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GENETIC FREEDOM OF THE SEAS IN THE AGE OF EXTRACTIVISM

Marine Genetic Resources in Areas Beyond National Jurisdiction

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> Characterized by scientists and mainstream media alike for being "utterly alien," newly discovered undersea life-forms are no longer gigantic, but microbial.
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> —Mariana Silva, "Mining the Deep Sea"[1]

Introduction

Nearly two-thirds of commercial pharmaceutical medicine originate from so-called natural products.[2] While terrestrial organisms have been used in medicine for millennia, the use of marine biological "resources" for purposes other than food, otherwise referred to as "marine bioprospecting," is more recent—and booming.[3] Marine ecosystems are particularly suited for bioprospecting: they are about twice as likely to yield at least one gene in a patent than their terrestrial counterparts. In fact, "the success rate in finding previously undescribed active chemicals in marine organisms is 500 times higher than that for terrestrial species."[4]

The extraction of marine genetic resources (referred to as MGRs in the expert jargon—but I will try to keep acronyms to a minimum in this chapter for legibility purposes) is growing rapidly, with over 38,506 natural products and 4,900 patents associated with genes of marine organisms, the latter increasing at a rate of 12 percent per year.[5] Scientists found, along these lines, that the "appropriation of MGRs is progressing much faster than the already impressive

FIGURE 4.1 The ROPOS manipulator arm holds a sample of an inactive chimney in which fossilized tubeworms are embedded, an extremely rare find. Ring of Fire 2002 Expedition. Image courtesy of NOAA.

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rate of domestication for aquaculture."[6] Marine genetic resources are, in other words, "a growing source of biotechnological and business opportunities"[7]—the new, and perhaps final, frontier[8] of what has been lauded, and also criticized, as the blue economy.

The discovery of marine organisms containing molecules and genes of commercial interest has proceeded alongside the scientific explorations of marine biodiversity. The term bioprospecting is often used in this context to refer to the search for living organisms as a source of commercially exploitable products, such as medicinal drugs. However, there is a considerable divergence of opinion within the international community as to the precise meaning of this term and whether it includes non-commercial products. At least in the context of marine genetic resources, the term is typically defined as including the entire research and development process from sample extraction by public scientific and academic research institutions (which are generally, but not exclusively, funded by governments) all the way to full-scale commercialization and marketing by biotechnology and other companies.[9] The focus of research on marine genetic resources is geographically broad as well, encompassing deep-sea genetic resources alongside genetic resources from other areas of the sea.[10]

Despite their growing significance as the new ocean frontier, there is currently no internationally agreed upon legal or scientific definition of marine genetic resources. The meaning of this term in the marine context has been inferred from definitions of genetic resources (not specifically devised in the marine context) in the 1992 Convention on Biological Diversity (also "Convention" herein) and the 2010 Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of the Benefits Arising from their Utilisation (herein, the "Nagoya Protocol").[11] Because they do not contain DNA, the Convention's definition of marine genetic resources leaves out derivatives (natural products, proteins, toxins, et cetera), which can be highly valuable for commercial ends. The utilization of derivatives is regulated by the complementary Nagoya Protocol.

Both the Convention on Biological Diversity and the Nagoya Protocol apply only to genetic resources sourced from *within* national jurisdictions and do not apply to Areas Beyond National Jurisdiction (herein in lowercase).[12] Such areas, which encompass over 95 percent of the oceans' volume, are defined by the United Nations as the open ocean waters that lie beyond the economic zones and jurisdiction of any one country.[13] Over the past few decades, fishing and mineral exploitation expanded into these areas. Meanwhile, the International Seabed Authority has recently granted licenses to 29 mining contractors for exploitation activities there. Deep-sea scientists point out that there is currently no legal regime that protects biodiversity in areas beyond national jurisdiction, cautioning that "over a 15-year period, a single mining operation could damage marine systems over an area of 50,000 square kilometers."[14]

Similar to fishing and mineral exploitation in areas beyond national jurisdiction, instances of marine genetic resources sourced from these areas are also

becoming more frequent, and likewise lacking regulation. Still, as of 2019, only one commercial product on the market was derived from marine genetic resources in areas beyond national jurisdiction.[15] To address the legal lacuna pertaining to the management of the multiple "resources" in areas beyond national jurisdiction, the United Nations decided in Resolution 72/249 of December 24, 2017 to convene an intergovernmental conference and has, since then, been negotiating a legally binding agreement, entitled 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 (herein, the "BBNJ"). The negotiations aim to address several topics, including marine protected areas and marine biological diversity.[16] Many have characterized marine genetic resources as the most challenging topic being discussed under the BBNJ treaty.

This chapter draws on interviews conducted with 20 deep-sea scientist and legal experts, as well as on observations of their work at one session of the BBNJ treaty negotiations that took place in the United Nations headquarters in New York City in 2017, to highlight the uneasy symbiotic relationship between scientists, legal experts, and policy makers. The chapter explores this relationship through the debates regarding the scope of marine genetic resources, which have involved questions about the significance of their place of origin, the standards regarding their documentation, and whether or not they should encompass digital sequence information (also "DSI"). The discrepancy between law's "terracentric"[17] need to fix bodies in place to better govern them and the more fluid materiality of the ocean is on display here, providing an opportunity to reflect on the underlying tensions between law and science as embodied and expressed by lawyers and scientists in the BBNJ context.

Alongside the visible contestations between scientists and legal experts regarding the definition of marine genetic resources, there are the less visibly shared assumptions that underlie this definition. The most obvious assumption is the very use of the term resources in this context. Arguably, defining life forms in this anthropocentric and utilitarian way already lends itself to extractivist regimes, which draw on colonial paradigm, worldview, and technologies to "reduce, constrain, and convert life into commodities."[18] It is therefore not surprising that the question for most of the scientists and legal practitioners engaged in this work has been *how* to utilize marine genetic resources and not *if* to do so. This, despite the shared understanding that wild harvests of marine organisms are undesirable from a conservation standpoint "because it is not always possible to predict their impact accurately."[19] That said, some marine scientists contend that "most marine bioprospecting does not harvest large amounts of materials. Once the original gene [or] derivative is identified, it can be reproduced in the lab without having to obtain more of it from the sea."[20]

The term *mare geneticum* was recently coined[21] to celebrate the newly found freedoms of the sea, more than 400 years after the coinage by Hugo Grotius of *mare liberum*. Whereas the original "freedom" referred to journeys of (certain)

ships across the ocean's surface, the journey undertaken here follows live matter as it travels from source, into data, and finally into information. The abstraction and extraction of marine life is enabled through its decontextualization as part of this "data travel."[22] Here, life is suspended from its bodily matter and ecological context and reconfigured as genetic sequences that can thus become mobile commodities for exploitation.

The chapter ends with an urgent call by marine experts, both legal and scientific, to seize the precious opportunity of crafting a new treaty for areas beyond national jurisdiction so as to challenge the pervasive extractivist logic that currently underlies ocean governance. Instead of abstracting, fragmenting, and decontextualizing ocean lifeworlds, an alternative way of relating to these more-than-human lives is called for.[23] A scientist I interviewed for this project reflected on how we might address the fragmented state of ocean law, which he blamed on lawyers.[24] From his perspective, a new treaty that encompasses both land and sea regimes would be an important step in the right direction.

Marine Genetic Resources *Within* National Jurisdiction

Article 2 of the Convention on Biological Diversity defines genetic resources as "material from plants, algae, animals, and microbial or other organisms, and parts thereof containing functional *units of heredity of actual or potential value*."[25] Such "actual or potential" value can be considered in environmental, economic, societal, and scientific terms, and is based on "the many ways in which biological materials (also referred to as biomolecules) function and how organisms interact to transform chemicals and change their environments."[26]

One of the key innovations of the Convention on Biological Diversity is the way it mapped out key principles regarding the access and benefit-sharing (also "ABS") of genetic resources. For example, Article 15 of the Convention states that each "contracting party" shall endeavor to create conditions to facilitate access to genetic resources for environmentally sound uses by other contracting parties. Moreover, each contracting party is required to take legislative, administrative, and policy measures with the aim of sharing in a fair and equitable way the results of research and development and the benefits arising from the commercial and other utilization of genetic resources. The equitability factor is one of the most contentious aspects of the Convention because of the limited experience of countries in dealing with access and benefit-sharing and the rather uneven administrations that have developed as a result.[27]

The Nagoya Protocol added the concept "derivatives" to the Convention on Biological Diversity's definition of genetic resources. According to Article 2 of the Nagoya Protocol, such derivatives are defined as any "*naturally occurring* biochemical compound resulting from the genetic expression or metabolism of biological or genetic resources, even if it does not contain functional units of heredity, therefore also encompassing secondary metabolites, enzymes, and natural products."[28] This clause has elicited major debates, mostly focusing on

whether derivatives are themselves a genetic resource, or whether they should only be considered when discussing how a genetic resource is utilized and, in turn, which access and benefit-sharing regime would be relevant to it.

If derivatives were not confusing enough, the term "digital sequence information" was introduced to the two treaty regimes in decisions CBD XIII/16 and NP-2/14,[29] and is currently negotiated under the auspices of the Convention on Biological Diversity. Although different from derivatives, the scope of digital sequence information is no less contested. Some definitions include only DNA, RNA, and protein sequences, while others encompass additional elements that are further removed from the "original" genetic matter.[30] Expanding the definition of a marine genetic resource to include the broadest scope of digital sequence information would bring under the treaty a wide range of sample types—from entire organisms, through environmental samples of water, ice, or sediment, all the way to samples derived from any of these, such as extracted DNA or tissue preparations preserved to enable utilization.[31]

Genetic resource "samples" and "data" are intrinsically connected and so deploying a rigid legal distinction between a resource, its derivative, and digital information is challenging on a scientific level. The exclusion of digital sequence information from the definition of marine genetic resources would also lead to "biotechnology companies profiting from use of the 'global commons' without redistribution to those states with a reduced capacity to undertake such work themselves."[32] At the same time, embracing a definition of marine genetic resources that includes a broad definition of digital sequence information might result in restrictions on access to data that is currently openly available, which could in turn hamper scientific research.[33] For this reason, the scientific community has often not been too keen about using the term digital sequence information to expand the scope and usages of genetic resources.[34]

Take, for example, a sponge that produces a toxin, and that toxin (but not the sponge) is used in pharmaceutical research. Under the Convention on Biological Diversity, this toxin is not classified as a (marine) genetic resource because it does not contain DNA, and thus no legal conditions or requirements are placed over its extraction from areas within national jurisdiction. However, under the Nagoya Protocol, and possibly also under the BBNJ, the sponge can be categorized as a derivative and at least its utilization would thus be covered and regulated.[35] Marcel Jaspars, the co-leader of one working group in the Deep-Ocean Stewardship Initiative, explained why an expansive approach toward the definition of genetic resources is most desirable:

> In my mind, a tree sap belongs to the tree. It came from the tree's biosynthetic process. Therefore, although it is not alive in itself, it's something that derived from that, it's a derivative and should be covered. But apparently, it's not necessarily covered [because] it's not a genetic resource. … Beer is an example. It's made by bacteria but there is no bacteria in it. It has no DNA in it, yet it's a very valuable product … it's a multi-billion-dollar

> market. Same with other things, like cosmetics that are made from plants. They won't contain the DNA in the plant oils, for instance, but they contain the oil. Their value is not [necessarily derived from] using the genes, it's actually about having the physical plant that you can grow and get the oil from. That's the value.[36]

Jeffrey Marlow, Assistant Professor of Biology at Boston University, similarly advocates for a broad definition of marine genetic resources that includes derivatives:

> If you don't include the derivatives, then things like antibiotics or proteins would not be included [in the definition of marine genetic resources]. Which means that you could harvest them, reuse them, or sell them without going through this legal framework. A more expansive definition would encompass all of that.[37]

According to Marlow, marine genetic resources should therefore be defined broadly in the BBNJ so that they encompass "all information associated with or extracted from a physical MGR sample, specifically including any genetic sequence information, in both raw and processed form."[38] From this point of view, the main objective of the new treaty is not to prevent turning matter into resource, but rather to more tightly regulate this process.

Marine Genetic Resources in Areas *Beyond* National Jurisdiction

Areas beyond national jurisdiction are the largest environment on the planet, encompassing 64 percent of the world oceans and 47 percent of the earth's surface.[39] The definitional scope of marine genetic resources in areas beyond national jurisdiction thus carries significant legal, scientific, and economic implications. Under the BBNJ negotiations, some states have insisted that marine genetic resources on the seabed in areas beyond national jurisdiction (otherwise known as the "Area") are comparable to mineral resources as defined by the United Nations Convention on the Law of the Sea ("UNCLOS"), and should therefore be encompassed by the common heritage of mankind principle[40] and subject to benefit-sharing regimes.[41] Other states have interpreted corresponding articles in UNCLOS as excluding biological resources and thus advocated to apply the freedom of the high seas principle to them, implying that no legal obligation exists to share the benefits arising from their exploitation.[42] To bridge these approaches, marine policy advisors have suggested that the BBNJ adopt a novel *sui generis* regime that would provide for unique access and benefit-sharing mechanisms.[43]

A central question deliberated by the BBNJ policy makers and scientists is whether benefits associated with exploitation of marine genetic resources should be shared by the entire international community, or whether they should only

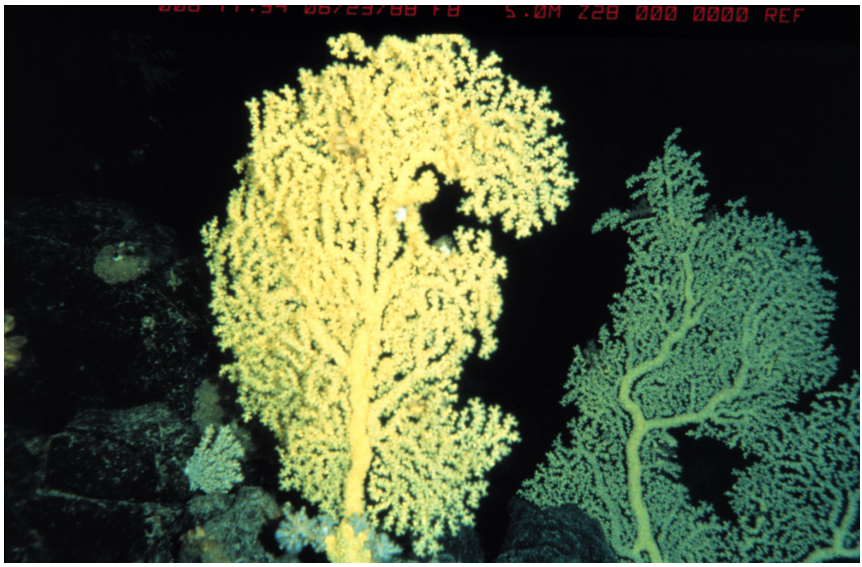

FIGURE 4.2 Gold coral on pillow lava in over 1,000 feet depth off Hawai'i, 1988. Pillow lava is commonly cited as the most abundant geological landform on earth's surface. Credit: OAR/National Undersea Research Program (NURP).

be shared by the wealthy developed states that have the technological capacity to exploit such resources, which are typically so difficult to access and require considerable investment. There are currently two broad approaches and mechanisms in response to this question: bilateral and multilateral. Both the Convention on Biological Diversity and the Nagoya Protocol have adopted a bilateral access and benefit-sharing approach. Under this approach, access and benefit-sharing transactions are defined as existing between the state where the marine genetic resource is found (one provider) and an individual or entity that requests access to this resource to use it for research and development (one user). The provider is obliged to facilitate access to the genetic resources found within its national jurisdiction, but maintains the sovereign right to make such access subject to the granting of prior informed consent (usually a permit) and mutually agreed upon terms (the conditions identified in an access and benefit-sharing contract).[44] The user must share benefits with the provider in an equitable and fair way, based on the terms established between the two parties.

Ocean experts have been debating which governance model to apply to marine genetic resources in areas beyond national jurisdiction. The bilateral approach is not readily applicable to marine genetic resources from areas beyond national jurisdiction under the existing UNCLOS regime, as these resources neither fall under the jurisdiction of a particular state nor under the authority of a global entity that could grant its consent and negotiate an access and benefit-sharing agreement with an interested user.[45] A multilateral access and benefit-sharing system would create a common pool, or a "global commons,"[46] and then establish access rules.[47] But the multilateral approach is much less commonly used

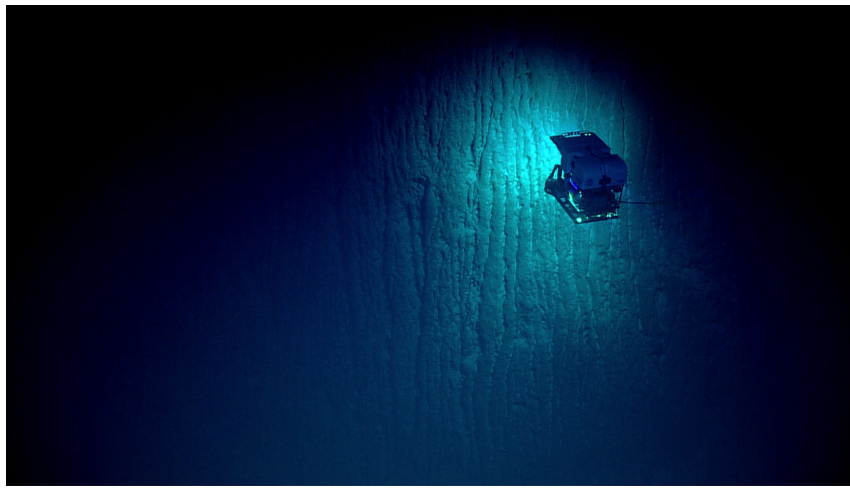

FIGURE 4.3 ROV Deep Discoverer observes a cliff that marks the edge of a coral platform in American Samoa. Image courtesy of the NOAA Office of Ocean Exploration and Research, Mountains in the Deep: Exploring the Central Pacific Basin.

and has been put to practice only with regard to a limited number of genetic resources.[48] While the appropriate BBNJ regime is being debated,[49] a small group of countries and transnational companies are already disproportionately influencing production volumes and revenues from the bioprospecting of marine genetic resource.[50]

Another issue that has not been adequately considered when negotiating the governance model for marine genetic resources in areas beyond national jurisdiction is the desirable patent regime. One way of securing exclusive access to a marine genetic resource is to patent it.[51] Patenting is especially significant in areas beyond national jurisdiction because the granting of a patent always occurs within a national jurisdiction and is thus determined by the domestic law of that state, regardless of where the marine genetic resource was sourced.[52] Consequently, rights in relation to patents (as opposed to *access* rights) are not affected by the absence of a specific regulatory regime in areas beyond national jurisdiction.[53] By 2018, 862 marine species were associated with patents, the majority of which pertain to microbial species, and 221 companies registered 84 percent of all patents pertaining to marine species (universities accounted for 12 patents).[54] One single corporation, the German multinational chemical manufacturer BASF, registered 47 percent of these patent sequences. Sophie Arnaud-Haond, a researcher at a French marine research institute, explained the problematic implications of the current patent regime on the documentation of marine genetic resources:

> If we want a fair sharing of benefits, it's not the sampling step [that] we have to [regulate]—it's the patenting step. And we don't. We pretend to ignore

> all that. The World Trade Office [WTO] has refused, in the last ten or fifteen years, to mandate [the recording of] the origin of the samples from which a particular MGR derived. … The solution is not in our hands, it's in the hands of the WTO, and they should do something about it.[55]

Despite its obvious relevance and importance to it, the existing patent regime is not currently considered under the BBNJ. The question, then, is whether the new legal regime negotiated under the BBNJ is "even capable of fostering greater equity and ocean stewardship, or is it too deeply seeped in a broader mode of extractive governmentality."[56] According to scholar Macarena Gómez-Barris, the answer is clear. Law, for her, is "embedded within a global political economic and interstate system that does not serve as a steward to the natural world but sells it to the highest commodity market."[57] The fact that patents are off the table in the BBNJ negotiations seems to support this criticism. Expressing her related critique toward international law's significant role in the creation of the neoliberal global economy while recognizing its powerful potential to steer the future in a positive direction, international law scholar Janne Nijman wrote: "To save the legitimate popular grievances from exploitation by extreme Right nationalist politicians, justice in all its dimensions needs to underpin the international rule of law."[58]

Marine Genetic Resources Under the Future BBNJ Regime

As of 2019, the draft of the BBNJ treaty defined marine genetic resources as "any material of marine plant, animal, microbial or other origin, [found in or] originating from areas beyond national jurisdiction and containing functional units of heredity with actual or potential value of their genetic and biochemical properties."[59] Although he had originally advocated for a broader definition, Marcel Jaspars thought that this definition of marine genetic resources under the draft of the BBNJ was *too* broad. Muriel Rabone is the Data and Sample Collector at London's Natural History Museum, and works with the Museum's Deep-Sea Systematics and Ecology Research Group. Similar to Jaspars, Rabone was concerned about the unintended consequences of the BBNJ possibly expanding the definition of marine genetic resources too broadly. She explained in our interview that "genetic databases are the lifeblood of biological science." If genetic resources were to be defined broadly and the BBNJ mandated subscription to access the database, for example, this "would not be acceptable to the scientific community [as it would] hamper that open data [archive]." She explained that "this is where the disquiet and the concern among scientists toward the BBNJ is coming from."[60]

Based on lessons learned from negotiations of prior international treaties, and the Nagoya Protocol in particular, the conveners of the BBNJ have set out to ensure that the consultation process included input from the scientific community.[61] But the scientific involvement in the legal process has often been

challenging, as the two expert groups differ on even the most basic issues of terminology and classification. For example, scientists generally use the term "deep-sea" to refer to any part of the ocean, pelagic or benthic, deeper than 200 meters, without reference to the national boundaries within this space. In legal terms, however, this range is called the "High Seas," and is separated from the regime on the sea floor, which is referred to as "the Area."[62] Working in the field, marine scientists will often sample organisms across jurisdictional boundaries, even during one single expedition. Margaret Spring is a deep-sea scientist from the Monterey Bay Aquarium and former Chief of Staff at the United States National Oceanic and Atmospheric Administration (NOAA). For her, the central question is: "how do you deal with the fact that [marine] genetic resources move across boundaries when you're doing science?"[63] In our interview, Arnaud-Haond explained that with most marine animals,

> you have absolutely no control over the fact [that] they live within an [exclusive economic zone or EEZ], or [that] their genetic material can be found at one stage or the other of their lifespan in areas beyond national jurisdiction. It's like birds. All oceans are connected, whereas different continents are not.[64]

Since their organisms typically don't recognize legal borders and jurisdictional lines, the marine scientists were consistently amazed at the legal experts' insistence on asserting linear, telluric geographies. Here from Jaspars:

> At the very beginning, [one lawyer] asked me, in all seriousness, "Can you tell if an animal originates from the EEZ or ABNJ?" And I said, "No. It can swim from one to the other." That was a revelation to him. [L]awyers are very smart people and they ask lots of questions … [But] a lot of them are based on absolutely no science whatsoever. [In] my interaction with lawyers [I will] often write the same message again and again and again, but maybe in different ways, until they get it.[65]

The underlying tensions between lawyers and scientists in the BBNJ context reveal the discrepancy between law's terracentric need to fix governable bodies in place and the more fluid realities of oceans and their lifeworlds as reflected in scientific knowledge.

To make sense of the negative attitude toward lawyers expressed in some of these quotes by the marine scientists, it might help to reflect on the earlier dynamics that accompanied the Convention on Biological Diversity and the Nagoya Protocol. Evidently, these treaty processes excluded the scientists from important decision-making processes that were in turn handled exclusively by lawyers and policy makers. This, despite the fact that the importance of an interdisciplinary decision-making process was acknowledged by some of the central figures already during the negotiations of UNCLOS. As Elisabeth Mann Borgese put it in 1993:

> If the issues under consideration are interdisciplinary, the decision-making process must be interdisciplinary. It cannot be implemented by just one discipline, for example, the lawyers and the politicians (who generally are lawyers). It must involve scientists, economists, industrial managers, and all others whose disciplines are involved.[66]

While the treaty-making processes that ensued were less inclusive than was called for, it is also the case that when the two expert communities have worked together in such contexts, this work would often result in deep frustrations. Related to the incompatibility between law and science as pertaining to place-making practices, the legal and scientific communities have also been incongruent in their approach toward time. "The scientific landscape is developing much more rapidly than associated legislation," one of the scientists told me.[67] Including scientists in the process would, in this view, provide the additional benefit of accounting for the rapid pace of scientific development, in synthetic biology in particular.[68]

This approach, which is shared widely among scientists and lawyers alike, represents an important assumption about the relationship between science and law—namely, that science leads the way, while law follows.[69] Sheila Jasanoff problematized this assumption when she wrote that "the law today not only interprets the social impacts of science and technology but also constructs the very environment in which science and technology come to have meaning, utility, and force."[70] And so whereas law is often depicted as separate from and as constantly racing to catch up with science, the two are in fact deeply interdependent and even coproduced—as is strongly evident in the context of marine genetic resources.

Further differences—and commonalities—between law and science have emerged during the BBNJ negotiations over the definition of marine genetic resources. One of the main concerns in this context, which is linked to the characterization of law as lagging behind science, is that the regulation of marine genetic resources would stifle scientific advancement. As one of my interlocutors put it: "Regulation must ensure to not stifle innovation or impede research progress in any way. Input from the scientific community is … crucial to the BBNJ discussions."[71]

Negotiating the BBNJ: Lawyers, Scientists, and Policy Makers

The BBNJ process has revealed some of the differences in the legal and scientific modes of knowing the world. Jaspars offered in this context that:

> The lawyers are often very keen on having a box to put around something in which they can say, "Everything that belongs inside the box belongs inside the box. Everything outside is somewhere else." And they start testing the boundaries' conditions, asking how you would get from inside the box to outside the box. That takes creative thinking. It's very nice.

> They ask lots of really good questions. I just don't know how to answer most of the questions they're asking.[72]

Further reflecting on the difference between legal and scientific thinking, Jaspars told me:

> I was shown four or five definitions by [one of the BBNJ] delegations. … The lawyers saw a big difference between them. For me they were just very similar definitions that meant roughly the same thing. It was about jurisdictional boundaries. So, [the debate was] whether you use the word ocean or marine or whether you use habitat or environment, things like that. To me, that was interesting. But I'm a very visual thinker. I like to draw diagrams and create pictures. Lawyers, on the other hand, like to use lots of words.[73]

From Jaspars's perspective, then, the difference between law and science is not only reflected in their disparate definitions, but also goes deep into the way that these groups are trained to see the world. Fran Humphries is a legal researcher of marine biodiversity situated in Brisbane. Her interview shed additional light on the relationship between the ways that legal and scientific experts construct and convey knowledge. In her words: "Sometimes the information from scientists can be so technical that the policy makers can't see what is relevant for their particular policy. They're looking for a more broad-brushed kind of thing."[74] Jaspars explained, along these lines, that: "lawyers don't want something that is too heavily defined because you get in trouble with a clear scientific definition. You don't want something that can be misinterpreted."[75]

Alongside scientists and lawyers, policy makers have played an important, albeit often under-explored, role in negotiating international treaties, and the BBNJ treaty is no exception. Humphries explained that there are three actors at work in the BBNJ, which breaks up what others have often perceived as one indistinct group of lawyers into two very different groups. In her words:

> There are the lawyers who want to get into the nitty gritty, watertight definitions that can capture things and be held up. … Then you have the diplomats who focus on the diplomatic language, making it broad enough. [Thirdly,] from the scientists' perspective, this text [becomes] so broad that it's unworkable because it can incorporate many activities. … So it's actually the policy makers who broaden it out to make it so big that it's frightening for both scientists and lawyers because they can't exclude things. … The draft text of the BBNJ treaty is a simple form [of] diplomatic language. It's not even a legal text, it's what we call a "legal framework." It's not like national laws [that are] able to capture those sorts of nuances.[76]

The trick when negotiating a treaty, according to Humphries, is to find language that is specific enough to mean something and broad enough to withstand changes in time and differences in interpretation among nation-states. Jaspars

clarified that: "A lot of treaty law, in order to be passed, needs to be very general, so that it's acceptable to everyone and everyone can implement it in such a way that their national legislation can recognize."[77]

According to Humphries, then, the problem of the cross-disciplinary BBNJ negotiations is not, as so many others depicted, the tense relationship between law and science, which she sees as actually being deeply compatible, but instead lies within the diplomatic or political realm. Furthermore, Humphries divides diplomats into two subgroups: policy advisors from national governments, and "career negotiators," who "don't necessarily have any grasp on the topic, but … their skills are essentially to make deals with other countries behind closed doors." For Humphries, the aspect of diplomacy foregrounds the uniqueness of international law, which requires specific expertise in the art of negotiation itself. The generalized international law negotiator who is not an expert in substance but in form is a perfect example for the power of abstraction in contemporary law of the sea—its decontextualizing away from matter and into a legal realm where it can then be detached from lively situated properties into a two-dimensional platform for exploitation and extraction.

Humphries's interpretation resonates with discussions within international law about the rule of law and its legitimacy vis-à-vis politics. If Hugo Grotius argued in the 17th century that "recourse to law would take international actors away from the divisive and dangerous field of 'politics' and into the world of abstract and neutral rules to be applied by impartial courts and expert arbitrators,"[78] then contemporary Finnish legal scholar Martti Koskenniemi claimed that law is fundamentally political. In his words: "even as law did offer a specialist vocabulary and a set of institutions that would enable the translation of raw interests into the language of rules, the way those rules then operated remained still dependent on contestable (and often contested) assumptions about the world."[79] The idea that international law is separate from politics was also criticized by Janne Nijman. In her words:

> to produce authoritative interpretations and eventually substantive resolutions of conflicts, international law ultimately depends on political choices made in the daily practices of international law. The international rule of law as a—profoundly liberal—flight from politics was revealed to be an illusion of sorts.[80]

International law's politics are quite specific: it adopts a Western liberal political theory that presents itself as universal, rather than utilizing a regional, cultural, and historically-specific language. This also explains the yet underrecognized importance of local groups in international law. Humphries emphasized in this context that the BBNJ has actually included a group that focuses on Indigenous knowledge. In her words:

> People are genuinely trying to grapple with incorporating traditional knowledge into the BBNJ, which is fabulous. In this forum, policy makers [are] really trying to understand what traditional knowledge means for this

> treaty and how we would use the knowledge and protect it, not just [for] marine genetic resources, but also for the other elements.[81]

The question one might pose in this context is whether Indigenous knowledge can be meaningfully incorporated into an existing political regime that defines living organisms as resources and that speaks in the utilitarian language of benefit-sharing. At the same time, for local and Indigenous groups to not be part of the BBNJ negotiations would mean not having a voice at the regulatory table. This is a common dilemma for Indigenous experts as they navigate the existing governance structures that they so fundamentally oppose.

Digital Sequence Information: A Legal-Scientific Journey

The debates over the adequate infrastructure, procedures, and standards pertaining to the production and management of marine genetic resources can also be referred to as debates over "data regimes." Here, the foundational distinction of Western science between nature and culture maps onto the corresponding distinction between raw sample and data to introduce a further distinction, this time between data and information.[82] According to this distinction, data describes the inherent properties of material artifacts as distinguished from "research outputs or other value-adding steps."[83] Operating within this logic, data is presumed to be neutral and objective until a human or an algorithm transforms it into information. The distinction between data and information thus relies on two interrelated assumptions: first, that DNA is the original and most natural and neutral matter, and second, that human intervention interrupts this naturalness and "contaminates" it.[84]

Should digital sequence information be confined to "representational data" (such as the DNA sequence GTACCTGA)? And, if not, to what extent should it include processing activities performed with that data by data producers, curators, and users to generate information? According to experts from the Deep-Ocean Stewardship Initiative, "different amounts of work are needed to convert different types of data into information."[85] Under this approach, to decide whether something falls into the definition of a digital sequence information, one would need to consider its proximity to the "original" genetic resource as well as the degree of "biological processing" it has undergone. In other words, one should ascertain "how far along the flow from genetic resource onwards to DNA, RNA, protein sequences and metabolites DSI can be considered to extend."[86]

Additionally, human labor is distinguished based on its complexity. Data that is intensely worked upon and thus severed from the material source becomes information. The availability of easy tools for DNA or protein conversion defines the resulting knowledge as data, whereas the difficulty of 3-D protein folding models defines it as information. By this logic, DNA sequences that are considered data today would have been defined as information 50 years ago, when the act of examining and documenting a sample was a process of human-guided

FIGURE 4.4 The top portion of a tubeworm from the Brine Pool, photographed in the deep sea of the northern Gulf of Mexico with white light by Operation Deep Scope Expedition, 2004. Credit: NOAA/OAR/OE.

interpretation. If a given tool of interpretation is sufficiently ubiquitous and its meaning standardized within the scientific community then it is no longer seen as generating information, only data. In other words, the distinctions between data and information—and the nature-culture assumptions that underpin it—change over time. Information today will become data tomorrow (but not the other way around). And so while data seems uninteresting, in fact: "the real source of innovation in current biology is the attention paid to data handling and dissemination practices and the ways in which such practices mirror economic and political modes of interaction and decision making, rather than the emergence of big data and associated methods per se."[87]

Enfolded into seemingly technical deliberations about data, the major scientific debates of this digital era illuminate deeper debates about the definition and scope of scientific knowledge and its relationship with other social and legal practices. In the words of philosopher Sabina Leonelli:

> Data are at once technical and social objects, local products and global commodities, common goods to be freely shared and strategic investments to be defended, potential evidence to be explored and meaningless clutter to be eliminated—and the tension between these conflicting and yet perfectly adequate interpretations is what keeps debates around data and their role in science so lively and indicative of the multifaceted nature of scientific and technological expertise.[88]

"Data journeys" entail processes of decontextualization ("to make sure that data are extracted from their original birthplace") and recontextualization ("to make it possible for researchers unfamiliar with these data to assess their evidential value and use them for their own research purposes").[89] Specifically, the legal abstraction of marine life occurs through a threefold legal-scientific process: first, organisms are configured as marine genetic resources, then as data, and finally, as information. This legal abstraction is what enables the decontextualization of marine life as an object of juridical and scientific knowledge and, thus, the exploitation of this life through capitalist extraction. The debates over the scope of marine genetic resources and their relation to digital sequence information illustrate that the scientific definition of data and its regulation are tied together and even coproduced. The next section moves to consider these data debates as they apply to the specific context of the BBNJ.

Archiving Marine Genetic Resources: The Devil Is in the Data

Although the BBNJ negotiations are still underway, access to marine genetic resources is already happening on the ground and, along with it, the production of massive marine databases. Deep-sea records currently available from areas beyond national jurisdiction include 371,890 records of 10,437 species, observed between 1866 and 2018.[90] However, the records are not consistent. Generally, there is a shortage in deep-sea taxonomists and in funding for taxonomic research. Specifically, the existing data reflects taxonomic priorities and geographic biases, such as the extensive sampling in the North East Atlantic.[91] Consequently, there are taxonomic data gaps in certain parts of the world's oceans.[92] Along these lines, Jaspars described large ocean patches, especially in the Pacific, from which data was never collected and sequenced. A recent expedition to one such site involved the discovery of microbes that are estimated to be one-hundred million years old.[93]

Alongside the concerns about the equitable uses of data archives in the context of the deep sea, two fundamental questions remain in this context: first, what should be classified as data? and, second, which standards should govern the production of this data? While a consensus is emerging among deep-sea scientists about the importance of data openness and transparency, practices vary with regard to sharing information on marine scientific research activities, and no central global cruise registry currently exists to facilitate such information sharing.[94] As part of this tendency, a growing number of sequences are deposited without reference to their formal scientific names, what scientists call "operational taxonomic units." This practice has resulted in an explosion of "dark taxa"—species in databases such as GenBank that lack useful scientific reference data[95]—and the generation of excess "taxonomic entities" with limited scientific meaning.

A related issue that has come up in the negotiations for the BBNJ treaty is the "lack of site and other core associated data connected to genetic data"[96]—what is also referred to as "contextual data." While the database guidelines often

recommend that contextual data be uploaded alongside the sequences, there often is no obligation to provide any more data about the specimen than a mandatory specimen ID number. This has resulted in a proliferation of sequences deposited at genetic data repositories without sample collection information. The disconnect between sequence and contextual data is perceived by many deep-sea scientists as a significant problem.[97] From the other end, an abundance of data requirements will often translate into terabytes of data for just one single study—which introduces yet another set of problems.[98] The practical implications of imposing standards for contextual data across the board are also questionable, as commercial products are rarely, if ever, traced back to their source in areas beyond national jurisdiction.[99]

In sum, the data journey that defines certain forms of life as marine genetic resources or as digital sequence information involves decontextualization from their material entity and their recontextualization as *res juridicus*. The price of this journey is the alienation of this source, which renders it irrelevant for protection as a form of ocean life. This potential loss of protection is especially relevant in the context of environmental or e-DNA—that is, the DNA extracted from environmental samples (such as soil, water or air) without requiring a sample from an identified organism source.[100] If DNA matters in databases only when it can be recontextualized "back" to the living organism from which it was sourced,[101] then in the case of e-DNA asserting such a contextual link becomes even more challenging.

Such expert discussions have become especially important due to the technological advancements that allow not only a journey away from the organic source of the DNA but also a journey back to the source through advanced synthetic biology. Indeed, synthetic biology could potentially combine useful gene sequences from different organisms and insert them into a host organism. The gene sequences in turn "become very difficult to trace back and it is important to find a workable solution to link all of the parts together."[102] Law holds an affirmative biopolitical power to (re)make life from information by regulating the obligatory passage points in these various data journeys.

Mare Geneticum as the "Final Frontier": Final Thoughts

This chapter has explored the concept of marine genetic resources, or MGRs, using this exploration as a lens into the complex interrelations between science and law and among scientists and legal experts—especially as this has manifested in their work on drafting the new treaty for areas beyond national jurisdiction, referred to as the BBNJ. Up to this point, much of the debate on the legal status of marine genetic resources obtained from areas beyond national jurisdiction has been concerned with the monetary benefits that could arise from their commercial utilization.[103] Yet some have come to see marine genetic resources as the "last frontier," highlighting that their central benefits lie far beyond the financial sphere.

The concept *mare geneticum* has been applied to all forms of the frontier, monetary and otherwise. *Mare geneticum* is a modernized version of Hugo Grotius's freedom of the seas, or *mare liberum*. This updated version of Grotius's concept contends that freedom includes not only the right to freely travel upon the ocean's surface but also to "shar[e] its natural resources in an organized and regulated fashion, in particular commodities like fish and minerals."[104] Beyond the conventional commodities associated with the sea, this chapter has highlighted another form of extraction: marine genetic resources. As the marine experts who have coined the term put it: "The first benefit to be shared under *mare geneticum* is enabling and facilitating access to marine genetic resources and associated data, thus empowering humankind to make the best of the *last frontier that is the ABNJ* [areas beyond national jurisdiction]."[105] In their words: "the *Mare Liberum* of the 17th century finds its echo in the *Mare Geneticum* of the 21st century."[106]

Upon reading this chapter, one might question, or at least be more suspicious of, the celebratory mode of *mare geneticum* proponents in the BBNJ context. Rather than paving a novel path forward that departs from anthropocentric ways of viewing the ocean as a resource for humans to grab and extract from, the BBNJ seems to be mirroring and duplicating prior principles and treaties, especially the freedom of the seas principle, the Convention on Biological Diversity, the Nagoya Protocol, and, of course, UNCLOS.

Drawing on my interviews with marine experts and recording their concerns, I have argued here that such approaches toward governing the ocean are largely anachronistic. Faced with this opportunity for change, the current trajectory of the BBNJ seems to be falling into the same potholes of the prior regimes. Jeffrey Marlow commented along these lines that: "The treaty is a relatively conservative document in that it is borrowing a lot from what's been done before, without questioning the first principles of how the science has evolved and how the environment has changed since a lot of these things were initially written."[107]

Existing international treaty law usually inflicts fragmentation and violence by tearing ocean life and matter out of spatial and temporal contexts. This is performed in the traditional way, by physically extracting fish and minerals; but it is also done by extracting living DNA samples from the ocean, transforming them into digital sequences, and then recontextualizing them into commodities. Operating under the auspices of the BBNJ, certain deep-sea scientists have recently cautioned about the dangers of such an extractivist approach.

Indeed, several years into the BBNJ negotiations, some deep-sea scientists are now considerably less thrilled about genetic freedoms and more concerned about whether the new treaty will resolve the problems of the prior legal treaties,[108] and the Nagoya Protocol in particular. The criticism of the deep-sea scientists toward the Nagoya Protocol is multifold and includes its overwhelming economic focus,[109] its stifling bureaucratic processes,[110] and its disregard of scientists and their concerns.[111] Arnaud-Haond put it in the bluntest terms:

> Nagoya is a complete disaster. … What Nagoya did that was extremely deleterious was that it imposed the very same amount of bureaucracy on companies and on the conservationists and researchers. [This, although we] do not have the means of the pharmaceutical companies: we don't have lawyers; we don't have all this administrative bunch of people doing the administrative work for us. We do it ourselves.[112]

More broadly, the deep-sea scientists I spoke with pointed to the challenges faced by the access and benefit-sharing model of the Convention on Biological Diversity and the Nagoya Protocol. For them, the still nascent consideration of digital sequence information under the BBNJ might provide an opportunity to sever benefit-sharing from access so as to mitigate the biotechnological inequalities of access.[113] This "would secure benefits while maintaining open science and generating funds from taxes, levies, or tiered approaches that feed a multilateral fund."[114]

But if the BBNJ treaty indeed moves away from the Nagoya Protocol and its related mechanisms, this would introduce incongruencies between terrestrial and marine regimes, which would in turn result in what Jaspars described as "loopholes that would allow us to do something with marine species that we couldn't do with terrestrial species." Such loopholes, he explained, might end up facilitating problematic jurisdiction shopping between land and sea.[115]

In light of these myriad problems and after negotiating multiple international biodiversity protection treaties, Jaspars has come to altogether question the fundamental binary between land and ocean both reflected and reinforced by the existing treaty regimes. Since these treaties impact each other in deep ways, it is time, in his opinion, to consolidate the legal protection of life—both on land and at sea—into one organic law. In the introduction to this volume, I referred to such an approach that moves from the binaries of land/sea to more fluid land-sea regimes as "amphibious legal geographies."[116] To conclude, I circle back to Jaspars' vision for the future of the BBNJ: "I would honestly start again with a new treaty from the bottom up. I would make it multilateral; I would make it about sharing; and I would make it all-inclusive."[117] How to do so without repeating the mistakes of UNCLOS is the challenge of ocean governance at this precarious time.

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Notes

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12 Obviously, it is often unclear where the marine genetic resource was sourced. Harriet Harden-Davies (Post-Doctoral Research Fellow, Nereus Program at the Australian National Centre for Ocean Resources and Security, University of Wollongong & delegate of Deep-Ocean Stewardship Initiative), telephone interview by author, November 24, 2019. See also "Advancing Science-Based Policy," Deep-Ocean Stewardship Initiative, accessed October 2, 2020, https://www.dosi-project.org/.
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15 Rabone et al., "Access to Marine Genetic Resources," 3.

16 From the resolution: "the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction, in particular, together and as a whole, marine genetic resources, including questions on the sharing of benefits, measures such as area-based management tools, including marine protected areas environmental impact assessments and capacity-building and the transfer of marine technology." GA Res 72/249, ¶ 2 (December 24, 2017); see also "Ocean Genomics," 20.

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18 Macarena Gómez-Barris, *The Extractive Zone* (Durham: Duke University Press, 2017), xix.

19 Arrieta et al., "What Lies Underneath," 18321.

20 Marcel Jaspars (Co-Lead, Deep Sea Genetic Resources Working Group of the Deep-Ocean Stewardship Initiative), e-mail communication with author, April 7, 2022.

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29 *Decision Adopted by the Conference of the Parties to the Convention on Biological Diversity*, GA Dec XIII/16, UN Doc CBD/COP/DEC/XIII/16 (December 16, 2006); Nagoya Protocol.

30 "Digital Sequence Information—Clarifying Concepts," Deep-Ocean Stewardship Initiative, March 2020, https://www.dosi-project.org/wp-content/uploads/070-DSI-Policy-brief-V4-WEB.pdf, 2.
31 Rabone et al., "Access to Marine Genetic Resources," 3.
32 Ibid., 7–8. For this reason, the Consortium of European Taxonomic Facilities has recently proposed to replace the term "DSI" with "NSD"—Nucleotide Sequence Data—which, they argue, is a more precise term as it specifically refers to *raw* sequences. "Digital Sequence Information on Genetic Resources – Concept and Benefit-Sharing," Consortium of European Taxonomic Facilities, 2019, https://www.cbd.int/abs/DSI-views/2019/CETAF-DSI.pdf.
33 "2017, GGBN Letter to CBD on DSI," Global Genome Biodiversity Network, May 6, 2020, https://library.ggbn.org/share/s/RWfhVdVKSriNmj8MPvG8qw, 1; "Digital Sequence Information," International Chamber of Commerce Commission on Intellectual Property, May 30, 2017, https://iccwbo.org/content/uploads/sites/3/2017/05/ICC-IP-position-paper-on-digital-sequence-information.pdf, 1. The scientific community has pointed to current barriers to taxonomic related biodiversity research arising from ABS regulations within national jurisdictions. See Rohan Pethiyagoda, "Biodiversity Law Has Had Some Unintended Effects," *Nature* 429, no. 6988 (2004): 129; Meegan-Kumar, "The Nagoya Protocol," 31–35; Dirk Neumann et al., "Global Biodiversity Research Tied Up by Juridical Interpretations of Access and Benefit Sharing," *Organisms Diversity & Evolution* 18 (2018): 1–12; Prathapan et al., "When the Cure Kills," 1405–1406. Similar concerns have been raised by several states that any future regulation of access to marine genetic resources in areas beyond national jurisdiction could hinder marine scientific research. See International Institute for Sustainable Development, "BBNJ IGC-1 Highlights," *Earth Negotiations Bulletin* 25, no. 176 (2018), https://enb.iisd.org/vol25/enb25176e.html.
34 Sarah A. Laird and Rachel Wynberg, "Fact-Finding and Scoping Study on Digital Sequence Information on Genetic Resources in the Context of the Convention on Biological Diversity and the Nagoya Protocol," *Convention on Biological Diversity*, January 12, 2018, https://www.cbd.int/doc/c/e95a/4ddd/4baea2ec772be28edcd10358/dsi-ahteg-2018-01-03-en.pdf. See also Jaspars, interview. In the BBNJ context, different delegations opted to replace the term DSI with the term "*in silico*," to indicate a more spatially specific and thus more restrictive definition. This approach was adopted in the Access to Marine Genetic Resources Report, which stated that: "The accessibility of MGR from sources in situ (on site), ex situ (samples in collections) and in silico (information in databases) is key to the functioning of the deep-sea research community." Rabone et al., "Access to Marine Genetic Resources," 7.
35 Harden-Davies, interview.
36 Jaspars, interview.
37 Jeffrey Marlow (Assistant Professor of Biology, Boston University), telephone interview by author, October 17, 2019.
38 Rabone et al., "Access to Marine Genetic Resources," 4–7.
39 "Areas Beyond National Jurisdiction," Global Environmental Facility, 2021, https://www.thegef.org/topics/areas-beyond-national-jurisdiction; see also Alex G. Oude Elferink, "Exploring the Future of the Institutional Landscape of the Oceans Beyond National Jurisdiction," *Special Issue: New Frontiers in Ocean Environmental Governance* 28, no. 3 (2019): 236–243; Alex G. Oude Elferink, "Coastal States and MPAs in ABNJ: Ensuring Consistency with the LOSC," *International Journal of Marine and Coastal Law* 33 (2018): 437–466; Vito De Lucia, "The Question of the Common Heritage of Mankind and the Negotiations towards a Global Treaty on Marine Biodiversity in Areas Beyond National Jurisdiction: No End in Sight?" *McGill International Journal of Sustainable Development Law and Policy* (2020), http://dx.doi.org/10.2139/ssrn.3542384.

40 See Marie Bourel et al., "The Common of Heritage of Mankind as a Means to Assess and Advance Equity in Deep Sea Mining," *Marine Policy* 95 (2018): 311–316. See also Prue Taylor, "The Common Heritage of Mankind: Expanding the Oceanic Circle," in *The Future of Ocean Governance and Capacity Development*, ed. International Ocean Institute—Canada (Nijhoff: Brill, 2018), 142–150.
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43 Elizabeth Druel and Kristina Gjerde, "Sustaining Marine Life Beyond Boundaries: Options for an Implementing Agreement for Marine Biodiversity Beyond National Jurisdiction Under the United Nations Convention on the Law of the Sea," *Marine Policy* 49 (2014): 90–97.
44 "Introduction to Access and Benefit-Sharing," Secretariat of the Convention on Biological Diversity, 2011, https://www.cbd.int/abs/infokit/revised/web/all-files-en.pdf.
45 Thomas Greiber, "An International Instrument on Conservation and Sustainable Use of Biodiversity in Marine Areas beyond National Jurisdiction," IUCN, accessed October 6, 2021, https://www.iucn.org/sites/dev/files/import/downloads/paper_iii___options_and_approaches_for_access_and_benefit_sharing.pdf, 3.
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48 Namely, plant genetic resources for food and agriculture listed in Annex I of the ITPGRFA and the influenza viruses covered by the PIPF. See "International Treaty on Plant Genetic Resources for Food and Agriculture," United Nations, 2009, http://www.fao.org/3/i0510e/i0510e.pdf.
49 Because of high investment costs, uneven distribution of technologies and expertise, and legal ambiguity. See David Kenneth Leary, *International Law and the Genetic Resources of the Deep Sea* (Leiden: Martinus Nijhoff, 2007), 170. See also Morten Walløe Tvedt, "Chapter 11 Marine Genetic Resources: A Practical Legal Approach to Stimulate Research, Conservation and Benefit Sharing," in *The Law of the Seabed*, ed. Catherine Banet (Nijhoff: Brill, 2020), 238–254; and Robert Blasiak et al., "Corporate Control and Global Governance of Marine Genetic Resources," *Science Advances* 4, no. 6 (2018): eaar5237.
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51 Blasiak et al., "Corporate Control."
52 Leary, *International Law and the Genetic Resources of the Deep Sea*, 170.
53 Ibid.
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57 Ibid. Although she is talking about South America, her analysis is not less poignant in the deep sea.
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59 UN General Assembly, Revised Draft Text of an Agreement 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, ¶ 1, November 18, 2019, A/CONF.232/2020/3.
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62 United Nations Convention on the Law of the Sea art. 87, December 10, 1982, 1833 UNTS 432. See also Rabone et al., "Access to Marine Genetic Resources," 8.
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66 Elisabeth Mann Borgese, "The Process of Creating an International Ocean Regime to Protect the Ocean's Resources," in *Freedom for the Seas in the 21st Century: Ocean Governance and Environmental Harmony*, eds. Jon M. Van Dyke et al. (Washington, D.C.: Island Press, 1993), 23–37, 29.
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68 Ibid. According to Meegan-Kumar, the over legalistic approach that left the scientists out was one of the pitfalls currently facing the Nagoya Protocol. See also Rabone et al., "Access to Marine Genetic Resources," 15.
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73 Ibid.
74 Fran Humphries (Senior Research Fellow and Program Leader of the Law and Nature Research Program, Griffith University), Zoom interview by author, October 6, 2020.
75 Jaspers, interview.
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78 Paraphrased in Martti Koskenniemi, "EJIL Foreword: Imagining the Rule of Law: Rereading the Grotian 'Tradition,'" *European Journal of International Law* 30, no. 1 (2019): 17–52, 17.
79 Ibid.

80 Nijman, "Grotius' 'Rule of Law,'" 1107.
81 Humphries, interview.
82 DOSI is a "global network of experts which seeks to integrate science, technology, policy, law and economics to advise on ecosystem-based management of resource use in the deep ocean." Deep-Ocean Stewardship Initiative, "Advancing Science-Based Policy."
83 DOSI, "Digital Sequence Information," 2.
84 The United States Supreme Court case *Chakrabarti* decided on similar grounds that what is "patentable" is based on whether or not human intervention into natural life occurred. *Diamond v. Chakrabarty*, 447 U.S. 303 (1980). There, the Court held that a live, human-made microorganism is patentable subject matter under statute providing for issuance of a patent to a person who invents or discovers any new or useful manufacture or composition of matter. The material in question was distinguished from Newton's discovery of gravity, Einstein's discovery of the formula $E = mc^2$, and any other discovery of the "handiwork of nature," since it did not exist in nature before being produced by Chakrabarty.
85 Deep-Ocean Stewardship Initiative, "Advancing Science-Based Policy."
86 DOSI, "Digital Sequence Information," 3.
87 Leonelli, *Data-Centric Biology*, 2.
88 Ibid., 195.
89 Ibid., 194.
90 Rabone et al., "Access to Marine Genetic Resources," 11. Data was extracted from areas beyond national jurisdiction at depths of 500 meters and greater from the Ocean Biogeographic Information System (OBIS).
91 Rabone et al., "Access to Marine Genetic Resources," 11.
92 European Commission, "Report of the Workshop," 17.
93 Jaspars further noted that although access to such a place is "phenomenally expensive, the sedimentation rates are so low in the Pacific, [that] what they found is that one meter or two meters [down] is already one million years." But these extraordinarily ancient microbes are situated relatively close to the seafloor. "They went to this water in the middle of nowhere, they drilled a hole a few hundred meters down, and they went down hundreds of millions of years [finding] a 100-million-year-old bacteria. It was a big news splash a few weeks ago." Jaspars, interview. News reports about this event include Elizabeth Pennisi, "Scientists Pull Living Microbes, Possibly 100 Million Years Old, From Beneath the Sea," *Science*, July 28, 2020, https://www.sciencemag.org/news/2020/07/scientists-pull-living-microbes-100-million-years-beneath-sea.
94 Muriel Rabone et al., "Assessing and Sharing Benefits from Marine Genetic Resources from Areas Beyond National Jurisdiction: Building on Best Practices in the Scientific Community," Deep-Ocean Stewardship Initiative, March 2019, https://www.researchgate.net/publication/332152611, 2.
95 Rabone et al., "Access to Marine Genetic Resources," 10. See Roderic D.M. Page, "DNA Barcoding and Taxonomy: Dark Taxa and Dark Texts," *Philosophical Transactions of the Royal Society B* 371, no. 1702 (2016): 20150334.
96 Rabone et al., "Access to Marine Genetic Resources," 10. See also Lisa C. Pope et al., "Not the Time or the Place: The Missing Spatio-Temporal Link in Publicly Available Genetic Data," *Molecular Energy* 24, no. 15 (2015): 3802–3809.
97 Rabone et al., "Access to Marine Genetic Resources," 10. See also Pope et al., "Not the Time or the Place," 3802–3809; Paolo Gratton et al., "A World of Sequences: Can We Use Georeferenced Nucleotide Databases for a Robust Automated Phylogeography?" *Journal of Biogeography* 44, no. 2 (2016): 475–486; John Deck et al., "The Genomic Observatories Metadatabase (GeOMe): A New Repository for Field and Sampling Event Metadata Associated with Genetic Samples," *PLoS Biology* 15, no. 8 (2017): e2002925.
98 Rabone et al., "Access to Marine Genetic Resources," 10.

99 According to Jaspars, they were only traced back once, in the case of a face cream. Jaspars, interview, see also "Kiehl's Abyssine Cream +," Birchbox, accessed October 21, 2020, https://www.birchbox.com/product/1793/kiehls-abyssine-cream.
100 Pierre Taberlet et al., "Environmental DNA," *Molecular Ecology* 21, no. 8 (2012): 1789–1793.
101 Harden-Davies, interview; see also European Commission, "Report of the Workshop," 10.
102 European Commission, "Report of the Workshop," 16.
103 Yet some marine scientists have pointed out that this is unfounded. As one put it: "these monetary benefits have gained a prominence out of scale to their likelihood and without any evidence of their importance to date." Rabone et al., "Access to Marine Genetic Resources," 7.
104 Broggiato et al., "*Mare Geneticum*," 6.
105 Ibid., 22–23.
106 Ibid., 6.
107 Marlow, interview.
108 Jaspars, interview.
109 Humphries, interview; Kristina Gjerde (High Seas Policy Advisor, the International Union for Conservation of Nature Global Marine and Polar Program), in-person interview by author, Cambridge, MA, September 25, 2019.
110 Arnaud-Haond, interview.
111 Rabone et al., "Access to Marine Genetic Resources," 15.
112 Arnaud-Haond, interview. See also Prathapan et al., "When the Cure Kills," 1405–1406. The authors contend that "the NP [Nagoya Protocol] and resulting national ambitions on Access and Benefit Sharing (ABS) of genetic resources have generated several national regulatory regimes fraught with unintended consequences. Anticipated benefits from the commercial use of genetic resources, especially those that might flow to local or indigenous communities because of regulated access to those resources, have largely been exaggerated and not yet realized. Instead, national regulations created in anticipation of commercial benefits, particularly in many countries that are rich in biodiversity, have curtailed biodiversity research by in-country scientists as well as international collaboration."
113 Sarah Laird et al., "Rethink the Expansion of Access and Benefit Sharing," *Science* 367, no. 6483 (2020): 1200–1202.
114 Ibid., 1202. See Charles Lawson et al., "The Future of Information Under the CBD, Nagoya Protocol, Plant Treaty, and PIP Framework," *Journal of World Intellectual Property* 22, nos. 3–4 (2019): 103–119.
115 Jaspars, interview.
116 For a detailed exploration of the land-sea binary and its impacts see the Introduction to this volume. See also Moana Jackson, "Indigenous Law and the Sea," in *Freedom for the Seas in the 21st Century: Ocean Governance and Environmental Harmony*, eds. Jon M. Van Dyke et al. (Washington, D.C.: Island Press, 1993), 41–48; Stephen Allen, Nigel Bankes, and Øyvind Ravna, *The Rights of Indigenous Peoples in Marine Areas* (London: Bloomsbury Publishing, 2019).
117 Jaspars, interview.