disastrously. The anthropologist Stephen Brush notes that distribution of samples from the CGIAR Genebanks for the period of 1973–2004 "peaks just as the UNEP discussions get going in Nairobi to draft the CBD in 1988. By 2004, we are at the same level where we were in 1973. The breakdown of plant collecting and germplasm exchange is a veritable 'tragedy of the anti-commons' for crop germplasm" (2011).

Brush's observation can be updated. Michael Halewood et al. (2020) graph the period 2005–2019 in "Germplasm Acquisition and Distribution by CGIAR Genebanks", which shows a steep rise from an initial 1000 in 2004 to 14,000 in 2011, thanks largely to national agricultural research system centers (NARs). The ascent coincides with "Securing the Biological Basis of Agriculture," a project funded by the Bill and Melinda Gates Foundation. With the sunset of "Securing the Biological Basis," accessions dove to 2000 in 2014. From 2015 to 2019, the graph looks like a roller-coaster of dampened elevations, between 2000 and 4000 acquisitions.

Conflation of use value with exchange value is again explanatory; providers outside the system may have expected more than exchange value. The MLS lacks *effective* oligopoly power to capture rents which would incentivize accessions. The 2019 proposal of the Subscription

System for the enhanced MLS, is a royalty rate of 0.015% (ITPGRFA, 2019, p. 2). The unwelcome question persists—ABS, why bother?

A hopeful answer derives from the strong response to the modest incentives from the aforementioned project. Empowerment of the MLS to negotiate significant royalties could increase accessions and also stem on-farm genetic erosion. For the CBD and NP, similar hope lies in the proposed GMBSM.

Success for a multilateral approach will take time. Yet genetic erosion is ongoing. How to get traditional communities to freely exchange seeds and deposit samples into the CGIAR Genebanks? The genie is out of the bottle and wary of going back in. Can she be enticed into a new bottle? An answer coherent with ABS is one which incentivizes communities to deposit samples and participate in seed exchanges. The ITPGRFA and NP should allow communities to capture rents for knowledge that is not public domain. The MLS of the ITPGRFA or a GMBSM of the NP could establish a databank that determines which uses are still unpublished and eligible for trade secret protection (Vogel, 2000, 2007). The MLS or GMBSM could negotiate with the users and distribute royalty income to the communities. Precisely because the requisite infrastructure is so daunting, we the authors have refrained from including traditional knowledge in our presentations on the GMBSM (e.g., Ruiz Muller, 2016). Nevertheless, those same challenges mean that fungibility with existing government initiatives will not be a problem. The proposal for a GMBSM over traditional knowledge (TK) is ideal for large-scale philanthropy (Vogel, 2018).

7 | ITPGRFA: SCOPE OF NATURAL INFORMATION

Provision for wild relatives of crops (WRoC) lies in Article 5.1(d) and Article 5.2 of the ITPGRFA. WRoC also fall within the scope of the CBD and NP. Should a decision on WRoC by the CBD and NP be copied by the ITPGRFA, then that decision would also be binding on the USA, as a Party to the ITPGRFA. The pursuit of harmony among the agreements may prove fortuitous. One half of the WRoC in the USA are endangered (Khoury et al., 2020). A successful ABS on WRoC arising from harmonization could also soften resistance of the USA to the CBD and NP.

The proposed GMBSM must be tweaked for the realities of WRoC, for which the letters of HIPPO are scrambled. WRoC face the threat of climate change (P) more acutely than do other terrestrial species. Hence, remittance of royalty income to Parties on the basis of (H) would not prevent simultaneous harm from (P). Claimants for ABS on IPR-protected utilizations of WRoC should include Parties which have reduced (P) in excess of current commitments for CO_2 reductions. A homology exists with marine species threatened by acidification from atmospheric CO_2 (SPDA, 2021). Just as land-locked countries should be incentivized to reduce pressure on marine species through climate action, countries without a Vavilov Center should be similarly incentivized. When a biogeographic island appears doomed, the Provider should transplant the population of interest to an amenable location within its jurisdiction; should such sites not be available, then the Provider should explore sites outside its jurisdiction and share the claim with the country which stewards the transplanted population (see Box 2).

Box 2: Centers for TK and refuges for transplanted WRoC

Under the proposed MLS or GMBSM for TK, communities would upload uses of crop species as well as uses of nonfood and nonagricultural species, and download public-domain uses that may have been previously unknown to that community. Given the wealth of TK in the public domain and the diffusion of domesticated species worldwide, probably few communities fully exploit what is within their midst. Facilitated access to this public-domain knowledge is a significant incentive for participation in an MLS or GMBSM for TK.

TK noncoincident with the public domain would qualify for trade-secret protection and negotiation with users. The economist would note that the demand for nonfood and nonagricultural uses will be significantly more inelastic than those for food and agriculture (e.g., pharmaceutical). By the Ramsey Rule of Public Finance, goods with inelastic demand should command a royalty substantially higher than that observed for goods with elastic demand (Rosen, 1992). Because the infrastructure for a MLS or GMBSM for TK is a significant expenditure, the cost of implementation for all interested communities will likely exceed the funds available from public or philanthropic sources. A criterion for selecting candidate communities could be the ongoing deposit of crop samples into the CGIAR Genebanks and continued participation in seed exchange.

A complementary source of community income could be compensation for transplantation and stewardship of WRoC endangered by climate change or urbanization. An example is *Solanum chacoense* which produces leptine glycoalkaloids that afford pest resistance for the potato *Solanum tuberosum* (Ronning et al., 2000). Leptine production and accumulation varies in *S. chacoense* according to ecogeography, which is multi-jurisdictional. Accessions of high production and accumulation are rare. Incentives should be institutionalized for a systematic inventory with subsequent transplantation and stewardship whenever such populations are endangered by changes in climate or land use.

8 | BOUNDED OPENNESS AS THE "RIGHT NAME": ANOMALIES DEMONSTRATE ROBUSTNESS

The handle for a robust multilateral modality of ABS must serve the NP of the CBD, BBNJ of UNCLOS, AT, ITPGRFA and PIP. Heeding the Chinese saying that Wilson is fond of quoting, we ask: What is the "right name?" We suggest "bounded openness" (Vogel et al., 2011; Vogel, Angerer, et al., 2018; Vogel, Ruiz Muller, et al., 2018), which is the term launched by the political scientist Chris May (2010) in *The Global Political Economy of Intellectual Property*. May wrote about the informatics revolution and left "bounded openness" undefined, apparently purposefully. He adamantly rejected any "one-size-fits-all" reform of the IPR system. Although the pluralism is admirable, we return to our opening remark: policymaking demands detail. Undefined terms can render international agreements contestable, as has happened with the word "material" in the CBD.

Inasmuch as treaties become international law once in force, any proposed definition for bounded openness will inevitably resemble legalese. We have tried our hand at crafting a definition that affords both exclusionary and inclusionary criteria.

> Bounded openness: Legal enclosures which default to, yet depart, from *res nullius* to the extent the departures enhance efficiency and equity, which must be balanced when in conflict. (SPDA, 2016) (Box 3)

Can "bounded openness" serve as the ABS modality for any genetic resource? From Copernicus to Einstein, anomalies have inspired reductionism and resulted in robustness. The most anomalous context for ABS among the half-dozen agreements on genetic resources is that of the PIP. Grega Kumer of the International Federation of Pharmaceutical Manufacturers Association pinpoints the contradiction "[b]iodiversity is about conservation and sustainable use of genetic resources, but when it comes to pathogens we are working to eradicate them, to annul them" (Hillsdon, 2020). Can bounded openness resolve the anomaly of conservation, sustainable use and ABS for pathogens? Resolution would mean robustness.

Box 3: Old wine, new bottle(s)?

A skeptic might dismiss bounded openness as little more than a restatement of intellectual property. Patents, copyrights and trademarks depart from *res nullius* because they enhance efficiency and equity; the terms of intellectual property are balanced precisely because efficiency and equity are in conflict (e.g., a short patent life could enhance equity at the expense of efficiency). Is bounded openness just old wine in a new bottle? The answer is nuanced. The novelty lies in the conceptualization of the bounds. They are added to openness as the default (criterion #1), which thereby creates a heavier burden of proof that equity (criterion #2) and efficiency (criterion #3) are being enhanced. "Bounded openness over natural information" satisfies the three criteria: genetic resources flow freely for R&D (criterion #1); royalties are due only on the value added through intellectual property and distributed proportional to custodianship (criterion #2); transaction costs are minimized (criterion #3).

The skeptic may remain unpersuaded. Could "bounded openness" be the new bottle, not for intellectual-property but for the MLS? Striking is this similarity between the two ABS modalities: no royalty obligation exists should an intellectual property not obtain (Article 13.2.d.ii of ITGRAFA). Less striking are the "facilitated access" of the MLS and the "openness" in "bounded openness". The former incurs the transaction costs of standard material transfer agreements *ex ante* research; the latter incurs none. Dissimilar are the issues of rents, fairness and equity. The MLS assumes that the agreed rate is fair and equitable, as otherwise Parties would not have reached agreement. Economics teaches differently. To the extent that many providers lay outside the system, the race to the bottom may begin and end with capitulation of Providers to comparison-shopping users of the non-CGIAR-Genebank providers. The lower case (provider) and the upper case (Provider) is the distinction between persons, natural and legal, and the State. Under bounded openness, incentives are more prominent. Rents for traditional knowledge not yet in the public domain could be significant and lead providers to deposit in the CGIAR Genebanks as well as engage in seed exchange and re-exchange. Such practices keep the biological medium viable (see Box 2).

We return to the interconnectedness of the agreements, not only among themselves but also with the Vienna Convention. "Conservation" is not defined in the CBD and can only be reasonably interpreted as preservation of pathogens *ex situ* (Rourke, 2018). In other words, eradication of pathogens *in situ* does not contradict "conservation". Unlike "conservation," the CBD does define "sustainable use" (UNCBD, 1992, Article 2). Consistent with that definition would be containment of pathogens through public health measures and development of diagnostics and vaccines. ABS can therefore facilitate both the first and second objectives of the CBD. The bounds to openness would be incentives for rapid submission of samples into the international medical research stream (Vogel et al., 2013) as well as Provider access to diagnostics and vaccines free of rents (SPDA, 2021).

9 | CONCLUSION

"A rose by any other name" does not work for "The Phenom" of Figure 1. Once artificial or natural information is interpreted as the object of access in R&D, a multilateral system can be constructed in a way that all the international agreements that concern ABS become harmonious. The optimal modality is bounded openness. Expansion of the MLS in the ITPGRFA or establishment of a GMBSM in the NP, can capture rents. Incentives align. Distribution of the royalty income would relieve the pressures that drive genetic erosion and extinction. But how would such blue-skies thinking ever translate into institutional reform? Actions must be strategically planned across the various forums by Parties and stakeholders who perceive common ground (see Box 4).

Viewed holistically, bounded openness will help transition us toward our rightful status as individuals in one half of Earth, which is the clarion call of E.O. Wilson. And to the naysayers of half-Earth, we respond that bounded openness is the other half of the solution. The economic foundations are uncontroversial and the policy recommendation, timely. Perhaps no better way exists to start the UN Decade of Ecosystem Restoration 2021–2030 than by adopting this robust modality for ABS (UNEP, 2019).

Box 4: Strategic action plan for bounded openness as the modality for ABS

Economics is difficult even for economists. Its abstractions hazard alienating or intimidating the intended audience. For example, classification of IPRs as monopolistic will seem loaded to industrial users sympathetic to TRIPs. Yet the description is imperative for bounded openness as the modality of ABS. In economics, monopoly has no pejorative connotation when applied to intellectual property (McCarthy et al., 2004). To prevent alienation, "monopoly intellectual property" should be modified with "limited-in-time" and accompanied by the justification for such privilege, viz., the asymmetric structure of fixed and marginal costs. Policy reform rests on such outreach. Stakeholders supportive of strategic actions for "bounded openness" should organize and:

1. Respond to calls for peer reviews or submission of views concerning any aspect of ABS in the several international agreements concerning genetic resources;
2. Emphasize in media outlets that discussions on the placeholder DSI must include vetting of "natural information";
3. Explore case studies on utilization of genetic resources as thought experiments for bounded openness (SPDA, 2021). Iconic species should be favored for their potential to pierce the public sphere as in, for example, the case of the Komodo dragon (Jenner et al., 2017);
4. Coordinate graduate-level theses in allied disciplines that elaborate some aspect of "bounded openness";
5. Liaise with a government amenable to a pilot project which would sort out how to distribute royalty income among claimants to a GMBSM, where property holders of biogeographic islands would simulate Parties to the CBD;
6. Discuss in intellectual property forums how application procedures can be adapted for a Yes/No disclosure of utilization of genetic resources;
7. Approach philanthropists for large-scale and multi-year financing to grapple with the transformation of traditional knowledge into trade secrets.

ACKNOWLEDGMENTS

We would like to thank the United Nations Secretariat to the Convention on Biological Diversity for publishing narrative-formatted peer reviews of the commissioned studies concerning "Digital Sequence Information" and the "Global Multilateral Benefit-Sharing Mechanism" in the Inter-sessional Periods 2017–2018 and 2019–2020. This article has benefited greatly from the discerning comments of Newton C. Fawcett, Stanley P. Kowalski, Omar Oduardo-Sierra, three anonymous referees and the editors.

CONFLICT OF INTEREST

No conflict of interest exists.

AUTHOR CONTRIBUTIONS

Joseph Henry Vogel undertook the initial drafts of the narrative. Manuel Ruiz Muller contributed to the legal and institutional basis and Klaus Angerer, to the underlying science. Dino Delgado-Gutiérrez and Alfredo Gálvez Ballón ascertained that the argument cohered with the trajectory of the Sociedad Peruana de Derecho Ambiental, which has supported research teams to explore ABS in refereed articles, commissioned reports and submission of views to the Conference of the Parties of the United Nations Convention on Biological Diversity.

DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

ORCID

Joseph Henry Vogel https://orcid.org/0000-0002-5297-2173
Manuel Ruiz Muller https://orcid.org/0000-0002-6328-6427

Klaus Angerer https://orcid.org/0000-0002-1983-0026
Dino Delgado-Gutiérrez https://orcid.org/0000-0003-1982-1637
Alfredo Gálvez Ballón https://orcid.org/0000-0003-0481-1655

REFERENCES

Brazil Law No. 13.123 (2015). Article 20. http://www.wipo.int/edocs/lexdocs/laws/pt/br/br161pt.pdf

Brush, S. B. (2011). The anti-Commons threat to farmers' rights: The case of crop germplasm (pp. 64-65). In J. H. Vogel (Ed.), *The museum of bio-prospecting, intellectual property and the public domain* (pp. 55–72). Anthem Press.

Buck, M., & Hamilton, C. (2011). The Nagoya protocol on access to genetic resources and the fair and equitable sharing of benefits arising from their utilization to the convention on biological diversity. *Reciel*, *20*(1), 47–61. https://doi.org/10.1111/j.1467-9388.2011.00703.x

Chandler, M. (1993). The biodiversity convention: Selected issues of interest to the international lawyer (p. 174). *Colorado Journal of International Law & Policy*, *141*(4), 141–175.

Crick, F. (1970). Central dogma of molecular biology. *Nature*, *227*, 561–563. https://doi.org/10.1038/227561a0

Darwin, C. (1859). *On the origin of species*. Murray.

du Plessis, P. (2021). RE: 3. Policy options feasibility and appropriateness (April 24–May 2) [#2109]. Discussion Forum on DSI Policy Issues, UN Secretariat of the Convention on Biological Diversity. https://www.cbd.int/dsi-gr/forum.shtml?threadid=2044

ETC Group. Captain Hook Awards for Biopiracy. (2016). https://www.etcgroup.org/content/captain-hook-awards-reveal-biopirate-villains-and-celebrate-biodiversity-defenders-un

Garner, B., & Black, H. C. (Eds.) (2019). Bailment. In *Black's law dictionary* (11th ed.). Thomson Reuters.

Halewood, M., Jamora, N., Noriega, I., Anglin, N., Wenzl, P., Payne, T., Ndjiondjop, M., Guarino, L., Kumar, P., Yazbek, M., Muchugi, A., Azevedo, V., Tchamba, M., Jones, C., Venuprasad, R., Roux, N., Rojas, E., & Lusty, C. (2020). Germplasm Acquisition and Distribution by CGIAR Genebanks. *Plants*, *9*(10), 1296. https://urldefense.com/v3/__http://dx.doi.org/10.3390/plants9101296__;!!N11eV2iwtfs!ugOJdiJxUEjXV4ndGz7OQBrz_5CkLpxtLn6fFIn1yvlZHodxrH-SaLcUaCyGJP9TpnjaPQJiSEuSAVYSu-Y$

Hillsdon, M. (2020). Will the Convention on Biological Diversity Hinder the Sharing of Pathogens - like the Corona Virus (June 19). The Guardian.

ITPGRFA. (2001). http://www.fao.org/3/a-i0510e.pdf

ITPGRFA. (2019). Ninth Meeting of the Ad Hoc Open-ended Working Group to Enhance the Functioning of the Multilateral System, Interim Report. Rome, Italy. http://www.fao.org/3/ca5578en/ca5578en.pdf

Jenner, A., Bhagwandin, N., & Kowalski, S. (2017). Antimicrobial resistance (AMR) and multidrug resistance (MDR). Overview of Current Approaches, Consortia and Intellectual Property Issues. https://scholars.unh.edu/cgi/viewcontent.cgi?article=1322%26context=law_facpub

Khoury, C. K., Carver, D., Greene, S. L., Williams, K. A., Achicanoy, H. A., Schori, M., León, B., Wiersema, J. H., & Frances, A. (2020). Crop wild relatives of the United States require urgent conservation action. *Proceedings of the National Academy of Sciences*, *117*(52), 33351–33357. https://doi.org/10.1073/pnas.2007029117

Kolbert, E. (2014). *The sixth extinction*. Henry Hold and Company.

May, C. (2010). *The global political economy of intellectual property rights* (2nd ed.). Routledge.

McCarthy, J. T., Schechter, R. E., & Franklyn, D. J. (2004). *McCarthy's desktop encyclopedia of intellectual property* (3rd ed., pp. 384–386). Bureau of National Affairs.

Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity. (2010). https://www.cbd.int/abs/doc/protocol/nagoya-protocol-en.pdf

Natural Resource Defense Council. (2008). *Professor E.O. Wilson: Saving and exploring Earth's biodiversity with Elizabeth Kolbert*. The Town Hall. https://www.youtube.com/watch?v=GIlvstjsp8I

Oduardo-Sierra, O., Hocking, B. A., & Vogel, J. H. (2012). Monitoring and tracking the economics of information in the convention on biological diversity: Studied ignorance (2002–2011). *Journal of Politics and Law*, *5*, 29. https://doi.org/10.5539/jpl.v5n2p29

Reports & Data. 2020. Biotechnology market size, growth & analysis. https://www.reportsanddata.com/report-detail/biotechnology-market

Ronning, C. M., Kowalski, S. P., Sanford, L. L., & Stommel, J. R. (2000). Geographical variation of solanidane aglycone glycoalkaloids in the wild potato species Solanum chacoense bitter. *Genetic Resources and Crop Evolution*, *47*, 359–369. https://doi.org/10.1023/A:1008751329260

Rosen, H. S. (1992). *Public finance* (3rd ed.). Irwin.

Rotkin, M. (2018). Half-Earth or half solution?: E.O. Wilson's solution to species loss. *Solutions* 9(1). https://www.thesolutionsjournal.com/article/half-earth-half-solution-e-o-wilsons-solution-species-loss/

Rourke, M. F. (2018). Never mind the science, here's the Convention on Biological Diversity: Viral sovereignty in the smallpox destruction debate. *Journal of Law and Medicine*, *25*(2), 429–447. https://pubmed.ncbi.nlm.nih.gov/29978646/

Ruiz Muller, M. (2015). *Genetic resources as natural information. Implications for the convention on biological diversity and Nagoya protocol (p. 5)*. Routledge. https://doi.org/10.4324/9781315754451

Ruiz Muller, M. (2016). New approaches to access and benefit sharing: The case for bounded openness and natural information. Side event at the Conference of the Parties XIII to the UN Convention on Biological Diversity. http://www.actualidadambiental.pe/wp-content/uploads/2017/12/TranscriptSideEventCOP13BoundedOpenness.pdf

Samuelson, P. A., & Nordhaus, W. D. (2010). *Economics* (19th ed.). McGraw Hill.

Scholz, A.H., Hillebrand, U., Freitag, J., Devanshi, S., Seitz, C., Thiele, T., & Van Zimmeren, E. (2020). Finding Compromise on ABS and DSI in the CBD: Requirements & Policy Ideas from a Scientific Perspective. WiLDSI Project. https://www.dsmz.de/fileadmin/user_upload/Collection_allg/Final_WiLDSI_White_Paper_Oct7_2020.pdf

Schrödinger, E. (1944). What is Life? 1943 Lectures. Dublin Institute of Advanced Studies, Trinity College. http://www.whatislife.ie/downloads/What-is-Life.pdf

Schwab, K. (2016). *The fourth industrial revolution (p. 1). World economic forum*. Crown Publishing.

Seidman, L. M. (2012). *On constitutional disobedience*. Oxford University Press. https://doi.org/10.1093/acprof:osobl/9780199898275.001.0001

Sociedad Peruana de Derecho Ambiental/Peruvian Society for Environmental Law. (2016). Submitted view for the Updated report and synthesis of views in response to paragraph 7(b) of Decision XII/24 (2016): 2, fn 2. https://bch.cbd.int/synbio/peer-review/2015-2016/

Sociedad Peruana de Derecho Ambiental/Peruvian Society for Environmental Law. (2017) Lawful Avoidance of ABS: Jurisdiction Shopping and Selection of non-Genetic-Material Media for Transmission. Proposals for new and emerging issues for consideration received after COP-13. https://www.cbd.int/emerging/

Sociedad Peruana de Derecho Ambiental/Peruvian Society of Environmental Law. (2015). Preventing "jurisdiction shopping" for transboundary resources in a NonParty: The case of Puerto Rico. New and emerging issues relating to the conservation and sustainable use of biological diversity. https://www.cbd.int/emerging/

Sociedad Peruana de Derecho Ambiental/Peruvian Society of Environmental Law. (2021). *Fairness, Equity and Efficiency for the Convention on Biological Diversity and the Nagoya Protocol: Analysis of a Rodent, a*

Snail, a Sponge and a Virus. Report. Eschborn, Germany: The ABS Capacity Development Initiative. https://www.abs-biotrade.info/fileadmin/Downloads/Resources/Fairness-Equity-Efficiency-for-the-CBD-and-the-NP/Study-Fairness-Equity-Efficiency-for-the-CBD-and-the-NP-2021.pdf

Stannard, C. (2013). The multilateral system of access and benefit sharing: Could it have been constructed in another way? (p. 262). In M. Halewood, I. López Noriega, S. Louafi, & S. (Eds.), *Crop genetic resources as a global commons* (pp. 243–264). Routledge.

UNCBD. (1992). https://www.cbd.int/convention/text/

UNCBD Secretariat. (2010). Report of the first part of the ninth meeting of the ad hoc open-ended working group on access and benefit-sharing. UNEP/CBD/WG-ABS/9/3. https://www.cbd.int/doc/meetings/abs/abswg-09/official/abswg-09-03-en.pdf

UNCBD Secretariat. (2018). Report of the ad hoc technical expert group on digital sequence information on genetic resources (p. 5). CBD/-DSI/AHTEG/2018/1/4/. https://www.cbd.int/doc/c/4f53/a660/20273cadac313787b058a7b6/dsi-ahteg-2018-01-04-en.pdf

UNEP. (2019). Press Release: New UN Decade on Ecosystem Restoration offers unparalleled opportunity for job creation, food security and addressing climate change Decade of Ecosystem Restoration (2021-2030). https://www.unenvironment.org/news-and-stories/press-release/new-un-decade-ecosystem-restoration-offers-unparalleled-opportunity

Vienna Convention on the Law of Treaties (with annex). (1969). Article 26. https://treaties.un.org/doc/Publication/UNTS/Volume%201155/volume-1155-I-18232-English.pdf

Vogel, J. H. (1991). The intellectual property of natural and artificial information. CIRCIT Newsletter. Melbourne, Australia: Centre for International Research on Communication and Information Technologies.

Vogel, J. H. (1994). *Genes for sale*. Oxford University Press.

Vogel, J. H. (Ed.) (2000). *The biodiversity cartel*. CARE.

Vogel, J. H. (2007). Reflecting financial and other incentives of the TMOIFGR: The Biodiversity cartel. In M. Ruiz & I. Lapeña (Eds.), *A moving target: Genetic resources and options for tracking and monitoring their international flows* (pp. 47–74). Gland, Switzerland. http://data.iucn.org/dbtw-wpd/edocs/EPLP-067-3.pdf

Vogel, J. H. (2018). Economics resolves ABS for genetic resources and traditional knowledge once both are defined accurately. Submissions on Article 10 of the Nagoya Protocol pursuant to decision NP-2/10. https://www.cbd.int/abs/submissions/np-2-10/joseph-henry- vogel-en.pdf

Vogel, J. H. (2019a). Peer review: Combined study on traceability and databases. https://www.cbd.int/abs/DSI-peer/2019/Study2-3/JosephHenryVogel.pdf

Vogel, J. H. (2019b) Peer review: Study on domestic measures. United Nations Secretariat of the Convention on Biological Diversity. https://www.cbd.int/abs/DSI-peer/2019/Study4/JosephHenryVogel.pdf

Vogel, J. H. (2019c). Peer review: Study on concept and scope. United Nations Secretariat of the Convention on Biological Diversity. https://www.cbd.int/abs/DSI-peer/2019/Study1/JosephHenryVogel.pdf

Vogel, J. H. (2020). Peer review: Study to identify specific cases of genetic resources and traditional knowledge associated with genetic resources that occur in transboundary situations for which it is not possible to grant or obtain prior informed consent. https://www.cbd.int/abs/Art-10/Peer-review/Vogel.pdf

Vogel, J. H., Álvarez-Berríos, N., Quiñones-Vilches, N., & Medina-Muñiz, J. L. (2011). The economics of information: Studiously ignored in the Nagoya protocol on access and benefit sharing. *Law Environment and Development Journal*, *7*, 52. http://www.lead-journal.org/content/11052.pdf

Vogel, J. H., Angerer, K., Ruiz Muller, M., & Oduardo-Sierra, O. (2018). Bounded openness as the global multilateral benefit-sharing mechanism for the nagoya protocol. In C. R. McManis & B. Ong (Eds.), *Routledge handbook on biodiversity and the law* (pp. 377–394). Routledge. https://doi.org/10.4324/9781315530857-26

Vogel, J. H., Fuentes-Rivera, C., Hocking, B. A., Oduardo-Sierra, O., & Zubiaurre, A. (2013). Human pathogens as capstone application of the economics of information to convention on biological diversity. *International Journal of Biology*, *5*(2), 121–134. https://doi.org/10.5539/ijb.v5n2p121

Vogel, J. H., Ruiz Muller, M., Angerer, K., & Oduardo-Sierra, O. (2018). Ending unauthorised access to genetic resources (aka biopiracy): Bounded openness. Inside Views. Intellectual Property Watch/International IP Policy News. http://www.ip-watch.org/2018/04/06/ending-unauthorised-access-genetic-resources-aka-biopiracy-bounded-openness/

von Wettberg, E., & Khoury, C. K. (2020). Access to crop digital information and the sharing of benefits derived from its use: Background and perspectives. *Plants, People, Planet*, *2*, 178–180. https://doi.org/10.1002/ppp3.10105

Wilson, E. O. (1986). The current state of biodiversity (p. 16). In E. O. Wilson (Ed.), *Biodiversity* (pp.3–18). National Academy Press.

Wilson, E. O. (1994). *The naturalist (p. 345)*. Island Press.

Wilson, E. O. (1998). *Consilience (p. 4)*. Knopf.

Wilson, E. O. (2016). *Half-earth*. W.W. Norton.

Winands-Kalkuhl, S., & Holm-Müller, K. (2015). Bilateral vs. multilateral? On the economics and politics of a global mechanism for genetic resource use. *Journal of Natural Resources Policy Research*, *7*(4), 305–322. https://doi.org/10.1080/19390459.2015.1097022

How to cite this article: Vogel, J. H., Ruiz Muller, M., Angerer, K., Delgado-Gutiérrez, D., & Gálvez Ballón, A. (2022). Bounded openness: A robust modality of access to genetic resources and the sharing of benefits. *Plants, People, Planet*, *4*(1), 13–22. https://doi.org/10.1002/ppp3.10239