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INTRODUCTION

In 1980, the U.S. Supreme Court issued its seminal decision, *Diamond v. Chakrabarty*.[1] That decision permitted the patenting, and hence the private ownership, of man-made living organisms.[2] What the reams of paper filed in this watershed case did not anticipate was how the patenting of genetically modified organisms would cause nations and individuals responsively to assert property rights over naturally occurring biological and genetic material. The propertization of living organisms and their genetic material did not remain cabined to "man's handiwork." Rather, it set off an unexpected chain reaction of collateral propertization of unmodified genetic and other biological material.

Until recently, nations and individuals treated genetic material—the subcellular sequences that direct the structure and characteristics of all living things—as open access property.[3] Like information in the

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1 447 U.S. 303 (1980).

2 *Id.* at 318.

3 *See* John R. Adair, *The Bioprospecting Question: Should the United States Charge Biotechnology Companies for the Commercial Use of Public Wild Genetic Resources?*, 24 ECOLOGY L.Q. 131, 141 (1997) (noting that access to all wild genetic resources had traditionally

public domain, genetic resources were available in principle for the use of all.[4] No one held an exclusive ownership interest in this material, and individuals and countries freely shared samples of seeds, soil and even animal specimens containing it.[5] In sharp contrast, today, extensive ownership rights envelop genetic material.[6] Individuals and corporations patent genetic sequences that they have isolated.[7] Meanwhile, national governments of developing countries, which house most of the world's genetic material in its natural state, increasingly assert sovereign ownership rights over biological samples containing this material.[8]

What accounts for this transformation? Explaining the evolution of property rights from open access or global commons regimes to more exclusive ones has long presented one of the great challenges to understanding developments in the law.[9] This long-standing query holds particular importance today. Nations and societies preserve fewer places, spaces and goods as open access or commons property,

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been open); Edgar J. Asebey & Jill D. Kempenaar, *Biodiversity Prospecting: Fulfilling the Mandate of the Biodiversity Convention*, 28 VAND. J. TRANSNAT'L L. 703, 707 (1995) (stating that genetic resources were traditionally viewed as part of a "common heritage . . . freely available to all"); Cary Fowler, *Protecting Farmer Innovation: The Convention on Biological Diversity and the Question of Origin*, 41 JURIMETRICS J. 477, 480–81 (2001) (noting the "long-established system of easy access to biological resources); Kal Raustiala & David G. Victor, *The Regime Complex for Plant Genetic Resources*, 58 INT'L ORG. 277, 284 (2004) ("For most of human history, the rule of common heritage governed [plant genetic resources]."). Briefly, the cells of all living things contain genes. Genes code for proteins, and proteins determine the structure and characteristics of life forms. MATT RIDLEY, GENOME 6–9 (1999).

4 Sabrina Safrin, *Hyperownership in a Time of Biotechnological Promise: The International Conflict to Control the Building Blocks of Life*, 98 AM. J. INT'L L. 641, 644 (2004).

5 *See id.* at 641, 644–45.

6 *Id.* at 645–46.

7 While a gene or a genetic sequence in its natural state cannot be patented, a patent may issue if the naturally occurring gene is synthesized from its original state and ascribed a useful function. *See* Utility Examination Guidelines, 66 Fed. Reg. 1092, 1093 (Jan. 5, 2001); Linda J. Demaine & Aaron Xavier Fellmeth, *Reinventing the Double Helix: A Novel and Nonobvious Reconceptualization of the Biotechnology Patent*, 55 STAN. L. REV. 303, 359–60 (2002). For example, no patent may issue for a gene in a person that bears responsibility for breast cancer while the gene remains in the person. A patent, however, may issue if someone isolates the gene and identifies a useful function for it. The isolated and purified genetic sequence does not exist in nature.

8 Safrin, *supra* note 4, at 641.

9 *See* Thomas W. Merrill, *Introduction: The Demsetz Thesis and the Evolution of Property Rights*, 31 J. LEGAL STUD. S331, S331 (2002); *see also* Hanoch Dagan & Michael A. Heller, *The Liberal Commons*, 110 YALE L.J. 549, 561 (2001) (stating that the evolution from commons to private property "remains a puzzle").

replacing them instead with more exclusive property regimes.[10] Over the last several decades, knowledge, in particular, has undergone increased propertization, and the trend to expand intellectual property rights continues.[11]

The canonical explanation offered by Harold Demsetz for the evolution of property regimes[12] is that private property rights emerge when the economic value of a resource changes relative to the costs of controlling it such that it becomes cost-efficient to establish a property regime over the resource and to internalize costs or benefits previ-

10 On the general expansion of private property at the expense of open access or commons systems, see DAVID BOLLIER, PUBLIC ASSETS, PRIVATE PROFITS 27–31 (2001).

11 *See* LAWRENCE LESSIG, THE FUTURE OF IDEAS 3–16 (2001); *see also* Michael A. Carrier, *Cabining Intellectual Property Through a Property Paradigm*, 54 DUKE L.J. 1, 12 (2004) (describing how the duration and scope of intellectual property rights have been expanding without limit); Edmund W. Kitch, *Intellectual Property and the Common Law*, 78 VA. L. REV. 293, 293 (1992) (noting wide agreement that intellectual property protection has expanded in recent years). Legal protection has increased in two important ways: The domain of the protected interest has expanded, and the nature of the protection accorded has expanded. *See* Wendy J. Gordon, *On Owning Information: Intellectual Property and the Restitutionary Impulse*, 78 VA. L. REV. 149, 151–57 (1992); *see also* Carrier, *supra*, at 8–12 (noting the "dramatically enlarged scope and duration" of intellectual property). Patents now extend to innovations that a previous generation considered unpatentable. These include software, living organisms and business methods. The standards for obtaining a patent have relaxed. *See* ADAM B. JAFFE & JOSH LERNER, INNOVATION AND ITS DISCONTENTS 10–11 (2004). Patent examiners used to operate under the edict that when in doubt they should reject. *Id.* at 34–35. Today the operating assumption is when in doubt, grant. *Id.* Property rights in the area of copyright have expanded dramatically in duration, scope and in the categories of work eligible for protection. *See* Eldred v. Ashcroft, 537 U.S. 186, 193–94 (2003) (upholding Congress's expansion of the copyright term by twenty years); Carrier, *supra*, at 13–16; Gordon, *supra*, at 152–54. For the expansion of property rights in the area of trademark, see Boston Prof'l Hockey Ass'n v. Dallas Cap & Emblem Mfg., 510 F.2d 1004, 1012 (5th Cir. 1975) (applying the antidilution doctrine so as to threaten to grant perpetual protection for symbols even when their use causes no confusion as to the source of origin); Robert N. Klieger, *Trademark Dilution: The Whittling Away of the Rational Basis for Trademark Protection*, 58 U. PITT. L. REV. 789, 851–63 (1997); Mark A. Lemley, *The Modern Lanham Act and the Death of Common Sense*, 108 YALE L.J. 1687, 1687–88 (1999); David Dante Troutt, *A Portrait of the Trademark as a Black Man: Intellectual Property, Commodification, and Redescription*, 38 U.C. DAVIS L. REV. 1141, 1144–46 (2005).

12 Harold Demsetz, *Toward a Theory of Property Rights*, 57 AM. ECON. REV. PAPERS & PROC. 347 (1967). Merrill notes that most efforts to explain the transformation of property rights from open access or commons systems to more exclusive ownership regimes begin with Demsetz's work. *See* Merrill, *supra* note 9, at S331. Indeed, many, if not most, first year property law courses begin with Demsetz's celebrated work. *See, e.g.*, JESSE DUKEMINIER ET AL., PROPERTY 41–50 (6th ed. 2006).

ously experienced as externalities.[13] Changes in relative value typically occur when some external shock, like the introduction of a new technology or the opening or closing of particular markets, alters the costs and benefits of the existing property regime.[14] Biotechnology explains the transition of genetic material from open access property to private or government property from a Demsetzian perspective.[15] The introduction of this novel technology, which enables the manipulation of genes to create new agricultural, therapeutic and other goods, increased the actual or the potential value of the underlying genetic material used by the technology.[16] This increased value engendered the creation of property rights over genetic material.[17]

Yet, one cannot explain the overall evolution of property rights over genetic material from an open access or global commons good to a private or government-owned good by pointing to an increase in its economic value relative to the costs of controlling it. Actual or potential value does not explain today's extensive property regimes over genetic material. Indeed, the extent of these rights and the costs of establishing and maintaining them often exceed the material's economic value.[18] As we shall see, the Demsetzian account does not adequately explain the rise of property rights in other areas either.

Under the classic Demsetzian account, the emergence of private property rights marks a progressive development that should be celebrated because it reflects a society's movement to a more efficient property regime.[19] Others have proposed a more sinister interest

13 Demsetz, *supra* note 12, at 350. Demsetz identified three types of externalities internalized by private property rights. First, the creation of private property rights creates incentives for people to improve the resource in question. *Id.* at 356. Otherwise, the community as a whole would benefit from the individual's work, creating a free rider problem. Second, in the case of a scarce resource, private property rights can mitigate its depletion, and hence prevent a tragedy of the commons. *Id.* Third, the creation of private property rights can reduce the number of parties who must agree to control spillover effects, such as flooding and pollution. *Id.* at 356–57. Property rights can thereby facilitate a consensus to address these problems. Merrill, *supra* note 9, at S331–32.

14 Stuart Banner, *Transitions Between Property Regimes*, 31 J. LEGAL STUD. S359, S359 (2002); Demsetz, *supra* note 12, at 350.

15 Raustiala & Victor, *supra* note 3, at 279, 282–83.

16 *Id.*

17 *See id.* (applying Demsetz's thesis to the evolution of property rights over plant genetic material).

18 *See infra* Part III.C.

19 Banner, *supra* note 14, at S360. Scholars have criticized Demsetz's thesis on a number of grounds. Richard A. Posner faults Demsetz for making an unjustified "leap from assuming efficiency maximizing behavior of individuals to assuming efficiency-maximizing behavior of a society." DUKEMINIER ET AL., *supra* note 12, at 49

group theory for the emergence of property rights.[20] This Article suggests that instead of the progressive dynamic envisioned by the classic Demsetzian account, a more subtle and damaging chain reaction dynamic can come into play that interest group theory neither anticipates nor explains.[21] This Article argues that the establishment and the expansion of intellectual and other property rights have an internally generative dynamic. The assertion of or demand for property rights by some engenders the assertion of or demand for related property rights by others. This cycle of increased demand for and resulting recognition of property rights may have little to do with the actual or the potential value of the resource in question relative to the costs of controlling it. Rather, the creation of property rights itself engenders the demand for additional property rights.

Part I develops this chain reaction theory for the evolution of property by drawing upon several case studies: (a) the newly established property regimes over genetic material; (b) the recent move-

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(quoting Richard A. Posner, *Some Uses and Abuses of Economics in Law*, 46 U. CHI. L. REV. 281, 289 (1979)). Carol Rose and Barry Fried note that while Demsetz criticizes common property, he gives short shrift to its virtues. *Id.* at 50. Finally, others fault Demsetz for attempting to derive conclusions on property ownership and use "from incomplete historical data on primitive societies." *Id.* at 50 (quoting Eric T. Freyfogle, *Land Use and the Study of Early American History*, 94 YALE L.J. 717, 740 n.73 (1985)). Despite these criticisms, Demsetz's thesis remains the most common starting point for understanding why property rights evolve. *See supra* note 12.

20 Saul Levmore points out that for every optimistic efficiency-based story about the evolution of property rights there exists a pessimistic interest-group-based story. Saul Levmore, *Two Stories About the Evolution of Property Rights*, 31 J. LEGAL STUD. S421, S431 (2002). For example, Terry Anderson and Peter Hill posit that property rights emerge because individuals of superior ability act to capture the economic rents from the creation of property rights. Terry L. Anderson & Peter J. Hill, *Cowboys and Contracts*, 31 J. LEGAL STUD. S489, S490–93 (2002). According to Stuart Banner, when powerful oligarchs control both the political system and the largest share of resources whose value would be maximized by the creation of property, property rights will arise. Banner, *supra* note 14, at S365–70. Interest group theories, for example, appear to best explain Congress's recent extension of the copyright term by twenty years. Congress seems to have largely bowed to the demands of the Disney Corporation and other politically powerful corporations who stood to gain from the extension. *See generally* WILLIAM M. LANDES & RICHARD A. POSNER, THE ECONOMIC STRUCTURE OF INTELLECTUAL PROPERTY LAW 408–09 (2003) (describing the forces that called for and even drafted the Sonny Bono Copyright Term Extension Act, Pub. L. No. 105-298, 112 Stat. 2827 (1998) (codified at 17 U.S.C. §§ 301–304 (2000)).

21 Interest group theories do not explain, for example, the emergence of property rights over naturally occurring genetic material or sui generis intellectual property rights over traditional knowledge, discussed *infra* Part I.A–B. Those proposing and promulgating these rights, most notably developing country governments, do not constitute interest groups.

ment to establish intellectual property rights over traditional knowledge; and (c) the dramatic increase in patent activity even though paradoxically the expected value of individual patents has diminished, commonly referred to as the patent paradox.[22]

Part II offers three explanations for why property rights evolve in a chain reaction. The first two draw upon group behavior theory and focus on social dynamics rather than on the kind of economic factors that Demsetz and his followers have emphasized. The third flows from property's core right—the right to exclude.

The chain reaction theory for the evolution of property rights yields several important insights which are developed in Part III. First, the creation of property rights in one sphere can trigger unanticipated changes in other property regimes, a phenomenon that traditional theories do not usually anticipate nor adequately explain.[23] In fact, those demanding or creating the initial property rights may even be aghast at the repercussions of their actions. Today's global economy makes this collateral creation of property rights more pronounced because changes in property rights in one country can trigger unanticipated changes in the property regimes of another. Second, the thesis gives new importance to first movers in the evolution of property rights precisely because first movers may initiate a chain reaction of propertization. Third, while a change in actual or potential value occasioned by a technological or market breakthrough may provide the impetus for moving toward a property regime, the transition process itself may have little to do with value or any cost-benefit calculation. As a result, the overall resulting property regime may not reflect an efficient outcome from a cost-benefit perspective and may be worse than the regime that preceded it.

The chain reaction theory for the evolution of property rights has both explanatory power and cautionary implication. It helps explain the emergence of more restrictive property regimes and the expansion of existing ones.[24] It does not, however, purport to explain the

22 Gideon Parchomovsky & R. Polk Wagner, *Patent Portfolios*, 154 U. PA. L. REV. 1, 5, 17 (2005) (summarizing the patent paradox).

23 Some have drawn attention to a "domino" effect that the commoditization of certain goods can have. They argue that once market value enters the rhetoric for that good, this rhetoric can contaminate all thinking about it. *See generally* Margaret Jane Radin, *Market-Inalienablilty*, 100 HARV. L. REV. 1849, 1912–14 (1987) (describing the domino theory). The domino effect differs from the chain reaction dynamic discussed in this Article. The chain reaction dynamic envisions property rights in one sphere engendering the creation of property rights in a different though related sphere, and is not rhetoric-based.

24 Property theorists distinguish between different forms of property regimes that represent a spectrum of access accorded to a given resource. These include: open

transformation of property regimes in all situations or to serve as the exclusive explanation for the process through which all property rights evolve. Other theories, like the powerful interest group theories,[25] theories that focus on the evolution of property norms in close-knit communities,[26] or those that point to other factors for property rights such as the nexus between property and human flourishing,[27] may better explain the transformation of property in some situations or may operate in conjunction with the chain reaction theory in others. The chain reaction theory is cautionary because it shows that once property rights are created, they take on a life of their own and can have serious unanticipated consequences. Therefore, deci-

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access regimes, commons property regimes, state-ownership regimes and private property regimes. *See, e.g.*, Dagan & Heller, *supra* note 9, at 555–58 (discussing the three standard forms of ownership—commons property, private property, and state property). Open access regimes allow the greatest amount of access. *Id.* at 557. Open access resources remain available to all. *Id.* Commons property remains available to all members of a given group. *Id.* If that group is sufficiently large, the difference between open access and commons resources is slight. *Id.* In state ownership regimes, the state owns the resource in question and can provide extensive or little access to the good in question. Private property belongs to a given individual or legal person who can generally restrict access. *Id.* at 556. Recently, scholars have identified mixed regimes which blend aspects of both commons and private property. *See* Robert A. Heverly, *The Information Semicommons*, 18 BERKELEY TECH. L.J. 1127, 1161–64 (2003); Henry E. Smith, *Semicommon Property Rights and Scattering in the Open Fields*, 29 J. LEGAL STUD. 131, 131–34 (2000). This Article tackles the transition from more open systems of property to more restrictive ones. While this usually involves the evolution of an open access or general commons resource to a private property good, it can also involve the movement from an open access good to a more restricted one, such as to a state-owned or limited commons good.

25 *See supra* note 20.

26 Some suggest that property rights "emerge as a norm widely shared among the members of a close-knit community with a strong commonality of interests." Merrill, *supra* note 9, at S336–37 (identifying the norm theory and the interest group theories as the two main theoretical clusters for explaining the transformation of property rights). Richard Epstein, for example, points to the emergence of informal exclusion rights to on-street parking following snowstorms as a situation where a property norm emerges in a neighborhood community. Richard A. Epstein, *The Allocation of the Commons: Parking on Public Roads*, 31 J. LEGAL STUD. S515, S528–33 (2002). Robert Ellickson posits that efficient norms emerge in close-knit communities of well-informed and similarly endowed people. ROBERT C. ELLICKSON, ORDER WITHOUT LAW 167 (1991); Robert C. Ellickson, *Property in Land*, 102 YALE L.J. 1315, 1320–21. *But see* Eric A. Posner, *Law, Economics, and Inefficient Norms*, 144 U. PA. L. REV. 1697, 1706, 1724–25 (1995) (criticizing the view that closely knit communities produce efficient norms).

27 Margaret Jane Radin, *Property and Personhood*, 34 STAN. L. REV. 957, 957 (1982) (arguing "that to achieve proper self-development . . . an individual needs some control over resources in the external environment" and those "necessary assurances of control take the form of property rights").

sionmakers, when granting new property rights or expanding existing ones, need to take into account the reverberation effect of their actions up front.[28]

In most scholarship on tangible and intangible property, to the extent that the fields are considered together, the tendency is to borrow insights from conventional property rights and apply these insights to intellectual property.[29] The scholarship also focuses on the evolution of property in national contexts. This Article, in contrast, uses case studies from intellectual property to yield insights into the evolution of property generally, upending our usual way of thinking.[30] Moreover, it draws upon international developments to shed light on a long-standing question in property law that has remained insufficiently illuminated in national contexts. In doing so, it may represent the next frontier in the study of international law, namely the use of

28 The issue of how much property constitutes too much falls outside the scope of this Article.

29 *See, e.g.*, Carrier, *supra* note 11, at 5 (arguing that legal limitations on tangible property should apply to intellectual property); Wendy J. Gordon, *A Property Right in Self-Expression: Equality and Individualism in the Natural Law of Intellectual Property*, 102 YALE L.J. 1533 (1993) (applying Lockean tenants of property to intellectual property); Justin Hughes, *The Philosophy of Intellectual Property*, 77 GEO. L.J. 287 (1988) (applying a range of property theories, including Margaret Jane Radin's property as personhood theory, to intellectual property). *But see* Brett M. Frischmann, *Evaluating the Demsetzian Trend in Copyright Law*, REV. L. & ECON. (forthcoming 2007) (manuscript at 14–24), *available at* http://ssrn.com/abstract=855244 (using copyright law to challenge Demsetz's normative thesis by arguing that externalities do not necessarily distort the allocation of resources and that for certain classes of intellectual property works less internalization may lead to more investment).

30 The evolution of property rights over both tangible goods and over knowledge involves the same core issue of why and how people seek to establish ownership rights over goods. Stephen R. Munzer, *The Commons and the Anticommons in the Law and Theory of Property*, *in* THE BLACKWELL GUIDE TO THE PHILOSOPHY OF LAW AND LEGAL THEORY 148, 149 (Martin P. Golding & William A. Edmundson eds., 2005). Moreover, the use of case studies from the intellectual property field appears particularly appropriate given that intellectual property rights themselves have sufficiently expanded over the last two decades increasingly to resemble property rights over tangible goods. *See* Carrier, *supra* note 11, at 4–5; *see also* Frank H. Easterbrook, *Intellectual Property is Still Property*, 13 HARV. J.L. & PUB. POL'Y 108, 112 (1990) (asserting, inter alia, that the "right to exclude in intellectual property is no different in principle from the right to exclude in physical property"); Mark A. Lemley, *Property, Intellectual Property, and Free Riding*, 83 TEX. L. REV. 1031, 1032 (2005) (noting that the legal regime for intellectual property "increasingly looks like the law of real property"). Furthermore, as demonstrated by the case study below involving genetic material, the line between tangible and intangible goods can blur. *See infra* Part I.A. An expansion of intellectual property rights over intangible goods like biotechnological innovations can trigger the expansion of property rights over tangible or quasi-tangible goods like raw genetic material.

international developments to help answer outstanding questions of general legal concern.[31]

I. THREE CASE STUDIES OF THE CHAIN REACTION EVOLUTION OF PROPERTY RIGHTS

In a nuclear chain reaction, the splitting of the nucleus of one atom releases neutrons which in turn split the nuclei of additional atoms and so on.[32] In a propertization chain reaction, the creation or the expansion of property rights causes individuals to seek additional property rights. Just as the first generation splitting of a nucleus produces second generation nucleic splits, the creation of first generation property rights engenders the creation of second generation property rights. These second generation property rights often arise in spheres related to, but other than, the sphere in which the original property rights arose and are generally unexpected by decisionmakers who created the first generation rights. While the creation of first generation property rights largely finds explanation and justification in traditional theories of tangible and intangible property rights, the second generation property rights that they engender do not. Unlike first generation private property rights, which may reduce tragedies of the commons, address resource scarcity, maximize efficiency, encourage investment in the development of the resource and, in the intellectual property context, promote innovation and creative works, second generation property rights do not accomplish these goals. This section will explore three case studies to illustrate how the chain reaction process works. The case studies show that, whatever the motivation for the creation or the expansion of some initial property rights, once these rights are created, another dynamic can kick in.

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31 Scholars of comparative law and international law often consider the laws of other countries or international standards to ascertain best legal practices or emerging norms. The approach utilized in this Article, in contrast, does not focus on a particular doctrinal question, such as whether the patent system ought to reward the first to file a patent application rather than the first to invent or whether the death penalty comports with the norms of nations comparable to the United States. Rather, it uses international developments to tackle broader legal puzzles. It thus adds a new realm to those suggested by other international law scholars for the innovative use of international law. *See, e.g.*, Anne-Marie Slaughter Burley, *International Law and International Relations Theory: A Dual Agenda*, 87 AM. J. INT'L L. 205 (1993) (suggesting an interdisciplinary approach whereby international relations theorists learn from international law and international lawyers learn from international relations theory); Jeffrey L. Dunoff & Joel P. Trachtman, *Economic Analysis of International Law*, 24 YALE J. INT'L L. 1, 5 (1999) (applying economic theory to international law but also suggesting that international law can inform our understanding of law and economics).

32 *See* AM. NUCLEAR SOC'Y, CONTROLLED NUCLEAR CHAIN REACTION 8 (1992).

A. The Evolution of Property Rights Over Genetic Material

Before *Chakrabarty*, with the notable exception of certain man-made plants that received a limited form of intellectual property protection in a few countries, types of living organisms, whether naturally occurring or man-made through traditional breeding, could not be exclusively owned.[33] For example, while a person might own a particular dog, no one could own a breed of dog. Moreover, nations treated genetic material as an open access resource.[34] As with the living resources of the high seas, states did not assert sovereignty over genetic material nor did they seek to appropriate it.[35] No single individual, corporation or nation held an exclusive right to prevent others from using the resource generally.[36]

The *Chakrabarty* case generated numerous amicus briefs.[37] All knew that if the Supreme Court allowed Dr. Chakrabarty to patent his genetically engineered oil-eating microbe, others would seek to patent and hence enjoy property rights over their man-made living creations. Indeed, in the ten years following Chakrabarty's victory, patents were extended in rapid order to isolated and purified genetic sequences,[38]

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33 *See* Raustiala & Victor, *supra* note 3, at 284.

34 *See supra* note 3.

35 Safrin, *supra* note 4, at 644–45 & nn.15–22.

36 *Id.* at 645 & n.22.

37 Diamond v. Chakrabarty, 447 U.S. 303, 316 (1980) (noting the large number of amicus briefs); *see also infra* notes 188–90, 192 (collecting amicus briefs in *Chakrabarty*).

38 *See* Amgen, Inc. v. Chugai Pharm. Co., 927 F.2d 1200, 1205–12 (Fed. Cir. 1991) (upholding a 1987 patent on a purified and isolated human DNA sequence encoding erythropoietin); U.S. Patent No. 4,370,417 (filed Apr. 3, 1980) (issued Jan. 25, 1983) (covering the DNA sequence for plaminogen activator protein). The *Chakrabarty* decision swung open the door to the patenting of "anything under the sun that is made by man." *Chakrabarty*, 447 U.S. at 309 (quoting S. REP. No. 82-1979, at 5 (1952)). In so doing, it created an environment favorable to the patenting of genetic sequences provided that they could be deemed man's handiwork. Earlier cases that allowed the patenting of isolated and purified chemical compounds provided the basis for a man's handiwork determination. *Parke-Davis & Co. v. H.K. Mulford Co.*, 189 F. 95, 97, 103 (C.C.S.D.N.Y. 1911), *aff'd in part, rev'd in part*, 196 F. 496, 500 (2d Cir. 1912), upheld a patent on adrenaline, a substance isolated and purified from the adrenal glands of animals. Judge Learned Hand reasoned that no one had ever isolated a similar substance, and the patentee "was the first to make [the extract] available for any use by removing it from the other gland-tissue . . . [whereby] it became for every practical purpose a new thing commercially and therapeutically." *Id.* at 103; *see also* Merck & Co. v. Olin Mathieson Chem. Corp., 253 F.2d 156, 164 (4th Cir. 1958) (upholding a patent on purified Vitamin B-12). In *Amgen*, the Federal Circuit noted that "[a] gene is a chemical compound, albeit a complex one." *Amgen*, 927 F.2d at 1206. The lower court in *Amgen* explained, "The invention claimed . . . is not as plaintiff argues the DNA sequence encoding human EPO since that is a nonpatent-

to man-made plants,[39] and to animals.[40] Unanticipated, however, was how the propertization of living organisms and their genetic material would set off a chain reaction of collateral propertization of unmodified genetic and other naturally-occurring biological material. First, the governments of developing countries began to assert sovereign ownership rights over raw genetic material in their countries and to restrict access to such material.[41] Second, patients began to assert property or other legal rights in biological specimens, such as blood or tissue samples, that they had contributed in the course of receiving medical treatment.[42] By the turn of the millennium, raw biological material increasingly moved from an open access or global commons good to a private or government-owned good.

Demsetz's thesis as well as traditional theories for the granting of intellectual property rights explain the actions of those who sought patents over bioengineered goods and isolated genetic sequences as well as developed countries' grant to them of these first generation property rights. The biotechnology revolution offered economic reward to those who could isolate genetic sequences and create bioengineered innovations. Chakrabarty and those that supported him sought to establish a property interest in their living innovations to capture the economic value of their contributions. The United States and most other developed countries extended patent protection to these inventions to promote their emerging biotechnology sectors.

Demsetz's thesis as well as traditional theories for intellectual or tangible property rights do not adequately explain nor even usually anticipate the second wave of propertization: the emergence of exclusive ownership rights over raw biological material. Granting property

able natural phenomenon 'free to all men and reserved exclusively to none. . . .' Rather, the invention as claimed . . . is the '*purified and isolated*' DNA sequence encoding erythropoietin." Amgen, Inc. v. Chugai Pharm. Co., 13 U.S.P.Q.2d (BNA) 1737, 1759 (D. Mass. 1989) (emphasis added) (quoting *Chakrabarty*, 447 U.S. at 309), *aff'd in part, vacated in part*, 927 F.2d 1200 (Fed. Cir. 1991). For a critique of gene patenting, see Eileen M. Kane, *Splitting the Gene: DNA Patents and the Genetic Code*, 71 TENN. L. REV. 707, 764–67 (2004).

39 *Ex parte* Hibbard, 227 U.S.P.Q. (BNA) 443, 444 (B.P.A.I. 1985) (allowing patent for genetically engineered maize seed).

40 *See, e.g., Ex parte* Allen, 2 U.S.P.Q.2d (BNA) 1425, 1426 (B.P.A.I. 1987) (permitting patent of a genetically modified oyster egg), *aff'd*, 846 F.2d 77 (Fed. Cir. 1988); U.S. Patent No. 4,736,866 (filed June 22, 1984) (issued Apr. 12, 1988) (covering a mouse genetically engineered for susceptibility to cancer, commonly known as the "Onco-Mouse").

41 *See infra* notes 49–52 and accompanying text.

42 *See infra* notes 62–80 and accompanying text.

rights in naturally occurring genetic material does not encourage innovation. This material already exists. Moreover, property rights in raw genetic material do not, for example, avoid tragedies of the commons or address resource scarcity. Genetic material is not at risk of overuse, and one need not fell a forest to access its genetic material. While a desire to profit from biological samples may play some role in demands both by developing countries and by patients for a property interest in their raw biological samples, it leaves much unexplained. Instead, as shown below, these second generation property rights arose in response to the first generation property rights.[43] A tit-for-tat dynamic, rather than a cost-benefit analysis designed to capture the actual or potential economic value of raw genetic material, animates the emergence of these responsive property rights.

Developing countries harbor the greatest amount of the world's naturally occurring genetic material because they comprise most of the countries which hug the equatorial line where the greatest numbers of life forms concentrate.[44] Why, these countries asked, should individuals and companies from gene-poor developed countries obtain genetic material free of charge from gene-rich developing countries when they then patent these genes and at times sell them back to the country where the genetic material originated?[45] Moreover, developing countries faced increasing pressure to extend patent protection to man-made living organisms and their genetic material. In the late 1980s, the United States began to require, as a condition of free trade relations, that other countries extend intellectual property

43 *See infra* Part I.B–C.

44 Envtl. Policy Studies Workshop, *Access to Genetic Resources: An Evaluation of the Development and Implementation of Recent Regulation and Access Agreements* 3 (Columbia Univ. Sch. Int'l & Pub. Affairs, Working Paper No. 4, 1999), *available at* http://www.biodiv.org/doc/case-studies/abs/cs-abs-agr-rpt.pdf.

45 WALTER REID ET AL., BIODIVERSITY PROSPECTING 23 (1993). *See generally* Keith Aoki, *Neocolonialism, Anticommons Property, and Biopiracy in the (Not-So-Brave) New World Order of International Intellectual Property Protection*, 6 IND. J. GLOBAL LEGAL STUD. 11, 47–50 (1998) (summarizing the objections of Vandana Shiva, Ruth Gana (Okediji), Rosemary Coombe, James Boyle, Jack Kloppenberg and others who have written about the "Great Seed Rip-off," whereby international conventions allowed plant breeders to use traditional indigenous varieties of seeds and "improve them" via minor genetic alterations without compensating the countries from where those seeds originated); James O. Odek, *Bio-Piracy: Creating Proprietary Rights in Plant Genetic Resources*, 2 J. INTELL. PROP. L. 141, 141 (1994) (explaining that developing countries now "passionately" protest the prospecting for plant species by scientists from multinational corporations in developing countries' tropical forests who then protect their discoveries through intellectual property rights). "To developing countries, these practices constitute uncompensated exploitation of their 'plant genetic resources' in the name of intellectual property rights." *Id.* at 141.

protection to bioengineered and other goods.[46] This link between trade and intellectual property rights blossomed in full with the 1994 adoption of the Agreement on Trade-Related Aspects of Intellectual Property Rights ("TRIPS Agreement") as part of the world trading system.[47] The TRIPS Agreement required countries to extend intellectual property protection to most bioengineered goods or face trade sanctions.[48]

In response to the propertization of improved genetic material, developing countries pressed for the international recognition of sovereign rights over raw genetic material in the 1992 Convention on Biological Diversity (CBD).[49] The CBD no longer considered genetic resources to form part of "the common heritage of mankind," as had traditionally been the case, but rather to fall within the province of

46 SUSAN K. SELL, POWER AND IDEAS 132–39 (1998) (discussing U.S. linkage of trade and intellectual property in bilateral negotiations); Laurence R. Helfer, *Regime Shifting: The TRIPs Agreement and New Dynamics of International Intellectual Property Lawmaking*, 29 YALE J. INT'L L. 1, 20–22 (2004) (discussing how the United States successfully achieved more stringent intellectual property protection standards in developing countries in the 1980s by linking intellectual property protection to trade and helped motivate the United States to shift intellectual property lawmaking from the World Intellectual Property Organization (WIPO) to the General Agreement on Tariffs and Trade (GATT)); G. Richard Shell, *Trade Legalism and International Relations Theory: An Analysis of the World Trade Organization*, 44 DUKE L.J. 829, 843–44 (1995) (describing statutes which give the U.S. President unilateral authority to impose trade sanctions on those countries which did not protect intellectual property by using section 301, "Super 301" and "Special 301," all of which were part of the Trade Act of 1974, Pub. L. No. 93-618, 88 Stat. 1978, as amended in 1988).

47 WORLD TRADE ORG., THE LEGAL TEXTS: THE RESULTS OF THE URUGUAY ROUND OF MULTILATERAL TRADE NEGOTIATIONS 321 (1999) [hereinafter TRIPS Agreement].

48 *Id.* art. 27, at 332–33. Article 27(3)(b) allows WTO members to exclude animals from patentability. *Id.* at 333. The United States, however, has pressed countries to extend such protection through post-TRIPS bilateral agreements, commonly referred to as TRIPS-plus agreements. GENETIC RES. ACTION INT'L (GRAIN), "TRIPS-PLUS" THROUGH THE BACK DOOR 4–5 (2001), http://www.grain.org/docs/trips-plus-en.pdf (identifying some 23 bilateral and regional agreements requiring intellectual property protection for life forms beyond that mandated by the TRIPS Agreement, including agreements with Jordan, Mongolia, Nicaragua, Sri Lanka and Vietnam). *See generally* Peter Drahos, *BITs and BIPs: Bilateralism in Intellectual Property*, 4 J. WORLD INTELL. PROP. 791, 792–807 (2001) (describing "TRIPS-plus" bilateral agreements between developing countries and the United States and the European Community).

49 Article 15(1) of the Convention on Biological Diversity, June 5, 1992, 1760 U.N.T.S. 143, 152 [hereinafter CBD] states: "Recognizing the sovereign rights of States over their natural resources, the authority to determine access to genetic resources rests with the national governments and is subject to national legislation." As of January 2007, 190 states have ratified or acceded to the convention. The United States has signed but not joined the Convention. Parties to the Convention on Biological Diversity, http://www.biodiv.org/world/parties.asp (last visited May 16, 2007).

sovereigns who would control access to such material.[50] Since 1993, over forty nations have passed or are in the process of passing laws which greatly restrict access to raw genetic material in their countries.[51] Under these laws, the national government either owns all raw genetic material in the country or greatly restricts access to it through a multilayered consent process.[52]

One can further see the reactive dynamic at play in the history of the International Undertaking on Plant Genetic Resources for Food and Agriculture ("International Undertaking"). In the 1920s and 1930s, a select number of developed countries began to grant plant breeders a limited form of intellectual property rights (commonly referred to as plant breeders' rights) for their new and stable plant varieties.[53] In 1961, they adopted a treaty to provide for these breeders' rights.[54] This marked a change from the traditional system where farmers and breeders freely shared their improved varieties with one another.[55] Developing countries responded to these new property rights by pressing for an international agreement that would guarantee that all breeding lines, whether traditional or improved, would remain open.[56] Eight developed countries refused to join this agreement out of concern that it would interfere with plant breeders' intel-

50 Cynthia M. Ho, *Biopiracy and Beyond: A Consideration of Socio-Cultural Conflicts with Global Patent Policies*, 39 U. MICH. J.L. REFORM 433, 473 (2006); Safrin, *supra* note 4, at 644–45, 647.

51 Lyle Glowka, *Bioprospecting, Alien Invasive Species, and Hydrothermal Vents: Three Emerging Legal Issues in the Conservation and Sustainable Use of Biodiversity*, 13 TUL. ENVTL. L.J. 329, 330–31 (2000) (reporting that fifteen nations or state provinces have passed laws greatly restricting access to raw biological, including genetic, material within their borders). Since Mr. Glowka's article, at least two other nations, Brazil and India, have put access-restricting regimes into place. *See* Safrin, *supra* note 4, at 641 n.4. At least thirty others are in the process of doing so as of 2000. *See* Glowka, *supra*, at 331 & n.9.

52 For an analysis of these laws, see Safrin, *supra* note 4, at 649–55.

53 *See* Fowler, *supra* note 3, at 477–78.

54 International Convention for the Protection of New Varieties of Plants, Dec. 2, 1961, 33 U.S.T. 2703, 815 U.N.T.S. 89 (as amended in 1978 & 1991) [hereinafter UPOV Convention], *available at* http://www.upov.int/en/publications/conventions/1991/pdf/act1991.pdf. Member States to this Convention must grant and protect breeders' rights at the national level for plant varieties that are new, distinct, uniform and stable. *Id.* art. 6(1).

55 Fowler, *supra* note 3, at 479–80; Raustiala & Victor, *supra* note 3, at 284–87.

56 *See* Naomi Roht-Arriaza, *Of Seeds and Shamans: The Appropriation of the Scientific and Technical Knowledge of Indigenous and Local Communities*, 17 MICH. J. INT'L L. 919, 928 (1996).

lectual property rights.[57] In 1989, these countries succeeded in adding an Annex to the International Undertaking, which expressly stated that the Undertaking would not compromise breeders' rights.[58] Having failed to maintain an open system, developing countries responded by asserting their sovereign rights over plant genetic material in a second Annex, which parties to the Undertaking adopted in 1991.[59]

While a desire to profit from genetic material partly underlies the development of sovereign rights over genetic material,[60] conspicuously absent from the years of international and national deliberations on arrangements to restrict access to genetic material are basic threshold determinations key to a cost-benefit analysis. One does not see, for example, calculations of the demand for raw genetic material as reflected in actual levels of bioprospecting activity. Decisionmakers and negotiators also appear uninterested in determining the actual supply of genetic material reflected, for example, in the extent to which raw genetic material is scarce or widespread. Missing too are estimated costs of establishing and enforcing government ownership regimes. Why?

The key operating dynamic is that of a tit-for-tat. Namely, if developed countries assert and demand that developing countries recognize intellectual property rights over man-made living organisms and isolated and purified genetic sequences, then developing countries believe that they should also assert property interests over the raw genetic material that may contribute to the patented goods. Raw genetic material has contributed to pharmaceutical innovations and improved crops from time immemorial. Yet sovereigns only asserted ownership rights over this material after the patent system recognized private ownership rights over the material and internationalized these property rights through pre-TRIPS agreements and eventually

57 International Undertaking on Plant Genetic Resources, FAO Conference Res. 4/89, at 8, 25th Sess. (Nov. 29, 1989) [hereinafter FAO Res. 4/89], *available at* ftp://ftp.fao.org/ag/cgrfa/Res/C4-89E.pdf.

58 *Id.* at 8–9.

59 International Undertaking on Plant Genetic Resources, FAO Conference Res. 3/91, at 12, 26th Sess. (Nov. 25, 1991) [hereinafter FAO Res. 3/91], *available at* ftp://ftp.fao.org/ag/cgrfa/Res/C3-91E.pdf (providing that the International Undertaking's heritage of mankind concept was "subject to the sovereignty of the states over their plant genetic resources" and that "nations have sovereign rights over their plant genetic resources").

60 Those encouraging developing countries to pass legislation restricting access to raw genetic material frequently characterized genetic material as "genetic oil" or "genetic gold." However, they made no serious attempt to back these assertions with facts.

through the TRIPS Agreement itself. Public statements of developing country leaders also evidence this responsive dynamic.[61]

Similarly, a cost-benefit analysis designed to capture the actual or the potential economic value of raw genetic material does not animate patient demands for a property interest or related legal right over contributed tissue samples. Again, a reactive dynamic plays out. Donors felt that if researchers and corporations obtain property rights by patenting cell lines and genetic sequences isolated from tissue samples, then they too should claim a property interest in the tissue samples from which those patents sprung.

Moore v. Regents of the University of California[62] represents the most celebrated case involving this kind of a property claim. University of California medical researchers freely obtained blood and tissue samples from patient John Moore in the course of treating him for hairy-cell leukemia.[63] Indeed, for generations, medical researchers freely and routinely used biological samples obtained from patients for research.[64] In *Moore*, however, the researchers not only developed a stable cell line from Moore's biological materials, they patented that line.[65] The *Moore* case has generated scores of law review articles,[66] and Moore's physicians engaged in a series of unconscionable and unethical acts for which the California Supreme Court recognized a claim for breach of fiduciary duty.[67] Few scholars, however, focus on the fact that when Moore believed that the medical researchers were

61 *See, e.g.*, U.N. Conference on Gov't and Dev., June 3–14, 1992, *Report Volume III: Statements Made by Heads of State or Government at the Summit Segment of the Conference*, 189, U.N. Doc. A/CONF.151/26/Rev.1 (Vol. III) (1993) [hereinafter U.N. Conference Report], *available at* http://documents-dds-ny.un.org/doc/UNDOC/GEN/N93/373/95/pdf/N9337395.pdf?OpenElement.

62 793 P.2d 479 (Cal. 1990).

63 *Id.* at 481–82.

64 *See id.* at 494–95 (describing large tissue repositories and the widespread free sharing between researchers of human cell lines); 1 ARTHUR B. LAFRANCE, BIOETHICS § 3.02[1], at 495 (1999); NAT'L BIOETHICS ADVISORY COMM., RESEARCH INVOLVING HUMAN BIOLOGICAL MATERIALS (1999), *reprinted in* CARL H. COLEMAN ET AL., THE ETHICS AND REGULATION OF RESEARCH WITH HUMAN SUBJECTS 701 (2005) ("The most common sources of human biological materials are diagnostic or therapeutic interventions in which diseased tissue is removed or tissue or other material is obtained to determine the nature and extent of a disease. Even after the diagnosis or treatment is complete, a portion of the specimen routinely is retained for future clinical [or] research . . . purposes.").

65 U.S. Patent No. 4,438,032 (filed Jan. 6, 1983) (issued Mar. 20, 1984).

66 *See* ALAN HYDE, BODIES OF LAW 67–74 (1997) (discussing some of the literature and adding to it).

67 *Moore*, 793 P.2d at 483–88.

using his tissue samples for academic and medical research[68] he, like generations of patients before him, did not object to their doing so. He brought suit asserting a property interest in his excised cells *only* when he learned that the researchers had obtained an exclusive property interest, through patent, in the cell line derived from him. He expressed outrage: "What the doctors had done, was to claim that . . . my genetic essence[] was their invention and their property."[69] Moore's assertion of a private property right in his excised tissue arose in response to the researchers' obtainment of a private property right in his cell line.

Although the California Supreme Court refused to recognize Moore's property interest in his excised spleen and other tissue samples,[70] as the patenting of cell lines and genetic sequences increased, patients and patient groups continued to seek legal remedy when their donated biological material found its way into patented goods.[71] In *Greenberg v. Miami Children's Hospital Research Institute, Inc.*,[72] a group of parents of children afflicted with the fatal Canavan disease and several nonprofit patient groups sued a research physician and his associated medical research institution for unjust enrichment.[73] For six years, Canavan families contributed blood, urine and autopsy samples as well as epidemiological and medical information in an effort to assist researchers discover the genes responsible for the disease.[74] Using such samples and information, the research team successfully isolated the responsible gene.[75] This model of successful collaboration broke down when the researchers patented the isolated genetic sequence. They thereby "acquired the ability to restrict any activity related to the Canavan disease gene, including . . . carrier and prenatal testing, gene therapy and other treatments . . . and research involving the gene and its mutations."[76] The donors had provided the

68 *Id.* at 486 (explaining that the medical researchers had disclosed to Moore that "they 'were engaged in strictly academic and purely scientific medical research'").

69 Lori B. Andrews, *The Gene Patent Dilemma: Balancing Commercial Incentives with Health Needs*, 2 HOUS. J. HEALTH L. & POL'Y 65, 93 (2002) (citing John Vidal & John Carvel, *Lambs to the Gene Market*, GUARDIAN (London), Nov. 12, 1994, at 25).

70 *See Moore*, 793 P.2d at 488–93.

71 For a discussion of the growing movement to accord donors property rights over genetic material, see Gary E. Marchant, *Property Rights and Benefit-Sharing for DNA Donors?*, 45 JURIMETRICS J. 153, 159–65 (2005).

72 264 F. Supp. 2d 1064 (S.D. Fla. 2003).

73 *Id.* at 1066.

74 *Id.* at 1067. The patient groups also contributed financially to the endeavor. *Id.*

75 *Id.*

76 *Id.*

genetic material and other support in the belief that any genetic tests "developed in connection with the research for which they were providing essential support would be provided on an affordable and accessible basis, and that [the] research would remain in the public domain."[77] Upon learning of the researchers' patent and their attempts to enforce it, the furious parents and patient groups sued to establish their own legal rights flowing from the materials that they had donated.[78] In the words of one Canavan parent, "[our suit] is not about the Canavan families wanting a piece of the pie."[79] Rather than seeking a share of future royalties, in their complaint, the donors sought to prevent the patent holders from restricting access to the Canavan gene and from limiting genetic screening tests.[80]

Taking a different tack to establish a property interest, some donors of biological material have insisted on co-ownership of any patents arising from biological materials that they contributed. For example, Sharon Terry, whose two children suffered from the debilitating PXE (pseudoxanthorma elasticum) disorder, donated tissue samples and began a tissue bank to collect additional samples from other PXE patients.[81] In return, Terry became a co-owner of the patent for the ultimately isolated PXE gene.[82] When researchers initially asked Sharon Terry for tissue samples from her children, she expressed surprise that researchers no longer shared existing samples with each other.[83] Terry and the PXE group that she founded have obtained a property interest in the patented gene derived from their donated biological specimens not for economic remuneration but

77 Greenberg v. Miami Children's Hosp. Research Inst., Inc., 208 F. Supp. 2d 918, 921 (N.D. Ill. 2002).

78 The parties settled the case before trial. The settlement provided for license-free use of the patented Canavan gene in research and stated that the plaintiffs would no longer challenge the hospital's ownership and licensing of the gene patent. Joint Press Release, Canavan Found. & Miami Children's Hosp. (Sept. 29, 2003), *available at* http://www.canavanfoundation.org/news/09-03_miami.php.

79 Eliot Marshall, *Families Sue Hospital, Scientist for Control of Canavan Gene*, 290 SCIENCE 1062, 1062 (2000).

80 *Id.* In particular, the donors sought to block Miami Children's Hospital's commercial use of the patented gene and strenuously objected to the Hospital's limitation on the number of tests that could be performed by each licensee and to its having forced the Canavan Foundation to cease free genetic screening. *Id.*

81 Andrews, *supra* note 69, at 105.

82 *Id.*; Paul Smaglik, *Tissue Donors Use Their Influence in Deal Over Gene Patent Terms*, 407 NATURE 821, 821 (2000) (reporting that researchers who want to use the samples in the PXE International blood and tissue bank must agree to the PXE group's terms, which include joint ownership of any resulting intellectual property rights).

83 Andrews, *supra* note 69, at 105.

rather to ensure that the gene and any resulting genetic tests remain available for the benefit of those who suffer from PXE.[84]

As Gary Marchant notes, it matters little whether the law automatically accords property rights in genetic material if donors insist on such rights as a matter of contract.[85] The Canavan case as well as the PXE precedent paved the way for property rights in genetic material through contract. Indeed, several patient advocacy groups for genetic diseases appear to be pursuing a PXE model for the sharing of genetic material whereby groups of tissue donors obtain property rights in donated DNA samples.[86]

In all of the cases discussed above, donors sought to establish a property or related legal interest in material that in a previous generation they would have freely made available, each in reaction to the assertion of or threatened assertion of a property interest by others. But for society's willingness to recognize a patent right in isolated genetic sequences and cell lines, neither Moore nor Greenberg would have brought suit nor would PXE patient advocates likely have pressed for co-ownership of patents.

B. Property Rights in Traditional Knowledge

Most knowledge that we use is both traditional and free. It consists of human innovation and insight developed over millennia and passed down from generation to generation. A child born today will benefit from language that she made no contribution to creating. She will use numbers and a system of mathematics for free. She will enjoy food, songs and dances developed by generations long gone. She will inherit a range of methodologies from the tying of shoelaces to the manipulation of a range of tools and objects. We take the free availability of most information as a given. No one thinks to thank the Chinese, let alone pay a royalty to China, whenever eating pasta. Mexico holds no intellectual property right in the widespread use of aloe vera in soaps and moisturizers. Our use of Arabic numerals generates no

84 *Id.*; Smaglik, *supra* note 82; *see also* Eliot Marshall, *Patient Advocate Named Co-Inventor on Patent for the PXE Disease Gene*, 305 SCIENCE 1226 (2004) (detailing the involvement of Terry and PXE in the patent process).

85 Marchant, *supra* note 71, at 163.

86 *See* Genetic Alliance BioBank, http://www.biobank.org (last visited May 16, 2007); Donna M. Gitter, *Ownership of Human Tissue: A Proposal for Federal Recognition of Human Research Participants' Property Rights in Their Biological Material*, 61 WASH. & LEE L. REV. 257, 318–19 (2004) (indicating that patient advocacy groups for autism and juvenile diabetes are pursuing biorepositories for genetic material); Marchant, *supra* note 71, at 164 (noting that several patient advocacy groups are pursuing genetic sample repositories following the PXE model).

royalties for Arab nations nor do parents pay a royalty to Israel whenever they name a child Jacob or Hannah.

Yet, today many nations demand the development of intellectual property regimes to cover "traditional knowledge."[87] A flurry of international activity has materialized on this issue. In 2000, the World Intellectual Property Organization (WIPO) established an intergovernmental committee to address the protection of traditional knowledge, innovations and creativity, and expressions of folklore.[88] In 1999, the Parties to the CBD established a working group to address traditional knowledge issues,[89] and the 1992 CBD itself exhorts nations to respect and protect traditional knowledge.[90] The CBD working group has met four times, and numerous regional and experts meetings have convened on the topic as well.[91] Even the World Trade Organization has taken up the issue, calling upon the TRIPS Council "to examine . . . the protection of traditional knowledge and folklore."[92] A study by WIPO indicated that the majority of countries surveyed believe in the need for an international agreement for the protection of expressions of folklore. Several nations, such as Brazil and Panama, have already enacted measures purporting to protect traditional knowledge.[93]

87 Nations have yet to agree on a consistent definition of traditional knowledge. WIPO has defined traditional knowledge as "tradition-based literary, artistic or scientific works; performances; inventions; scientific discoveries; designs; marks, names and symbols; undisclosed information; and, all other tradition-based innovations and creations resulting from intellectual activity in the industrial, scientific, literary or artistic fields." WORLD INTELLECTUAL PROP. ORG., INTELLECTUAL PROPERTY NEEDS AND EXPECTATIONS OF TRADITIONAL KNOWLEDGE HOLDERS 25 (2001), *available at* http://www.wipo.int/tk/en/tk/ffm/report/final/pdf/part1.pdf.

88 WIPO Intergovernmental Committee, http://www.wipo.int/tk/en/igc/ (last visited May 16, 2007).

89 Conference of the Parties to the Convention on Biological Diversity, Bratislava, Slovk., June 15, 1998, *Report of the Fourth Meeting of the Conference of the Parties to the Convention on Biological Diversity, available at* http://www.cbd.int/doc/meetings/cop/cop-04/official/cop-04-27-en.pdf.

90 CBD, *supra* note 49, art. 8(j).

91 *See* CBD, Meetings and Documents, http://www.biodiv.org/programmes/socio-eco/traditional/meetings.shtml (search "subject" for "Article 8(j): Traditional Knowledge, Innovations and Practices" and "Year" for "<previous meetings>"). The working group met in 2000, 2002, 2003 and 2006. *Id.*

92 World Trade Organization, Ministerial Declaration of 14 November 2001, WT/MIN(01)/DEC/1, 41 I.L.M. 746 (2002), *available at* http://www.wto.org/english/thewto_e/minist_e/min01_e/mindecl_e.htm.

93 WIPO, Intergovernmental Committee on Intellectual Prop. and Genetic Res., Traditional Knowledge and Folklore, *Information on National Experiences with the Intellectual Property Protection of Traditional Knowledge*, 39–90, WIPO/GRTKF/IC/5/INF/2 (July 7–15, 2003) (reproducing national statutes such as Panama Law No. 20 on the

What has occurred to cause nations to demand the extension of intellectual property rights to tradition? Anthropologist Michael Brown observes that "[i]n the late 1980s, ownership of knowledge and artistic creations traceable to the world's indigenous societies emerged, *seemingly out of nowhere*, as a major social issue."[94] However, something did happen in the late 1980s that likely engendered such demands: the internationalization of intellectual property. In the late 1980s, the United States began to impose trade sanctions against countries that accorded little or no protection to U.S. intellectual property goods, pursuant to a new U.S. law called "Special Clause 301."[95] As mentioned earlier, the United States also made trade with it conditioned upon the granting of intellectual property rights in a number of bilateral agreements.[96] Moreover, in 1986 and 1987, the United States and the European Union linked intellectual property and trade in the negotiating mandate for the Uruguay Round of the General Agreement on Tariffs and Trade.[97] The 1994 adoption of the TRIPS Agreement, which emerged from the Uruguay Round, required countries to put in place, as a condition of participating in the world trading system, copyright, patent, trademark and trade secret laws.[98] Beginning in the late 1980s, developing countries were forced to extend a host of intellectual property protection to a vast

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Special Intellectual Property Regime Upon the Collective Rights of Indigenous Communities for the Protection of their Cultural Identity and their Traditional Knowledge, Ley No. 20, de 26 de junio de 2000; Brazil Provisional Measure; Peru Law No. 27811, Ley No. 27811, de 10 de agosto de 2002; Law Introducing a Protection Regime for the Collective Knowledge of Indigenous Peoples Derived from Biological Resources, Medida Provisória No. 2.186-16, de 23 de agosto de 2001 (Brazil), *available at* http://www.wipoint/edocs/mdocs/tk/en/wipo_grtkf_ic_5/wipo_grtkf_ic_5_inf_2.pdf.

94 MICHAEL F. BROWN, WHO OWNS NATIVE CULTURE?, at ix (2003) (emphasis added).

95 Omnibus Trade and Competitiveness Act of 1988, 19 U.S.C. §§ 2242(a), 2412(b)(2) (1998); Kim Newby, *The Effectiveness of Special 301 in Cheating Long Term Copyright Protection for U.S. Companies Overseas*, 21 SYRACUSE J. INT'L L. & COM. 29, 32–62 (1995); Shell, *supra* note 46, at 843–44. Under this clause, the United States imposed trade sanctions on a number of developing countries, including Argentina, Brazil and China. Remigius N. Nwabueze, *Ethnopharmacology, Patents and the Politics of Plants' Genetic Resources*, 11 CARDOZO J. INT'L & COMP. L. 585, 592 (2003). The U.S. Trade Representative also identified India, Japan and Thailand as either priority countries or on the priority watch list for trade sanctions due to inadequate protection of intellectual property. Peter K. Yu, *Currents and Crosscurrents in the International Intellectual Property Regime*, 38 LOY. L.A. L. REV. 323, 361–62 (2004).

96 *See supra* note 46.

97 Helfer, *supra* note 46, at 20–21.

98 TRIPS Agreement, *supra* note 47, at 321–53. As of February 2007, 150 nations have joined the World Trade Organization (WTO) and are hence bound by the

range of knowledge that had hitherto remained free in their countries. They responded to these first generation intellectual property rights by demanding in numerous international fora the development of second generation intellectual property rights which would propertize traditional knowledge generated in their countries that had previously remained open.

One can see this nexus between the internationalization of Western intellectual property protection and the movement to propertize traditional knowledge in multiple contexts. For example, developing countries strongly object to the requirement that they extend patent protection to pharmaceutical goods.[99] This requirement appeared in several pre-TRIPS bilateral agreements, and the TRIPS Agreement mandates such protection.[100] In turn, developing country demands for the extension of intellectual property protection to traditional knowledge often concern the protection of folk remedies.[101]

Developing countries also strongly object to the extension of intellectual property protection to plants. While most developed

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TRIPS Agreement. *See* WTO, Members and Observers, http://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm (last visited May 16, 2007).

99 *See, e.g.*, Nadia Natasha Seeratan, Comment, *The Negative Impact of Intellectual Property Patent Rights on Developing Countries: An Examination of the Indian Pharmaceutical Industry*, 3 SCHOLAR 339, 347 (2001); Global Coal. Against the Indian Patent Amendment, 26 February, Global Day of Action Against "TRIPs+", The Indian Patent Ordinance (Feb. 9, 2005), http://www.health-now.org/site/article.php?articleId=414&menuId=13 (describing extensive protests against TRIPS conforming amendments in the pharmaceutical area); Amit Sen Gupta, Indian Patent Act—Jeopardizing the Lives of Millions (June 22, 2005), http://phm-india.org/issues/patents/indianpatentact.html; Prasanna Saligram, The Other Tsunami, http://www.shaii.org/index.php?option=com_content&task=view&id=54 (characterizing TRIPS implementing legislation as a "tsunami"). *See generally* MARTIN J. ADELMAN ET AL., CASES AND MATERIALS ON PATENT LAW 59–60 (2d ed. 2003) (stating that many developing countries did not extend patent protection to drugs and widely manufactured them; the TRIPS Agreement was of great importance for the pharmaceutical industry); Martin J. Adelman & Sonia Baldia, *Prospects and Limits of the Patent Provision in the TRIPS Agreement: The Case of India*, 29 VAND. J. TRANSNAT'L L. 507, 524–32 (1996) (discussing the pharmaceutical industry in India and the effect of TRIPS).

100 TRIPS Agreement, *supra* note 47, art. 27, at 332–33; *see also* Adelman & Baldia, *supra* note 99, at 529 ("TRIPS requires India to establish . . . a patent system that will provide effective protection for new drugs and the processes for making them.").

101 *See, e.g.*, Gerard Bodeker, *Traditional Medical Knowledge, Intellectual Property Rights & Benefit Sharing*, 11 CARDOZO J. INT'L & COMP. L. 785, 786–89 (2003); Michael J. Huft, *Indigenous Peoples and Drug Discovery Research: A Question of Intellectual Property Rights*, 89 NW. U. L. REV. 1678, 1700 (1995) (discussing how the antimalarial drug quinine, derived from the bark of South American Cinchona trees, was first used by the indigenous peoples of Peru); Shayana Kadidal, Note, *Plants, Poverty, and Pharmaceutical Patents*, 103 YALE L.J. 223, 258 n.176 (1993).

countries eventually joined the International Convention for the Protection of New Varieties of Plants (UPOV Convention)[102] that required countries to extend intellectual property protection to new plant varieties, prior to the adoption of the TRIPS Agreement, virtually no developing countries had joined.[103] As developed countries successfully pressed for property rights over plants through the International Undertaking, pre-TRIPS bilateral pressure and finally through the TRIPS Agreement itself, developing countries reacted by demanding new legal protection for the traditional contributions of farmers and farming communities who had improved crops over generations. Thus, they responded to the added Annex to the International Undertaking that accommodated plant breeders' property rights[104] with the addition of an Annex calling for the recognition of "Farmers' Rights."[105] Farmers' Rights recognized the historical and continued contribution of farmers to the development of crops.[106]

In response to requirements that developing countries extend copyright protection to artistic works, these countries now demand that some kind of property right extend to traditional songs and dances that originated in their countries. Indeed, furor over the use of traditional folklore like dance and song often erupt when a Western artist obtains a copyright on a product that incorporates folklore. For example, the German singer Enigma's incorporation of the native Taiwanese *Song of Joy* into his copyrighted song *Return to Innocence* generated uproar, even though a group of native Taiwanese had publicly performed the song in music halls across Europe.[107] Though now settled, the incident would engender even greater consternation today now that China and Taiwan must grant copyright protection to Enigma's song pursuant to the TRIPS Agreement.[108]

Even the language used by those demanding the creation of intellectual property rights over traditional knowledge indicates the rela-

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102 *See supra* note 54.

103 Roht-Arriaza, *supra* note 56, at 941 n.114.

104 FAO Res. 4/89, *supra* note 57.

105 International Undertaking on Plant Genetic Resources, FAO Conference Res. 5/89, at 10, 25th Sess. (Nov. 29, 1989) [hereinafter FAO Res. 5/89], *available at* ftp://ftp.fao.org/ag/cgrfa/iu/iutextE.pdf. The Annex on Farmer Rights was in addition to the Annex on Sovereign Rights discussed earlier. *See supra* note 59 and accompanying text.

106 FAO Res. 5/89, *supra* note 105.

107 The performances were at the behest of the Chinese and French Cultural Ministries. Angela R. Riley, *Recovering Collectivity: Group Rights to Intellectual Property in Indigenous Communities*, 18 CARDOZO ARTS & ENT. L.J. 175, 176–77 (2000).

108 China and Chinese Taipei (Taiwan) joined the WTO on December 11, 2001 and January 1, 2002, respectively. WTO, *supra* note 98.

tionship between the internationalization of intellectual property and the demand to fashion new intellectual property rights to cover traditional knowledge. Developed countries and their companies repeatedly decried the widespread copying of Western drugs, movies, songs and software as "piracy."[109] Mimicking such characterization, those advocating the creation of property rights over traditional knowledge reciprocally characterize the uncompensated use of traditional knowledge as "piracy."[110]

While the national governments of developing countries respond to the internationalization of intellectual property by demanding new forms of intellectual property, the demands by indigenous groups for the protection of their traditional knowledge, while sometimes reactive to Western intellectual property, can stem from other concerns. For example, indigenous groups sometimes seek to protect and control knowledge that they consider sacred or private.[111] They may also seek to prevent persons from fraudulently depicting an item as an authentic native craft. Addressing these concerns, however, does not require the creation of new property rights but can be met with legislation that prohibits certain bad acts.[112]

Demsetz's thesis largely explains why developed countries have in the last several decades greatly expanded intellectual property rights both in their countries and around the world.[113] As the economies of these countries came increasingly to depend less on the manufacture

109 *See, e.g.*, *Special 301 and the Fight Against Trade Piracy: Hearing Before the Subcomm. on International Trade of the S. Comm. on Finance*, 103d Cong. 19 (1993) (testimony of Ira S. Shapiro, General Counsel, Office of the U.S. Trade Representative); Newby, *supra* note 95, at 44 n.91, 48 (discussing the Business Software Alliance's estimates that "software piracy in China costs U.S. industry $322 million each year and . . . that there is a 94% software piracy rate in that country" and statements by music industry members objecting to American creativity being "pirated," "counterfeited" or "ripped off"); Jon Newton, *Movie Studios Poised for Piracy Fight*, TECHNEWSWORLD, Aug. 30, 2005, http://www.technewsworld.com/story/45777.html.

110 *See, e.g.*, JAMES BOYLE, SHAMANS, SOFTWARE AND SPLEENS 121, 126 n.14 (1996); VANDANA SHIVA, BIOPIRACY 10–13 (1997).

111 *See* BROWN, *supra* note 94, at 11–42; Christine Haight Farley, *Protecting Folklore of Indigenous Peoples: Is Intellectual Property the Answer?*, 30 CONN. L. REV. 1, 13 (1997); *see also* Daniel J. Gervais, *Spiritual But Not Intellectual? The Protection of Sacred Intangible Traditional Knowledge*, 11 CARDOZO J. INT'L & COMP. L. 467, 478 (2003) (defining sacred traditional knowledge and examining its relationships with IP law).

112 *See, e.g.*, Indian Arts and Crafts Act of 1990, 25 U.S.C. § 305(a) (2000). This statute prohibits the representation of a work as a native craft when it is not and provides for criminal and civil penalties for such misrepresentation. For a description of the Act and its history, see generally Roberto Iraola, *The Civil and Criminal Penalty Provisions of the Indian Arts and Crafts Act of 1990*, 36 CUMB. L. REV. 293 (2006).

113 *See supra* notes 12–14 and accompanying text.

of articles and more on the generation of innovative drugs, movies, software, music and other intellectual property goods, they stood to gain by developing property rights that would enable their corporations and citizens to capture the commercial value of these goods.[114] As with the emergence of property rights over raw genetic material, Demsetz's thesis does not explain the sudden demand by developing countries for ownership rights in tradition. Traditional knowledge did not suddenly become commercially valuable in the late 1980s. Communities that generated such knowledge and those that interacted with them had always used this knowledge and applied it in commercial ways. Classic explanations for intellectual property also fail to explain this development. According intellectual property protection to tradition does not encourage new works. These works already exist. In fact, granting these rights can hinder the development of new works because people can no longer draw upon as rich a public domain. Moral rights justifications also have little explanatory purchase because the people who created the traditional works are long gone. Instead, the demand by developing countries for the creation of property rights over traditional know-how primarily arose in reaction to the worldwide expansion of Western intellectual property rights. The internationalization of intellectual property began a chain reaction of propertization that not only encompassed new technologies and creative works, but also innovations and expressions existent for centuries.

C. The Patent Paradox

One can see the chain reaction dynamic operating, though in a different way, in the so-called patent paradox. The patent paradox constitutes one of the most puzzling phenomena of today's patent activity. In the United States, as well as in other countries, the amount of patent activity has risen dramatically even though, paradoxically, the expected value of individual patents has diminished.[115] Patent filings generally rose by about forty percent between 1998 and 2003.[116] In addition, "patent intensity—the measure of patents obtained per research and development dollar—approximately doubled from the mid 1980s to the late 1990s."[117] Meanwhile, empirical research indi-

114 *See, e.g.*, SUSAN K. SELL, PRIVATE POWER, PUBLIC LAW 8 (2003) (discussing how private corporations were the main proponents for stronger intellectual property protection in the TRIPS Agreement).

115 Parchomovsky & Wagner, *supra* note 22, at 5.

116 *Id.* at 5 n.2.

117 *Id.*

cates the low average expected value of the overwhelming majority of patents.[118] Empirical studies set the average value of patents at $7,500–$25,000.[119] This generally represents less than their average acquisition costs, which conservatively run $10,000–$30,000 per patent prosecuted in the United States and several times that for inventions prosecuted in multiple countries.[120] Estimates suggest that about 1.5% of patents are litigated, of which courts deem almost half invalid,[121] and only a small additional number are licensed for royalty (as opposed to cross-licensed).[122] Strikingly, most patentees view their patents to hold so little value that they let them lapse before the end of their term rather than pay the periodic maintenance fees.[123]

Scholars have offered several theories to explain why so many seek patents, notwithstanding the low expected value of the over-

118 *Id.* at 5.

119 *Id.* at 5 n.3; *see also* Mark Schankerman, *How Valuable is Patent Protection? Estimates by Technology Field*, 29 RAND J. ECON. 77, 93 (1998) (concluding that "most patents have very little private value" with the median private value of patent rights, in 1980 dollars, amounting to only $1631 in the pharmaceutical industry, $1594 in the chemical field, $2930 in the mechanical field and $3159 in electronics excluding Japan).

120 Kimberley A. Moore, *Worthless Patents*, 20 BERKELEY TECH. L.J. 1521, 1526 (2005); Parchomovsky & Wagner, *supra* note 22, at 15, 16 n.53 (estimating the cost of obtaining protection in ten European countries at over $95,000) (citing Erwin F. Berrier, Jr., *Global Patent Costs Must Be Reduced*, 36 IDEA 473, 479 (1996)).

121 *See* John R. Allison & Mark A. Lemley, *Empirical Evidence on the Validity of Litigated Patents*, 26 AIPLA Q.J. 185, 205–06 (1998) (reporting that in cases that result in a final judgment on validity, courts find the patents invalid forty-six percent of the time).

122 Mark A. Lemley, *Rational Ignorance at the Patent Office*, 95 NW. U. L. REV. 1495, 1507 (2001).

123 *See* Moore, *supra* note 120, at 1526 (stating that "53.71% of all patentees do allow their patents to expire for failure to pay one of their maintenance fees"). Maintenance fees in the United States are $830 at three and a half years, $1900 at seven and a half years, and $2910 at eleven and a half years. 35 U.S.C. § 41(b) (2000). This trend appears in other countries as well. A study of French and German patents showed that only seven percent of the former and eleven percent of the latter were maintained until their expiration date. Ariel Pakes, *Patents as Options: Some Estimates of the Value of Holding European Patent Stocks*, 54 ECONOMETRICA 755, 774 (1986) (detailing a study which covered over a million French patents applied for between 1951 and 1979 and approximately 500,000 German patents issued between 1952 and 1972), *cited in* Parchomovsky & Wagner, *supra* note 22, at 114 n.49; *see also* Jean Olson Lanjouw, *Patent Protection in the Shadow of Infringement: Simulation Estimates of Patent Value*, 65 REV. ECON. STUD. 671, 693 (1998), *cited in* Parchomovsky & Wagner, *supra* note 22, at 114 n.49. Lanjouw's study of a sample of German patents filed between 1953 and 1988 showed that less than fifty percent of the patents were maintained for over ten years and less than thirty-five percent were maintained until the statutory expiration date.

whelming majority of them. These include (a) the lottery theory, which likens each patent to a potential winning lottery ticket;[124] (b) the signaling theory, which suggests that firms secure patents to provide information to outside investors;[125] (c) the internal metric theory, which posits that patents provide a means to measure employee performance;[126] and (d) the patent portfolio theory, which argues that patents of little individual worth become valuable when bundled together in a portfolio.[127] Each of these theories helps explain the patent paradox.

The chain reaction theory adds to these hypotheses by suggesting that today people and corporations also seek patents because others have done so. Patent activity begets patent activity. The frenzy to obtain patent rights over genetic fragments illustrates this copycat behavior. In June of 1991, Dr. Craig Venter, on behalf of the National Institutes of Health (NIH), applied for patents on some 2700 gene fragments of unknown function that he had sequenced using automated sequencing methods.[128] These new sequencing methods enabled the rapid identification of thousands of genetic fragments per month.[129] NIH's attempt to patent and hence control a large quantity of genetic material whose function it had not identified was unprecedented. Academics and industry groups immediately and harshly

124 Individuals and corporations obtain patents in the hope that one of them will turn into a winning lottery ticket. Because they cannot know in advance which of their patents will ultimately prove the winner, they patent everything. F.M. Scherer, *The Innovation Lottery*, *in* EXPANDING THE BOUNDARIES OF INTELLECTUAL PROPERTY 3, 11 (Rochelle Cooper Dreyfuss et al. eds., 2001) (showing that "a minority of 'spectacular winners' appropriate the lion's share of" patent rewards).

125 The signaling theory suggests that patents provide cheap, valuable information about the invention or firm to, for example, potential investors. *See* Clarisa Long, *Patent Signals*, 69 U. CHI. L. REV. 625, 643–64 (2002).

126 *See* Richard C. Levin, *A New Look at the Patent System*, 76 AM. ECON. REV. 199, 200–01 (1986); Wesley M. Cohen et al., *Protecting Their Intellectual Assets: Appropriability Conditions and Why U.S. Manufacturing Firms Patent (or Not)* (Nat'l Bureau of Econ. Research, Working Paper No. 7552, 2000), *available at* http://www.dklevine.com/archive/cohen-survey.pdf. In this connection, it bears noting that even universities evaluate professors on the number of patents that they have received. *See, e.g.*, Rutgers University, Form No. 1-a, http://ruweb.rutgers.edu/oldqueens/docs/2006-2007/gen/Form%201-A.doc (evaluating professors for promotion and tenure in part on the number of patents that they have received).

127 Parchomovsky & Wagner, *supra* note 22, at 29–31. For a discussion of the strengths and the limits of most of these theories, see *id.* at 19–27.

128 Molly A. Holman & Stephen R. Munzer, *Intellectual Property Rights in Genes and Gene Fragments: A Registration Solution for Expressed Sequence Tags*, 85 IOWA L. REV. 735, 750 (2000); Arti Kaur Rai, *Regulating Scientific Research: Intellectual Property Rights and the Norms of Science*, 94 NW. U. L. REV. 77, 98–99 (1999).

129 Holman & Munzer, *supra* note 128, at 750.

denounced its action, and uncertainty existed as to whether the U.S. Patent and Trademark Office (PTO) would even issue patents on such gene fragments.[130] Despite these criticisms, legal uncertainty and the enormous expense of preparing and filing patent applications, once word of NIH's applications got out, the lemmings began their march. Applications covering hundreds of thousands of genetic fragments began to pour into the PTO. By 1996, Incyte Pharmaceuticals alone had filed patent applications covering 400,000 genetic fragments.[131] Many patent applications extended over 2000 pages.[132] This immense flood of patent application activity confronted the PTO with a ninety-year backlog.[133] Widespread criticism caused NIH to eventually withdraw its original and subsequent applications.[134] NIH's applications, however, had already initiated a chain reaction. Thousands of applications continued to pour into the PTO, notwithstanding NIH's withdrawals.

The increasingly widespread use of defensive patenting, which scholars have identified as a factor contributing to today's high levels of patent activity, further evidences a chain reaction dynamic.[135] Corporations and individuals obtain patents for maintenance in a patent arsenal. Should someone sue or threaten to sue a corporation for patent infringement, the corporation countersues or threatens to countersue for infringement of one of the patents that it has warehoused in its arsenal. The corporations hope that, in the face of this actual or threatened lawsuit, the plaintiff will dismiss its suit, and each corporation will return to business as usual. In the alternative, the corporation uses patents in its arsenal to cross-license its technology with other corporations.[136] Each corporation thereby avoids litiga-

130 *Id.*

131 Eliot Marshall, *Patent Office Faces 90-Year Backlog*, 272 SCIENCE 643, 643 (1996).

132 Holman & Munzer, *supra* note 128, at 754.

133 Marshall, *supra* note 131, at 643.

134 Holman & Munzer, *supra* note 128, at 751.

135 FED. TRADE COMM'N, TO PROMOTE INNOVATION 3–33 (2003) [hereinafter FTC Report], *available at* http://www.ftc.gov/os/2003/10/innovationrpt.pdf (describing the use of defensive patenting); John H. Barton, *Reforming the Patent System*, 287 SCIENCE 1933, 1933 (2000) (describing how firms try to protect themselves from patent infringement lawsuits by assembling patent portfolios—frequently on very minor inventions—"so they can deter litigation through the threat of reciprocal suit"); Cohen et al., *supra* note 126, at 17 (explaining that one of the reasons why firms patent inventions is to prevent infringement lawsuits and identifying defensive patenting as a primary factor causing the increase in patent activity, despite the fact that research and development executives do not perceive patents to be one of the best means of obtaining returns on their research and development investment).

136 JAFFE & LERNER, *supra* note 11, at 61.

tion. The ultimate outcome does not much differ from a situation where neither corporation had obtained the patents at issue.

The defensive patenting scenario currently affects several important industries. These include the semiconductor industry,[137] which accounts for some six percent of all issued patents.[138] It also includes the computer software industry, which receives at least five percent of issued patents, as well as the computer hardware sector.[139] Some fear that the biotechnology industry risks falling into a defensive patenting dynamic.[140] In the defensive patenting world in which these industries operate, patent activity occurs in response to prior patent activity. In chain reaction fashion, one patent begets another which begets another still and so on. Individuals, research institutions and corporations obtain these reactive patents not because of the patents' potential positive value, such as their ability to generate license revenue or to provide a manufacturer with a competitive edge, but rather because others in their field have obtained patents or might do so.[141] Commentators consistently liken the situation to an arms race, the quintessential example of a wasteful tit-for-tat, rather than to an enterprise

137 *See* John H. Barton, *Antitrust Treatment of Oligopolies with Mutually Blocking Patent Portfolios*, 69 ANTITRUST L.J. 851, 854–55 (2001) (describing how companies in the semiconductor industry amass patent portfolios for defensive purposes); Bronwyn H. Hall & Rosemarie Ham Ziedonis, *The Patent Paradox Revisited: An Empirical Study of Patenting in the U.S. Semiconductor Industry, 1979-1995*, 32 RAND J. ECON. 101, 107–09 (2001) (discussing how semiconductor manufacturers "harvest" more patents for their existing research and development both as a defensive strategy and to use as bargaining chips in cross-licensing arrangements with other patent holders); Rosemarie Ham Ziedonis, *Patent Litigation in the U.S. Semiconductor Industry*, *in* PATENTS IN THE KNOWLDEGE-BASED ECONOMY 180, 189–92, 207–10 (Wesley M. Cohen & Stephen A. Merrill eds., 2003).

138 John R. Allison & Mark A. Lemley, *Who's Patenting What? An Empirical Exploration of Patent Prosecution*, 53 VAND. L. REV. 2099, 2148 tbl.1 (2000) (finding that semiconductor patents accounted for 6.2% of all patents issued in the period that they studied).

139 FTC Report, *supra* note 135, at 26 (many companies in the semiconductor, computer hardware and computer software industries have responded to the risk of "unintentional and sometimes unavoidable" patent infringement litigation by filing hundreds of patent applications each year, which they "can use defensively against firms threatening infringement actions" (citations omitted)); *see also id.* at 6–7; (discussing defensive patenting) Carlos M. Correa, *Internationalization of the Patent System and New Technologies*, 20 WIS. INT'L L.J. 523, 538 (2002) (citing study that showed that software patents accounted for five percent of all patents issued by 2000). Allison and Lemley found that computer-related technology, which includes software, accounted for sixteen percent of issued patents in the random sample that they studied. Allison & Lemley, *supra* note 138, at 2148 tbl.1.

140 *See* Barton, *supra* note 135, at 1933–34.

141 *See supra* notes 135–40 and accompanying text.

designed to promote innovation by capturing the actual or the potential value of technological advances.

II. EXPLANATIONS FOR THE CHAIN REACTION EVOLUTION OF PROPERTY RIGHTS

Why do individuals, corporations and nations respond to the development or expansion of property rights by demanding the creation of or pursuing additional property rights? Three explanations follow.

A. Group Behavior Theory: The Imitation Impulse

In sandboxes and playgrounds throughout the world, one can observe the following dynamic. A toy sits in a corner untouched. It is commons property. Children know that the toy is available for the use of all and subject to the exclusive use of no one. Hours go by. Not a child shows the slightest interest in the object. Suddenly, one child begins to play with the toy. Within minutes, other children gather. A fight frequently ensues as the children now battle over something that they showed no interest in some fifteen minutes earlier.[142] Why?

Why does a song suddenly become popular? Why do people join a standing ovation, even if they experienced the performance as mediocre or bad? Imitation is an important and powerful social phenomenon, as has been demonstrated by numerous studies in zoology, sociology and social psychology.[143] Group behavior theorists Bikhchandani, Hirshleifer and Welch show that decisionmakers at some point will ignore their own information and pattern their behavior on the actions of those before them.[144] This phenomenon, which they call an information cascade, explains why societies converge on a norm and, on the basis of little information, will systematically make dubious choices. Their models demonstrate both that information cascades will eventually occur and that they often will result in imprudent outcomes.[145]

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142 I am grateful to Professor Ellen Goodman for pointing to the sandbox dynamic.

143 S. Bikhchandani et al., *A Theory of Fads, Fashion, Custom, and Cultural Change as Information Cascades*, 100 J. POL. ECON. 992, 995 (1992); *see also* Gregory S. Berns et al., *Neurobiological Correlates of Social Conformity and Independence During Mental Rotation*, 58 BIOLOGICAL PSYCHIATRY 245, 248, 252 (2005) (identifying a neurobiological basis for social conformity which indicates that individuals follow others even when the group is wrong because the group alters their perception rather than because they consciously decide to capitulate).

144 *See* Bikhchandani et al., *supra* note 143, at 996–97.

145 *Id.* at 1016.

Building on this work, John Miller and Scott Page recently tackled the standing ovation problem.[146] They summarize the problem as follows: A theater performance ends. The audience begins to applaud. The applause builds up tentatively and a few audience members stand. "Does a standing ovation ensue or does the enthusiasm fizzle?"[147] Using computational models, Miller and Page found that the system often converged on the wrong equilibrium. Most people stood even though most did not like the performance.[148] They also discovered that greater pressure to conform led to less efficient aggregation of information.[149] In addition, they found that people sitting in the front had a large impact, as almost everyone patterned their behavior off them.[150]

Many situations fall prone to a group behavior dynamic. Mass communication, international travel and the prodigious number of international negotiations and international organizations mean that people and countries quickly learn of and are influenced by developments occurring in other places. Governments rapidly know of legal developments in other countries, and international negotiations take place in a face-to-face environment with attendant group dynamic pressures. Corporations readily learn of each others' patenting activity. One no longer needs to scour government document depositories to find patents. Several clicks on the PTO website yield a bounty of information, and newspapers routinely report patenting trends.[151] Corporations, research institutions, nations and individuals know more than ever before what each other are up to and have greater susceptibility to copycat group behavior dynamics.

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146 John H. Miller & Scott E. Page, *The Standing Ovation Problem*, 9 COMPLEXITY 8 (2004).

147 *Id.* at 8.

148 *Id.* at 15.

149 *Id.*

150 *Id.* at 14–15. In addition to these socially demonstrated models of lemming-like behavior, a scientific theory of imitation suggests that humans behave like atoms. Mark Buchanan, *Bubble Physics*, BOSTON GLOBE (Aug. 7, 2005), *available at* http://www.boston.com/news/globe/ideas/articles/2005/08/07/bubble_physics/. Two French scientists recently noted that atoms influence each other in their directions and interactions. They found that "the way collections of atoms behave often depends only very weakly on the precise details of how the individual atoms interact with one another." *Id.* Directing their observations to the social world, these scientists concluded that imitation basically exaggerates any collective social response to real world trends. In other words, "imitation leads to distortion." *Id.*

151 *See, e.g.*, Floyd Norris, *You Can't Use that Tax Idea. It's Patented*, N.Y. TIMES, Oct. 20, 2006, at C1.

Group behavior theory helps explain why property rights evolve in a chain reaction. Some individuals begin to assert a property interest in a good. Others cue their behavior off of these initial actors and assert a property interest as well. No cost-benefit calculation takes place. This dynamic sheds light on the patent paradox. Some begin to seek a patent over an innovation hitherto believed unpatentable, such as a business method or a gene fragment. Others cue their behavior off these propertization pioneers and seek patent rights for themselves as well. The patent application deluge that followed NIH's applications for patents on gene fragments exemplifies this group behavior dynamic. As a leader in the scientific community, NIH served the societal function of a front row theater-goer standing to applaud. Other researchers and institutions followed its lead. The ongoing movement for the creation of sui generis intellectual property regimes over traditional knowledge may also have a group behavior dynamic. If enough prominent developing countries call for such rights, other developing countries follow suit.

Demsetz pointed to the Montagnais Indians of Quebec to illustrate his theory.[152] Traditionally, the Montagnais had an open access hunting regime.[153] By the beginning of the eighteenth century, they began to allocate exclusive hunting rights among tribe members.[154] According to Demsetz, they did so because the introduction of the colonial commercial fur trade increased the economic value of furs.[155] With the advent of this commercial trade, the benefits of a closed property regime became greater than the benefits of the open access hunting regime that preceded it.[156] Consequently, the Montagnais, in efficiency maximizing fashion, adopted private property rights over the land containing beavers.[157] As Thomas Merrill points out, even if one accepts Demsetz's explanation of why property rights evolve, the

152 Demsetz, *supra* note 12, at 351–52.

153 *Id.*

154 *Id.* at 352 (citing Eleanor Leacock, *The Montagnais 'Hunting Territory' and the Fur Trade*, 78 AM. ANTHROPOLOGIST MEMOIR 15 (1954)).

155 *Id.* at 351–52.

156 An often mentioned application of Demsetz's thesis involves the advent of barbed wire in the American West. This technological advance engendered the establishment of property rights in land for grazing cattle. It did so not by increasing the value of cattle but by reducing the cost of establishing a property regime in grazing land. Prior to barbed wire, people found it too costly to enclose cattle and to establish fixed land rights for ranchers. *See* Abraham Bell & Gideon Parchomovsky, *Of Property and Antiproperty*, 102 MICH. L. REV. 1, 9–10 nn.34–35 (2003); Daniel Fitzpatrick, *Evolution and Chaos in Property Rights Systems: The Third World Tragedy of Contested Access*, 115 YALE L.J. 996, 1004 (2006).

157 Demsetz, *supra* note 12, at 351–52.

process through which they evolve has long remained "a black box."[158] How does a society transition from point A, a situation without exclusive property rights, to point B, a situation with extensive property rights?

While no one can speak for the Montagnais, group behavior insights can help unravel the transition process mystery. The commercial fur trade likely explains why some Montagnais, seeking to profit from the trade, sought a property interest in the land containing beavers. Their demands for property rights, particularly if they held positions of prominence in the community, may have generated a chain reaction of similar property claims by others. These others likely had little information about the value of fur relative to the cost of controlling it. Rather, they patterned their behavior on the behavior of those that preceded them. Demsetz explicitly refrained from taking a position on whether adjustments in property rights would result from a conscious endeavor.[159] Group behavior insights as well as the case studies discussed above indicate that in many cases it is highly unlikely that the affected community makes a conscious cost-benefit calculation.[160] The emergence of private property or other more exclusive property regimes simply may be a bad idea whose time has come.

B. Breach of a Cooperative Norm

As John Dawson observed three decades ago, "Uncompensated gains are pervasive and universal; our well-being and survival depend on them."[161] And so we share. Indeed, experiments show that people cooperate and forgo free riding much more often than economists predict.[162] In fact, if most people cooperate and share "the social meaning of non-cooperation is greed."[163]

However, if some stop sharing and cooperating, preferring instead to claim certain property or knowledge as exclusively their own, continuing to share under such circumstances transforms the good public citizen into a public patsy. Game theorists have shown that in a repeated game, players will cooperate in the first period, but will defect in subsequent periods if the other player defected in the

158 Merrill, *supra* note 9, at S336; *see also* DUKEMINIER ET AL., *supra* note 12, at 49 ("[T]he mechanism by which private property comes about remains a mystery.").

159 Demsetz, *supra* note 12, at 350.

160 *See supra* notes 142–54 and accompanying text.

161 John P. Dawson, *The Self-Serving Intermeddler*, 87 HARV. L. REV. 1409, 1412 (1974).

162 Cass Sunstein, *Social Norms and Social Roles*, 96 COLUM. L. REV. 903, 945 (1996).

163 *Id.*

immediately preceding period.[164] Absent such defection, they will continue to cooperate.[165]

Underlying the creation of property rights over raw genetic and biological material is a desire by those demanding such rights that others not exploit them. When individuals and corporations began to patent isolated and purified genetic sequences, cell lines and living organisms, those from whom the raw biological material came felt exploited.[166] Nations with a history of colonial exploitation had a heightened sensitivity to such exploitation.[167] They no longer viewed the sharing of raw biological material as international collaboration but rather as "biocolonialism." As the President of Tanzania said, "[M]ost of us in developing countries find it difficult to accept the notion that biodiversity should [flow freely to industrial countries] while the flow of biological products from the industrial countries is patented, expensive and considered the private property of the firms that produce them. This asymmetry . . . is unjust."[168] Developing countries created property rights over material that they had previously shared to prevent others from taking advantage of them.

A similar sentiment animates patient property claims to biological specimens. Patients willingly donated biological specimens when they believed they were contributing to a greater social good.[169] The obtainment of patent rights by researchers and institutions over cell lines and genetic sequences breached this cooperative spirit. Contributors, like those who joined the effort to find the gene responsible for Canavan disease as well as John Moore, felt taken advantage of.[170] Their fury and sense of violation do not stem from concern over lost potential economic opportunities, but rather from being played the patsy.

In the case of traditional knowledge, when developed countries began to insist that developing countries cease copying intellectual property goods developed in the West, developing countries

164 ROBERT AXELROD, THE EVOLUTION OF COOPERATION 118–20 (1984); *see also* DOUGLAS G. BAIRD ET AL., GAME THEORY AND THE LAW 316 (1994) (calling this strategy "tit-for-tat").

165 AXELROD, *supra* note 164, at 118–20.

166 *See supra* notes 62–86 and accompanying text.

167 I thank Professor Tanya Hernandez for this point.

168 U.N. Conference Report, *supra* note 61, at 189; *see also* Craig D. Jacoby & Charles Weiss, *Recognizing Property Rights in Traditional Biocultural Contribution*, 16 STAN. ENVTL. L.J. 74, 89 (1997) (quoting Tanzanian President Ali Hassan Mwinyi's statement to the United Nations Conference on Environment and Development).

169 On the benefits of altruism, see RICHARD M. TITMUSS, THE GIFT RELATIONSHIP 195–246 (1971).

170 *See supra* notes 62–86 and accompanying text.

expressed resentment over the knowledge that they had shared with the West.[171] It was one thing for societies effectively to share knowledge with each other. It was quite another for technologically-advanced societies to wrap their knowledge in a web of intellectual property protections, while freely using the traditional knowledge of their less developed counterparts.

C. Fear of Exclusion

Of property's attributes,[172] most consider the right of the holder to exclude others to be the most important.[173] In the case of intellectual property, the right to exclude is the central and, in the case of patents, the only right accorded.[174] I suggest the following corollary: Of property's attributes, the one most likely to inspire fear among nonholders of a property interest is that they will be excluded from its use. When some begin to demand and receive new property rights, others naturally experience concern that they will no longer enjoy the ability to use the previously common resource. They respond by securing a property right for themselves in the good that is now the new object of propertization. In the alternative, they demand the creation of new property rights over some related good that they can exchange for access to the first object of propertization.

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171 *See infra* notes 208–10 and accompanying text.

172 Honoré identifies the following incidents of property: (1) the right to exclusive possession; (2) the right to personal use and enjoyment; (3) the right to manage use by others; (4) the right to the income from use by others; (5) the right to the capital value, including alienation, consumption, waste or destruction; (6) the right to security (that is, immunity from expropriation); (7) the power of transmissibility by gift, devise, or descent; (8) the lack of any term on these rights; (9) the duty to refrain from using the object in ways that harm others; (10) the liability to execution for repayment of debts; and (11) residual rights on the reversion of lapsed ownership rights held by others. A.M. Honoré, *Ownership*, *in* OXFORD ESSAYS IN JURISPRUDENCE 107, 112–28 (A.G. Guest ed., 1961).

173 *See, e.g.*, Felix S. Cohen, *Dialogue on Private Property*, 9 RUTGERS L. REV 357, 374 (1954) (characterizing property as something "to which the following label can be attached: To the world: Keep off X unless you have my permission, which I may grant or withhold"); Thomas W. Merrill, *Property and the Right to Exclude*, 77 NEB. L. REV. 730, 737–39 (1998) (arguing that "the right to exclude others . . . is the *sine qua non*" of property but also identifying other schools of thought which, while agreeing that property rights generally involve some right to exclude, disagree that the right to exclude is the core right).

174 *See* 35 U.S.C. § 154(a)(1) (2000).

This fear animates much of the frenetic patent activity underlying the patent paradox.[175] Companies and institutions feel compelled to obtain patents over slight and even dubious innovations out of concern that if they do not have such patents, they will have no currency to trade for access to other patented and potentially equally slight innovations. As Internet Patent News Service Editor Gregory Aharonian explains: "The big guys couldn't care less about the quality of their patents. . . . They just want as many as possible because they trade them like baseball cards. When you have a thousand patents and your competition has 1500, you don't care what they are, you just swap them."[176] Fear of exclusion also helps to explain why so many rushed to file patent applications over gene fragments. They feared that unless they obtained such patents, those who did would exclude them from entire fields of innovation.

The demand by developing countries for property rights over raw biological material partly arose from their concern that patent holders would exclude them from enjoying the benefits of technology, particularly biotechnology.[177] Developing countries sought property rights over raw biological material partly to leverage such rights for access to patented technologies.[178] The language and structure of the CBD itself evidences the creation of sovereign property rights as a means of leverage against other property rights. Article 15 of the CBD, entitled "Access to Genetic Resources," goes hand in hand with Article 16, entitled "Access to and Transfer of Technology." After effectively vesting national governments with the right to control access to genetic resources,[179] Article 15 stipulates that sovereigns should facilitate access to such material.[180] Article 16 links such sharing with the sharing of technological innovations, particularly technologies which utilize provided genetic material.[181] Together Articles 15 and 16 envision

175 One often sees today's patent environment described as a frenzy. *See, e.g.*, Legal Resources for Surviving the Patenting Frenzy of the Internet, Bioinformatics, and Electronic Commerce, http://www.bustpatents.com (last visited May 16, 2007).

176 Denise Caruso, *Digital Commerce*, N.Y. TIMES, Feb. 1, 1999, at C4.

177 *See supra* note 49 and accompanying text.

178 *Id.*

179 Article 15(1), "[r]ecognizing the sovereign rights of States over their natural resources," states that "the authority to determine access to genetic resources rests with the national governments," CBD, *supra* note 49, at 152, while Article 15(5) provides that access to this material requires the "prior informed consent of the [nation] providing such resources." *Id.*

180 *Id.* art. 15(2), at 152 ("[E]ach Party shall endeavour to create conditions to facilitate access to genetic resources.").

181 *See id.* at 153. Article 15(7) of the CBD states: "Each Contracting Party shall take . . . measures . . . with the aim of sharing in a fair and equitable way the results of

a world where developing countries provide raw genetic material in exchange for technological goods and know-how.[182]

One can also see the development of property rights as a means of leverage against other property rights in the renegotiation of the International Undertaking. Following the entry into force of the CBD, negotiations began to harmonize the International Undertaking with the CBD. These negotiations centered on whether nations would continue to share plant genetic material freely with each other to promote global food security or whether a more restrictive regime would govern. During the negotiations, prominent developing country representatives repeatedly offered to provide access to the raw genetic material of all plants in their countries, if developed countries would provide access to patented agricultural goods.[183]

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research and development and the benefits arising from the . . . utilization of genetic resources with the [nation] providing such resources." *Id.* at 152. In Article 16(1), the parties emphasize that technology "includes biotechnology," and undertake to provide or facilitate access to "technologies that . . . make use of genetic resources." *Id.* at 153. Article 16(2) provides that access to and transfer of this technology "shall be provided and/or facilitated under fair and most favourable terms, including on concessional and preferential terms where mutually agreed," but where technology is "subject to patents and other intellectual property rights, such access and transfer shall be provided on terms which recognize and are consistent with the adequate and effective protection of intellectual property rights." *Id.* at 153. Article 16(3) provides that each party to the Convention shall take measures

> with the aim that Contracting Parties, in particular those that are developing countries, which provide access to genetic resources are provided access to and transfer of technology which makes use of those resources, on mutually agreed terms, including technology protected by patents and other intellectual property rights, where necessary through [financial mechanisms] and in accordance with international law.

Id.

182 Other articles of the CBD also support this outcome. For example, Article 19(1) states that each party shall take measures "to provide for the effective participation in [its] biotechnological research activities" by parties who have provided access to genetic resources, particularly developing country parties. *Id.* at 155. Meanwhile, Article 19(2) requires parties to take practicable measures to promote "priority access on a fair and equitable basis" to the results and benefits of biotechnologies to countries, particularly developing countries, that provided genetic resources used in those technologies, provided such access is done on mutually agreed terms. *Id.*

183 I participated in these negotiations and personally heard these interventions. These negotiations ultimately resulted in the International Treaty on Plant Genetic Resources for Food and Agriculture, Nov. 3, 2001, ftp://ftp.fao.org/ag/cgrfa/it/ITPGRe.pdf (last visited May 16, 2007).

III. THREE CONSEQUENCES OF THE CHAIN REACTION EVOLUTION OF PROPERTY RIGHTS

The above discussion shows how and why the creation of new property rights can trigger a chain reaction of propertization, whereby individuals and societies respond to these new or expanded rights by demanding the generation of additional property rights. The chain reaction theory for the evolution of property rights has three key implications.

A. Collateral and Unexpected Property Regimes

First, as demonstrated above, the creation of property rights in one sphere may spawn the creation of property rights in a related, though other, sphere. Importantly, those who demand the creation of the initial rights, as well as the government actors who fashion these rights, appear not to anticipate the wave of collateral property rights that arises in response to their actions.

For example, the thousands of pages filed, read and debated in the *Chakrabarty* proceedings address the moral, legal, social, environmental and economic aspects of extending patents to living organisms. Petitioner, the PTO, opposed such patents, inter alia, on the grounds that such patents raised serious economic and social questions.[184] The Peoples Business Corporation argued that such patents would concentrate wealth in a few multinational corporations,[185] create biohazards[186] and reduce biological diversity.[187] According to the American Patent Law Association, biological patents would promote innovation.[188] Meanwhile, the Pharmaceutical Manufacturers Association found "no compelling economic, social, or moral reasons to distinguish" biotechnological inventions from other innovations.[189] Genentech emphasized the extraordinary benefits that biotechnology would bring to humanity,[190] while another amicus discussed at length the societal benefits of Chakrabarty's invention to a small Long Island

184 Brief for the Petitioner at 18–21, Diamond v. Bergy, 447 U.S. 303 (1980) (No. 79-136), 1980 WL 339757.

185 Brief on Behalf of the Peoples Business Commission, Amicus Curiae at 9, Parker v. Bergy, 447 U.S. 303 (1980) (No. 79-136), 1979 WL 200005.

186 *Id.* at 18–21.

187 *Id.* at 7–9.

188 Brief on Behalf of the American Patent Law Ass'n, Inc., Amicus Curiae at 4, Diamond v. Chakrabarty, 447 U.S. 303 (1980) (No. 79-136), 1980 WL 339772.

189 Brief on Behalf of the Pharmaceutical Manufacturers Ass'n, Amicus Curiae at 13 n.21, *Chakrabarty*, 447 U.S. 303 (No. 79-136), 1980 WL 339771.

190 Brief on Behalf of Genentech, Inc., Amicus Curiae at 12, *Chakrabarty*, 447 U.S. 303 (No. 79-136), 1980 WL 339766.

shipping village.[191] Not *one* brief opposing Chakrabarty's patent mentions that the extension of patents to life forms might, let alone would, cause donors of raw biological samples, such as patients and developing countries, to claim a responsive property right in these raw materials.[192] Those involved in *Chakrabarty*, from the litigants, to the amici, to the Supreme Court Justices themselves, all believed that they were simply deciding the extent to which property rights would extend to man's handiwork.[193] No one anticipated that their decision would alter the hitherto accepted norm of the relatively free availability of samples of nature's handiwork. Twenty-five years after *Chakrabarty*, ownership increasingly constitutes the norm not only for man-made living organisms, isolated genetic material and cell lines, but also, unexpectedly, for samples of raw biological materials.

Similarly, those pressing for the international expansion of Western intellectual property rights do not appear to have anticipated responsive demands for the creation of property rights over traditional knowledge. The legislative history of Special Clause 301 mentions no such prospect.[194] Those negotiating the TRIPS Agreement for the United States seemingly did not foresee the eventual responsive demand for intellectual property rights over traditional knowledge. In fact it does not appear that this response was even on their radar screens. Commentators on the history of the TRIPS Agreement do not mention traditional knowledge as an issue during the negotiations and confirm that calls to protect traditional knowledge came later.[195] In the same vein, when developed countries insisted on the

191 Brief of Cornell D. Cornish as Amicus Curiae at 8–13, *Parker*, 447 U.S. 303 (No. 79-136), 1979 WL 200006.

192 Brief for the Respondent, *Chakrabarty*, 447 U.S. 303 (No. 79-136), 1980 WL 339758; Brief of Dr. George Pieczenik as Amicus Curiae, *Chakrabarty*, 447 U.S. 303 (No. 79-136), 1980 WL 339773; Brief on Behalf of the New York Patent Law Ass'n, Inc., Amicus Curiae, *Chakrabarty*, 447 U.S. 303 (No. 79-136), 1980 WL 3397669; Brief Amicus Curiae of the Regents of the University of California, *Chakrabarty*, 447 U.S. 303 (No. 79-136), 1980 WL 339770; Brief of: Dr. Leroy E. Hood et al. as Amici Curiae, *Chakrabarty*, 447 U.S. 303 (No. 79-136), 1980 WL 339764; Brief on Behalf of the American Society for Microbiology, Amicus Curiae, *Chakrabarty*, 447 U.S. 303 (No. 79-136), 1979 WL 200007.

193 *Chakrabarty*, 447 U.S. at 310.

194 The legislative history of Special 301 appears in H.R. REP. No. 100-576, at 550–87 (1988) (Conf. Rep.), *as reprinted in* 1988 U.S.C.C.A.N. 1547, 1583–1620.

195 *See, e.g.*, Helfer, *supra* note 46, at 20–22; J.H. Reichmann, *Universal Minimum Standards of Intellectual Property Protection Under the TRIPS Component of the WTO Agreement*, 29 INT'L LAW. 345, 382–85 (1995) (discussing the overall history of the TRIPS Agreement and the likely response of developing countries but not mentioning anything about traditional knowledge or restriction of access to biological materials); Yu, *supra* note 95, at 357–70, 386–89 (discussing the history of TRIPS and mentioning

acknowledgement of Breeders' Rights within the International Undertaking, they did not anticipate the responsive insistence by developing countries on the recognition of Farmers' Rights.[196]

B. The Importance of First Movers

Second, the chain reaction theory for the evolution of property rights indicates that those who first demand property rights play a critical and underestimated role in the evolution of property rights. These propertization pioneers can trigger a chain reaction of demands for similar or different yet related property rights. The role that NIH played in the frenzy to patent genetic fragments beautifully illustrates the importance of first movers. When NIH sought to patent gene fragments, other researchers and institutions followed its lead and stampeded to the patent office.[197] Decisionmakers, therefore, must exercise extreme caution before bowing to the demands of these first movers. Accommodating their propertization requests can create a chain reaction of similar or related but different property requests by others.

Furthermore, as the case studies illustrate, courts and legislatures themselves can trigger a chain reaction when they create new property rights or expand existing ones.[198] At present, decisionmakers usually appear unaware that their actions can set off a process with widespread and, as demonstrated below, potentially undesirable implications.[199] The chain reaction theory cautions decisionmakers to think carefully before expanding property rights, particularly in borderline cases, and to build in restrictions on these rights more thoughtfully.[200] At a minimum, decisionmakers should exercise particular care before

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how the calls to protect traditional knowledge came later); *see also* A.O. Adele, *The Political History of the TRIPS Agreement: Origins and History of the Negotiations* (2001) (on file with author).

196 E-mail from Dr. Henry Shands, to author (Apr. 12, 2007) (on file with author).

197 *See supra* notes 128–33 and accompanying text.

198 *See supra* Part III.A.

199 *See infra* Part III.C.

200 *Id.* James Boyle points to a different yet equally troubling spiraling effect that further supports the need for caution before expanding intellectual property rights. Boyle notes that "[o]nce a new intellectual property right has been created over some informational good, the only way to ensure efficient allocation of that good is to give the rights holder still greater control over the user or consumer in the aftermarket." James Boyle, *The Second Enclosure Movement and the Construction of the Public Domain*, 66 LAW & CONTEMP. PROBS. 33, 50 (2003). New rights holders, therefore, press for "even *more* changes of the rules in their favor" so that they can enforce or maximize their new rights through, for example, relaxed privacy standards, enforceable shrinkwrap contracts and changes in antitrust laws. *Id.*

expanding property rights in situations where people have identified potential spillover effects.[201] For example, scholars, news services and academic organizations raised concerns that proposed new intellectual property rights over databases risked dramatically curtailing access to data itself.[202] Congress has so far refrained from creating property rights for databases and thereby has avoided initiating a chain reaction that would have likely led to the propertization of data.

C. Inefficient and Less Happy Outcomes

Third, the chain reaction thesis anticipates less efficient and happy outcomes than those suggested by Demsetz's thesis. While the initial creation of property rights may follow Demsetz's optimistic cost-benefit scenario, the second wave of property rights that it triggers appears to have little to do with any efficient economic calculus. Rather, it is responsive in nature. Those pressing for these second generation rights often simply imitate those before them or may seek to retaliate against the new first generation property norms that they object to. They seek new property rights out of a sense of justice.[203] They fear that unless they receive new property rights, which they can trade against the first generation rights, they will suffer exclusion from

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201 I thank Professor Pamela Samuelson for this point.

202 Database and Collections of Information Misappropriation Act, H.R. 3261, 108th Cong. (as introduced in the House, Oct. 8, 2003). Opposition based on the bill's likely interference with access to data included NetCoalition, a coalition of Internet service providers and large Internet related companies such as Google, Yahoo, Bloomberg and CNET, the American Civil Liberties Union and the National Academy of Engineering. *See* Grant Gross, *Congress Questions Database Protection Proposal*, INFOWORLD, Sept. 23, 2003, http://www.infoworld.com/article/03/09/23/HNdatabase_1.html; Net Coalition Database Protection: A Primer on the Debate in Congress Over Creating a New Property Right in Facts, (Oct. 20, 2003), http://www.netcoalition.com (search for "database protection"; follow "Backgrounders" hyperlink; then follow "Net Coalition Database Primer" hyperlink). Earlier testimony of William Wulf, on behalf of the U.S. National Academies of Sciences, the National Academy of Engineering and the Institute of Medicine, before the House Committee on Energy and Commerce on September 23, 2003, warned that any database legislation must take care to preserve the public domain status of factual information; and where uncertainty exists as to whether the effect of potential legislation might extend exclusive property rights to the factual information itself, Congress should "err on the side of caution." *Database and Collections of Information Misappropriations: Joint Hearing Before the Subcomm. on Courts, the Internet, and Intellectual Property of the H. Comm. on the Judiciary and the Subcomm. on Commerce, Trade, and Consumer Protection of the H. Comm. on Energy and Commerce*, 108th Cong. 44 (2003) (statement of William Wulf, President, National Academy of Engineering and Vice Chairman, National Research Council).

203 *See supra* Part I.

the marketplace.[204] When one takes into account the second generation property rights created in reaction to the first generation rights, the overall scenario may be less efficient than the property regime that preceded it. It is, at a minimum, less happy than the scenario anticipated by Demsetz's thesis.[205]

Turning first to property rights over biological and genetic material, as discussed earlier, the extension of property rights to man-made living organisms and their genetic material established by *Chakrabarty* and its progeny caused the governments of developing countries that possessed unimproved biological material to assert property rights over this material.[206] These property regimes are extremely costly to create, to administer and to enforce.[207] They essentially require countries to prevent most, if not all, subcellular genetic sequences of potential economic value from leaving their country without government authorization. Complying with these regimes also entails substantial expense,[208] and the regimes suffer from anticommons problems. An anticommons can occur when multiple individuals or entities have rights of exclusion to a given resource.[209] Anticommons problems exist because bioprospectors (those searching for potentially useful genetic material) must now obtain the consent of multiple property rightsholders, including the national government, local communities and individuals, before removing raw biological samples.[210]

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204 *See supra* Part II.C.

205 *Id.* Others have criticized the modern expansion of intellectual property rights on efficiency grounds. *See, e.g.*, Boyle, *supra* note 200, at 49–50; *see also* Brett M. Frischmann & Mark A. Lemley, *Spillovers*, 107 COLUM. L. REV. 257, 257–58 (2007) (arguing that positive externalities or spillovers can actually encourage innovation such that more intellectual property rights which effectively limit these spillovers can cause harm). This Article adds to these criticisms by pointing to the even greater economic and societal costs that flow from excessive intellectual property rights due to their setting off a chain reaction of yet additional property rights.

206 *See supra* Part I.A.

207 Jacoby & Weiss, *supra* note 168, at 93; Christopher D. Stone, *Land Use and Biodiversity*, 27 ECOLOGY L.Q. 967, 984–85 (2001); *see also* Safrin, *supra* note 4, at 649–52 (describing the cumbersome and complex nature of the access-restricting laws).

208 *See generally* KERRY TEN KATE & SARAH A. LAIRD, THE COMMERCIAL USE OF BIODIVERSITY 32–33 (1999) (noting that access regimes are elaborate and that many domestic and foreign scientists and companies report finding them cumbersome, time-consuming and costly to follow).

209 Michael A. Heller, *The Tragedy of the Anticommons: Property in the Transition from Marx to Markets*, 111 HARV. L. REV. 621, 622, 677 (1998).

210 Safrin, *supra* note 4, at 652–58 (describing the anticommons problems created by developing countries' access-restricting regimes).

Impressive revenue streams have not offset these high costs. In fact, rather than generating much revenue for their countries, the laws that restrict access to genetic material have caused scientists and corporations to cease or minimize their bioprospecting activity.[211] For example, after spending one million dollars and two years attempting to navigate Colombia's access-restricting regime, BioAndes, a private joint venture between a U.S. pharmaceutical company and a Colombian concern, abandoned its efforts not only in Colombia but also in the entire Andean Pact region.[212] For every bioprospecting success story, there are dozens of cases where the projects never got off the ground.[213] An extensive study conducted by Columbia University unearthed few successful bioprospecting cases.[214] Meanwhile, companies report that the CBD has caused them to rely more heavily on *ex situ* collections rather than brave the source countries' laws and regulations that restrict access to raw genetic material.[215] In the aftermath of the CBD, the collection of this material has slowed to a trickle.[216]

These regimes have failed to generate much revenue for their countries and the restrictive climate created by the CBD and these

211 Colin Macilwain, *When Rhetoric Hits Reality in Debate on Bioprospecting*, 392 NATURE 535 (1998); Safrin, *supra* note 4, at 657–58; David Labrador, *Refining Green Gold*, SCI. AM., Dec. 2003, at 38.

212 Envtl. Policy Studies Workshop, *supra* note 44, at 35–43. Andes Pharmaceuticals, Inc., one of the venture's principal partners, was "founded . . . as a direct response to the CBD with the 'mission to invert the current model for natural products drug discovery' by taking 'state-of-the-art technology to countries rich in biological diversity.'" *Id.* at 35. In addition, a Colombian national abandoned a bioprospecting project altogether after realizing the ramifications of the application process. *Id.* at 43.

213 Safrin, *supra* note 4, at 657; Christopher Locke, *Forest Pharmers: Bioprospecting in Rain Forests Raises Ethical Questions*, RED HERRING, Apr. 1, 2001, at 84, 86; *see also* BROWN, *supra* note 94, at 109–10 (reporting how there has been little commercial interest in bioprospecting and noting how most of the projects have been U.S. government subsidized). A fairly comprehensive three-hundred page book by Kerry ten Kate and Sarah Laird on access and benefit-sharing under the CBD discusses surprisingly few nongovernment examples of bioprospecting projects involving access to specimens of genetic material for research and then potential application in a biotechnological good, since the adoption of CBD. *See* TEN KATE & LAIRD, *supra* note 208. A large percentage, if not the majority, of the "benefit-sharing" cases discussed there occurred before the CBD, involved U.S. government subsidies or involved traditional payment for the extraction of bulk raw materials, such as kava, that are used as inputs for end products rather than genetic sampling. *Id.* at 104–08.

214 Envtl. Policy Studies Workshop, *supra* note 44, at 17–67.

215 TEN KATE & LAIRD, *supra* note 208, at 302.

216 *Id.* at 301.

regimes hamper the sharing of genetic material.[217] We see a similar trend with respect to biological specimens obtained from patients. While patients used to readily donate these samples, today, prior informed consent agreements and legal arrangements encumber these donations.[218]

Moreover, researchers no longer share genetic and biological material as freely with each other.[219] Concern over the growing unwillingness by scientists to share tangible research material prompted the NIH in 1999 to issue guidelines to encourage sharing.[220] The restrictive trend, however, continues. A 2005 study of genomics researchers found that, while most continued to receive tangible research material from their colleagues, the level of noncompliance with material transfer requests in 2003–2004 increased eighty percent over noncompliance levels in the late 1990s.[221] The study projected even higher rates of noncompliance in the future.[222] The study found that this lack of sharing significantly impeded research.[223] One in fourteen respondents said that noncompliance by other academics with material transfer requests caused them to abandon at least one project each year, and one in six respondents reported that delays in receiving material from other academics caused them to substantially delay their projects.[224]

Patent rights in the genetics area also appear to be spiraling to an inefficient and unhappy outcome. By mid-2000, the PTO had issued over 6000 patents on full-length genes isolated from living organisms and had under consideration over 20,000 gene-related patent applica-

217 *See* BROWN, *supra* note 94, at 138–39 (noting that the expansions of patents in the area of biotechnology research eventually made it increasingly difficult for ethnobotanists to collect wild plant specimens); Safrin, *supra* note 4, at 647–48.

218 *See, e.g.*, WORLD HEALTH ORG., GENOMICS AND WORLD HEALTH 142–45 (2002) [hereinafter WHO GENOMICS REPORT 2002], *available at* http://whqlibdoc.who.int/hq/2002/a74580.pdf (describing how the patenting of the genetic material of indigenous people is increasing opposition to population genetic studies).

219 *See supra* notes 81–84 and accompanying text.

220 Principles and Guidelines for Recipients of NIH Research Grants and Contracts on Obtaining and Disseminating Biomedical Research Resources: Final Notice, 64 Fed. Reg. 72,090, 72,092 (Dec. 23, 1999).

221 John P. Walsh et al., *View from the Bench: Patents and Material Transfers*, 309 SCIENCE 2002, 2002–03 (2005) [hereinafter Walsh et al., *View from the Bench*]. For the full study see John P. Walsh et al., Patents, Material Transfers and Access to Research Inputs in Biomedical Research (Sept. 20, 2005), http://tigger.uic.edu/~jwalsh/Walsh ChoCohenFinal050922.pdf.

222 Walsh et al., *View from the Bench*, *supra* note 221, at 2002–03.

223 *See id.*

224 *Id.* at 2003.

tions.[225] In a frenzy, researchers and companies rush to patent genes and parts of genes that they have isolated before someone else does.[226] All of this frenetic genetic patenting activity is, or at a minimum, risks creating an anticommons in genetic material that deters innovation.[227] As patentees acquire thousands of patents on genetic sequences for specific genes and fragments of genes, moving forward with any particular gene therapy requires securing the consent of these multiple patent holders.[228] Obtaining such consent, in turn, involves high transaction costs to locate and bargain with the holders of all of these gene patents.[229] Moreover, any one patent holder can thwart a project entirely by refusing to license its individual genetic component unless it receives a bribe.[230] For example, estimates indicate that the scientists who created the celebrated "golden rice" (a strain of rice genetically engineered for enhanced vitamin A) may have infringed as many as seventy patents.[231] However, the scientists who created the rice, which might prevent thousands of cases of blindness a year, report that they could not have created the rice had they attempted to identify and secure the consent of all implicated patent holders in the process.[232] According to the developer of the rice, he

225 Demaine & Fellmeth, *supra* note 7, at 359. "Over a sixth of these patents cover whole human genes and many of their significant alleles." *Id.* For an explanation of when one may patent a gene, see *supra* note 7.

226 *See generally* Nicholas Thompson, *Gene Blues*, WASH. MONTHLY, Apr. 2001, at 9, 10–11 (describing the race to patent genetic sequences).

227 *See* Dan L. Burk & Mark A. Lemley, *Policy Levers in Patent Law*, 89 VA. L. REV. 1575, 1625–26 (2003) (concluding that the biotech industry appears particularly susceptible to anticommons problems); Michael A. Heller & Rebecca S. Eisenberg, *Can Patents Deter Innovation? The Anticommons in Biomedical Research*, 280 SCIENCE 698, 699–700 (1998) (pointing to anticommons problems in basic medical research); Arti K. Rai, *The Information Revolution Reaches Pharmaceuticals: Balancing Innovation Incentives, Cost, and Access in the Post-Genomics Era*, 2001 U. ILL. L. REV. 173, 192–94 (pointing to anticommons problems in the biotechnological field); *see also* Fiona Murray & Scott Stern, *Do Formal Intellectual Property Rights Hinder the Free Flow of Scientific Knowledge? An Empirical Test of the Anticommons Hypothesis* 5 (Nat'l Bureau of Econ. Research, Working Paper No. 11465, 2005), *available at* http://www.nber.org/papers/w11465. This empirical study of the citation rates of scientific papers found a quantitatively modest but statistically significant anticommons effect in that citations of papers involving patented technologies declined by nine to seventeen percent after a patent issues. *Id.*

228 Burk & Lemley, *supra* note 227, at 1625–26.

229 *See generally id.* at 1611 (summarizing the effects of an anticommons).

230 *Id.* The problem is exacerbated even further by "reach through" licenses, whereby the owners of upstream patents seek control of and royalties on the downstream uses of their patented genes. *Id.* at 1626.

231 PETER PRINGLE, FOOD, INC. 33 (2003).

232 *Id.*

had to ignore the patents while he was experimenting with the rice "or I couldn't move at all."[233]

In addition to anticommons problems, genetic patenting may be leading to a related problem of patent thickets.[234] In contrast to an anticommons, which requires the aggregation of multiple inputs to create a single product, patent thickets occur where multiple overlapping patents cover the same technology and can choke an industry.[235] In a patent thicket environment, holders of patents can prevent each other from fully utilizing their patent rights as each holder's right overlaps with, and hence infringes upon, a right held by another.[236]

Not all agree that the present U.S. system for patenting genetic material is generally flawed.[237] While some studies suggest an anticommons problem,[238] others question whether a genetic anticommons of any significance exists.[239] For example, a 2005 study by Walsh, Cho and Cohen failed to find substantial evidence of patents limiting basic research. Only one percent of a random sample of 398

233 *Id.*

234 Arti K. Rai, *Fostering Cumulative Innovation in the Biopharmaceutical Industry: The Role of Patents and Antitrust*, 16 BERKELEY TECH. L.J. 813, 842 (2001).

235 Burk & Lemley, *supra* note 227, at 1627 (describing patent thickets).

236 *Id.*

237 Richard A. Epstein, *Steady the Course: Property Rights in Genetic Material*, at 22–26 (March 2003), http://www.law.uchicago.edu/faculty/epstein/resources/rae.genome.new.pdf (arguing that the current system basically functions well and that the U.S. should "steady the course," and rejecting "middle of the road" proposals described above in favor of an "all or nothing" approach where some genetic substances, like EST fragments, would be left in the public domain, but everything else would be governed by the usual rules of patent protection); *see also* Erik S. Maurer, Comment, *An Economic Justification for a Broad Interpretation of Patentable Subject Matter*, 95 NW. U. L. REV. 1057, 1090 (2001) (favoring a broad interpretation of patentable subject matter).

238 *See supra* note 227.

239 Charles R. McManis & Sucheol Noh, The Impact of the Bayh-Dole Act on Genetic Research and Development: Evaluating the Arguments and Empirical Evidence to Date 48 (Aug. 13, 2006) (unpublished manuscript) (summarizing recently released studies concerning the impact of Bayh-Dole on genetic research and concluding that anticommons concerns have been overstated), *available at* http://www.law.berkeley.edu/institutes/bclt/ipsc/papers2/mcmanis.doc. Earlier articles challenging an anticommons effect include John J. Doll, *The Patenting of DNA*, 280 SCIENCE 689, 689 (1998) (arguing that "new areas of technology do not create the need for a whole new specialized patent law"); Arti K. Rai & Rebecca S. Eisenburg, 66 LAW & CONTEMP. PROBS. 289, 298 n.47 (2003) (discussing patent thickets but stating that companies' responses have been to put things into the public domain); and John P. Walsh et al., *Work Through the Patent Problem*, 299 SCIENCE 1021, 1021 (2003) (concluding that strong patent protection in the area of research tools has little thwarted innovation).

biomedical academics reported project delays of over a month due to patents and patents had not caused any to completely abandon a line of research.[240] However, a report by the National Research Council expresses concern about the future.[241] It concludes that the lack of substantial evidence for an anticommons or patent thicket problem among biomedical researchers may simply be due to a lack of awareness among investigators about relevant patent rights, and this is changing.[242] Indeed, the Walsh study revealed that when scientists believed that their research implicated another's patent, some thirty percent either changed their research approach or substantially delayed their work.[243] Overall, most scholars believe that the patent system in the genetics area has overreached and inhibits innovation.[244]

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240 Walsh et al., *View from the Bench*, *supra* note 221, at 2002.

241 NAT'L RESEARCH COUNCIL, REAPING THE BENEFITS OF GENOMIC AND PROTEOMIC RESEARCH 134 (2005).

242 *Id.* at 135–36.

243 Walsh et al., *View from the Bench*, *supra* note 221, at 2002. At present, researchers may be gambling that patent holders will not sue them. This could rapidly change if a high-profile Napster-like case was brought against researchers and their institutions.

244 *See* Andrew Chin, *Research in the Shadow of DNA Patents*, 87 J. PAT. & TRADEMARK OFF. SOC'Y 846, 904–05 (2005) (demonstrating how even a small number of oligonucleotide patents would impair two of the most promising procedures for the discovery of other oligonucleotides and DNA molecules and concluding that the patenting of DNA molecules actually retards the "identification and sequencing of so many other useful DNA molecules" that DNA patents do not promote the discovery and disclosure of DNA molecules in aggregate); Heller & Eisenberg, *supra* note 227, at 701 ("An anticommons in biomedical research may be more likely to endure than in other areas of intellectual property because of the high transaction costs of bargaining, heterogeneous interests among owners, and cognitive biases of researchers."); Rai, *supra* note 227, at 192–94 ("An important impediment to accelerated preclinical and clinical investigation might be created by the hundreds of thousands of patent applications that have been filed by certain firms on early-stage genomics research . . . ."); Rochelle Cooper Dreyfuss, *Varying the Course in Patenting Genetic Material: A Counter-Proposal to Richard Epstein's* Steady Course 1 (N.Y.U. Sch. of Law, Pub. Law & Legal Theory Research Paper Series, Paper No. 59, 2003), *available at* http://ssrn.com/abstract_id=394000 (disagreeing with Epstein, noting that "the literature questioning aspects of genomic patenting and proposing all sorts of interventions" to limit the innovation inhibiting aspects of this patenting activity, like compulsory licensing, experimental use defenses and condemnation proceedings, is growing "large" and "fast"); *see also* Demaine & Fellmeth, *supra* note 7, at 462 (suggesting the current interpretation of the Patent Act leads to "blocking and conflicting patentable subject matter" which leads to "tollbooth charges, nonresearch development costs, and delays" in the area of biotechnology); Philippe Jacobs & Geertrui Van Overwalle, *Gene Patents: A Different Approach*, 23 EUR. INTELL. PROP. REV. 505, 505–06 (2001) (arguing that patents should not be granted for DNA but only for downstream medi-

The overprivatization of genetic material has a high cost. The anticommons and other problems engendered by both the sovereign-based and the patent-based ownership systems lead to the underutilization of potentially helpful genetic material. As a result, society incurs the opportunity cost of not enjoying potentially helpful drugs, therapeutics and other bioengineered goods. In addition, the extensive assertion of property rights over genetic material means that society forgoes the benefits of more open systems.[245]

In the case of genetic material, the open system that predated extensive sovereign and private rights over genetic material had numerous advantages. The widespread sharing of biological material that occurred under the open system increased rather than decreased the global genetic pool because it ensured the maintenance of genetic material in multiple locations.[246] It resulted, for example, in the widespread distribution and preservation of crops and crop varieties away

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cal goods). Others, while accepting the patent eligibility of isolated naturally occurring genes, have proffered a series of mechanisms, such as a research fair use exception or compulsory licensing, to diminish the reach and the innovation-inhibiting effects of these gene patents. *See, e.g.*, Donna M. Gitter, *International Conflicts Over Patenting Human DNA Sequences in the United States and the European Union: An Argument for Compulsory Licensing and a Fair-Use Exemption*, 76 N.Y.U. L. REV. 1623, 1678–90 (2001); Holman & Munzer, *supra* note 128, at 813–25 (proposing an ASCAP system for genes, whereby all would have access to registered, isolated and identified genes upon payment of a fixed fee); Janice M. Mueller, *No "Dilettante Affair": Rethinking the Experimental Use Exception to Patent Infringement for Biomedical Research Tools*, 76 WASH. L. REV. 1, 58–66 (2001) (suggesting a broad compulsory licensing system).

245 *See generally* KEMAL BASLAR, THE CONCEPT OF THE COMMON HERITAGE OF MANKIND IN INTERNATIONAL LAW 40–41 (1998) (describing the Romans' belief that sharing certain basic resources would further the common interest); BOYLE, *supra* note 110, at 9–10, 119, 125 (arguing for an expansion of the public domain, pointing to the "erroneous belief that the greater the level of intellectual protection, the greater the progress" and arguing that intellectual property regimes "can actually *slow down* scientific progress, *diminish* the opportunities for creativity, and *curtail* the availability of new products"); Brett M. Frischmann, *An Economic Theory of Infrastructure and Commons Management*, 89 MINN. L. REV. 917, 959–60 (2005) (identifying classes of resources that generate positive externalities for society if maintained as open access or commons goods); Carol Rose, *The Comedy of the Commons: Custom, Commerce, and Inherently Public Property*, 53 U. CHI. L. REV. 711, 768–70, 775–81 (1986) (generally setting forth the benefits of open access goods which enable a society to become wealthier by maintaining certain things, such as roads, as openly accessible).

246 Stephen B. Brush, *Genetically Modified Organisms in Peasant Farming: Social Impact and Equity*, 9 IND. J. GLOBAL LEGAL STUD. 135, 157 (2001) ("Genetic resources retain their viability partly because they are shared so widely."). Some resources benefit from being shared, creating a more the merrier effect. Carol M. Rose, *The Several Futures of Property: Of Cyberspace and Folk Tales, Emission Trades and Ecosystems*, 83 MINN. L. REV. 129, 150–52 (1998). Genetic resources constitute this kind of resource.

from their places of origin.[247] This benefited all. For example, under the open system, grapevine varieties from France were brought to the United States.[248] Later blight destroyed much of France's vineyards.[249] The United States sent grape root stocks back to France to rejuvenate France's ravished vineyards.[250] The American wine industry bases itself in part on vines from France.[251] The French wine industry in turn bases itself in part on repatriated grape root stocks from the United States.[252] The open system also facilitated the improvement of genetic material.[253] For example, breeders created the semi-dwarf varieties of wheat and rice that formed the bedrock of the Green Revolution from raw genetic material freely obtained from Japan.[254] In turn, these improved semi-dwarf varieties were rapidly shared throughout the world.[255] The open system also "produced *ex situ* international and national structures to conserve, share, and improve biological and genetic material" as well as facilitated international collaboration between scientists.[256]

The patent paradox and overall patent activity in the United States seem to indicate that the U.S. patent system has settled on a suboptimal level of property rights. Between 1983 and 2002, the number of patents issued in the United States roughly tripled, growing from 62,000 to 177,000 per year.[257] Patent applications also rose dramatically with the PTO receiving a staggering 350,000 applications per year by 2004.[258] This would constitute good news if it signaled that we

247 Brush, *supra* note 246, at 157.

248 *See generally* GEORGE ORDISH, THE GREAT WINE BLIGHT 103–19 (Sidwich & Jackson Ltd. 1987) (1972) (explaining the history of American and French experimentation with each other's grape roots and vinyards).

249 *Id.* at 15.

250 *Id.* at 103.

251 *Id.* at 19–32.

252 *Id.* at 103–19.

253 *Id.* at 116–19.

254 PRINGLE, *supra* note 231, at 42.

255 Brush, *supra* note 246, at 143.

256 Safrin, *supra* note 4, at 671. The Consultative Group on International Agricultural Research (CGIAR) represents an excellent example of the collection, sharing and improvement of genetic resources that flourished under the open system. The CGIAR system consists of sixteen international research centers that hold and improve seed and other plant material collected from around the world. Geoffrey Hawtin & Timothy Reeves, *Intellectual Property Rights and Access to Genetic Resources in the Consultative Group on International Agricultural Research*, *in* INTELLECTUAL PROPERTY RIGHTS III: GLOBAL GENETIC RESOURCES: ACCESS AND PROPERTY RIGHTS 41, 41–42, 53–55 (Steve A. Eberhart et al. eds., 1998).

257 JAFFE & LERNER, *supra* note 11, at 11 (representing a 5.7% increase per year).

258 *Id.*

had become a nation of Thomas Edisons. Yet, international comparisons show that U.S. inventions with confirmed worldwide significance grew "at a rate less than half that of domestic U.S. patent" grants in the 1990s.[259] The United States appears to be awash in patents of questionable merit and of little value.[260] IBM, for example, estimated that only forty of 10,000 patents that it had evaluated had any individual value.[261] Courts deem invalid almost half of the patents that they review.[262] As described above, most patent holders never recoup the costs of patent prosecution and perceive their patents to hold so little value that they let them lapse rather than pay the periodic maintenance fees.[263]

This extensive patent activity comes at a high price. People currently spend approximately $4.3 billion annually to obtain patents[264] and several billion more to enforce them.[265] A 2001 survey conducted by the American Intellectual Property Law Association estimated the direct litigation costs of a patent infringement lawsuit, where $1 million to $25 million dollars was at stake, at $2 million per side.[266] For cases with less than $1 million at risk, costs to each side ran $300,000 to $750,000, often almost equaling the amount at stake.[267] One study anticipated that in 1991 U.S. companies would have spent over $1 billion enforcing and defending patent lawsuits, "a substantial amount relative to the $3.7 billion" that they spent on basic research that year.[268]

In addition to these direct monetary costs, intellectual property scholars have identified other costs to overbroad intellectual property rights, including that they distort markets away from a competitive norm, interfere with the ability of other creators to work and can

259 *Id.* at 12, 142–44.

260 *Id.* at 143.

261 *See* James E. White, *The U.S. First-to-Invent System, the Mossinghoff Conclusion, . . . and Statistics*, 85 J. PAT. & TRADEMARK OFF. SOC'Y 357, 362 (2003).

262 Lemley, *supra* note 122, at 1500 (finding that courts hold invalid forty-six percent of the patents in cases where they issue a final judgment on validity).

263 *See supra* note 123 and accompanying text. As many as two-thirds of all patent owners allow their patents to expire rather than pay the maintenance fees. John R. Allison et al., *Valuable Patents*, 92 GEO. L.J. 435, 442 (2004).

264 Allison et al., *supra* note 263, at 435.

265 Lemley, *supra* note 122, at 1499–1502.

266 AM. INTELL. PROP. LAW ASS'N, REPORT OF ECONOMIC SURVEY 22 (2003).

267 *Id.*

268 Josh Lerner, *Patenting in the Shadow of Competitors*, 38 J.L. & ECON. 463, 470 (1995).

induce overinvestment in research and development.[269] Extensive patent rights improperly granted to trivial innovations can also impede scientific collaboration and can deter researchers from pursuing a field.[270] These intangible costs are exacerbated by the drag that extensive patent rights place on international scientific collaboration and international comity. Jaffe and Lerner conclude that the intangible costs of the present U.S. system with its high level of low quality patents greatly exceed even litigation costs.[271]

Property scholars note that property rights are sticky.[272] Once societies create them, they find them difficult to dislodge, and inefficient and imprudent property regimes do not readily self-correct.[273] Property rights over genetic material exhibit this stickiness. For example, rather than curtailing their control over raw genetic material in light of the dearth of bioprospecting activity, sovereigns have tightened their grip over genetic material even further by refusing to grant a patent unless the applicant has complied with their access-restricting regimes.[274] Although some contrary examples exist,[275] the expansion

269 For a summary of these arguments advanced by David Friedman, Brett Frischmann and others, see Lemley, *supra* note 30, at 1058–64 & nn.112–34. For a discussion of the costs of expansive intellectual property rights in cyberspace, see Ruth L. Okediji, *Trading Posts in Cyberspace: Information Markets and the Construction of Proprietary Rights*, 44 B.C. L. REV. 545, 545 (2003) (arguing that "expansive construction of intellectual property rights distorts the informational properties of such rights and reintroduces high search and use costs to transactions in cyberspace").

270 Arti K. Rai, *Engaging Facts and Policy: A Multi-Institutional Approach to Patent System Reform*, 103 COLUM. L. REV. 1035, 1072–73 (2003).

271 JAFFE & LERNER, *supra* note 11, at 174–75. Jaffe and Lerner, as well as Rai, *supra* note 270, disagree with Lemley. Lemley defends the PTO's poor quality of patent examination as rational from an economic perspective because these patents will never be litigated and are unlikely to be licensed. Lemley, *supra* note 122, at 1503–08. They therefore do not warrant extensive energy at the examination stage. *Id.*

272 *See, e.g.*, Carolyn J. Frantz, *Should the Rules of Marital Property Be Normative?*, 2004 U. CHI. LEGAL F. 265, 270; Merrill, *supra* note 9, at S337; *see also* Carrier, *supra* note 11, at 5 (finding the increased propertization of knowledge "irreversible").

273 Frantz, *supra* note 272, at 270.

274 *See* Safrin, *supra* note 4, at 665–67.

275 IBM, for example, recently dedicated hundreds of patented technologies to the public domain. *See* Press Release, IBM, IBM Helps Drive Open Source Development (Feb. 25, 2005), *available at* http://www-03.ibm.com/industries/education/doc/content/news/pressrelease/1258531110.html. The free software and open source software movements also demonstrate a movement in certain situations to either preserve or expand the public domain. *See* Robert W. Gomulkiewicz, *How Copyleft Uses License Rights to Succeed in the Open Source Software Revolution and the Implications for Article 2B*, 36 HOUS. L. REV. 179, 182–85 (1999).

of intellectual property rights that has occurred in the last two decades largely exhibits similar tenacity.[276]

While the press to grant intellectual property rights to traditional knowledge is new, it too is unlikely to produce an efficient regime. First, while initial demands to protect traditional knowledge stem from sympathetic groups, such as indigenous communities and developing states, any movement to create new property rights to protect traditional knowledge will not likely remain limited to knowledge from these communities or countries. The chain reaction thesis predicts that others, including those from Western societies, will demand that their Western traditional knowledge receive protection as well. Each year when I teach about international developments seeking to establish sui generis property regimes to cover traditional knowledge, some students invariably assert that traditional Western knowledge should receive the same protection.[277] For example, one student recently elaborated on all the property rights that would attach to the hamburger.[278] The developed country of Portugal has already enacted laws to protect traditional knowledge.[279] Should the movement to extend intellectual property rights to traditional knowledge take root, we will likely see demands to accord intellectual property protection not only to the knowledge of shamans but also to the Irish jig and to Greek mythology.

Second, the propertization of traditional knowledge may enable corporate moguls to own it. Once folklore is commodified, it can be sold to the highest bidder. Disney Corporation might purchase exclu-

276 Carrier, *supra* note 11, at 5.

277 *See, e.g.*, Michael Pesochinsky, Do We Have to Pay for the Indigenous Knowledge 18 (2005) (unpublished student paper, on file with author) (noting that most innovations are never patented and asserting that if intellectual property rights are extended to cover the traditional knowledge of developing countries then "the West may justly request" the payment of royalties whenever "the traditional knowledge of Western people . . . is put to use by developing countries").

278 The student analyzed the issue as follows:

> Suppose you buy a Big Mac Meal at McDonalds. . . . You would have to pay royalties to American Indians for the potato in fries and tomato in ketchup; also, do not forget the Hungarians who invented ketchup. Then you should pay India for cucumbers and Israel for pickling them. African countries can justly request royalties for deep frying french fries, and Iraq should be paid for wheat in buns. It would be very difficult to determine which country should get credit for beef, but Germany must be compensated for the whole idea of hamburger.

Id. at 18–19.

279 Portugal, Decree-Law No. 118/2002, art. 3(6) (April 20, 2002) (providing for the registration and the protection of traditional knowledge for a fifty year renewable term).

sive rights to Andean or German folklore. Merck might buy the folk remedies of India.

Finally, the overall cost to society of propertizing large swaths of traditional knowledge would be vast. "A culture could not exist," notes Wendy Gordon, if it prohibited all free riding.[280] "Every person's education involves a form of free riding on his predecessors' efforts, as does every form of scholarship and scientific progress."[281] According property status to all value would lead to "the ultimate disruption of community—paralysis."[282]

CONCLUSION

We live in a time of increased propertization. Classic theories for the evolution of property rights consider the emergence of private property to be a progressive development reflecting a society's movement to a more efficient property regime. As I have demonstrated in this Article, however, a more subtle and damaging chain reaction dynamic may characterize the emergence of property rights, a dynamic that traditional theories for intellectual and other property rights neither anticipate nor explain.

The chain reaction theory for the evolution of property rights has explanatory power. It anticipates and explains the emergence of second generation property rights, a phenomenon that has received little attention in the legal literature. It also contributes to unraveling the longstanding mystery of how property regimes evolve. In particular, societies sometimes move toward more exclusive property regimes through a process of demands for property rights that build upon each other and that have little to do with any efficiency calculation. The present propertization trend stems, in part, from the chain reaction dynamic.

The chain reaction theory also has cautionaray implications. It predicts that the more property rights a society recognizes the more property rights it will have in the future. Consequently, policy makers must exercise extreme caution before bowing to the demands of those who initially seek new or expanded property rights. Granting these rights will likely unleash a chain reaction of demands for, and result in the creation of, additional, unanticipated and potentially undesirable property regimes.

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280 Gordon, *supra* note 11, at 167.

281 *Id.*

282 *Id.* at 179 n.113.