

Taxonomy, biodiversity and their publics in twenty-first-century DNA barcoding

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We examine the crafting of publics in the global Barcoding of Life Initiative (BOLI)—seen as crucial for re-invigorating, and democratizing, early-twenty-first-century taxonomic sciences and hence for actually achieving biodiversity protection. Our approach to the issue of publics differs from that of conventional public understanding of or engagement with science work. Combining science and technology studies with critical political theory allows us to examine the discursive and material *formation* of publics occurring within the science of DNA barcoding. Co-productionist theory suggests BOLI to be actively crafting its prospective publics imaginatively, as an integral part of its self-composition as public science. Drawing on the work of Laclau's *On Populist Reason*, we examine how such normatively weighted abstract publics are necessarily chronically incomplete, with an unavoidable tension between the universal and the particular.

1. Introduction

Giving non-experts a way to identify species would open a goldmine of biological knowledge to students, teachers, government officials and the general public, and would transform our ability to understand and protect biological diversity. (Barcoding of Life, 2009)

The barcode and its associated enablers—digital scanning devices and databases—have relatively quickly become a taken-for-granted assemblage of technologies and practices for inventorying, classifying and stock-taking in many areas of contemporary social activity. The supermarket and the library are two places where we encounter these technologies, used to order and catalogue the entry and exit of scanned (and therefore instantly identifiable) goods to and from their designated shelf-space. No matter how commonplace barcoding technology has become in these public settings, however, *DNA-based* barcoding remains somewhat controversial within the science of taxonomy. The Barcoding of Life Initiative (BOLI) is an innovatory taxonomic project designed, through the sequencing of selected segments of DNA, to provide accurate, digitized, mobile and instantly accessible species-level information to anyone, anywhere, globally. The possibilities opened up by barcoding of these sequences have propelled many taxonomists into rethinking the way that taxonomy might go about its ordinary tasks of identifying, inventorying, and even classifying,¹ as part of an overall aim to know, name, document, and hence (it is assumed) protect the natural world.

It can be argued that most if not all science essentially imagines, takes place in, and has consequences for the public sphere. However, DNA barcoding can be seen as a case in which the explicit driving force behind it has been the desire to make species identification and biodiversity really matter for society; an urge commonly framed as the need to democratize taxonomy and enable a globally accessible “biodiversity commons.” BOLI actually seeks to promote two ideas: the democratization of taxonomy, where democratization is characterized as universal and rapid public access to precise information about nature (Costa and Carvalho, 2007; Holloway, 2006; Janzen, 2004b) and the urgent need to protect biodiversity globally. A taxonomy that has purchase beyond its conventional academic pursuits has been envisaged by the DNA barcoding community in different ways, ranging from a pragmatic science that will “deliver” to policy- and other end-users, to a science that will nurture humanity’s innate connection with the natural world (as imagined in E.O. Wilson’s *Biophilia*). These illustrate the heterogeneity of both the taxonomic community and the very publics or user communities towards which some barcoder-taxonomists are turning their attention. This model of public-science interaction contains an implicit model of distributed knowledge-agency, knowledge, and responsibility, of global dimensions. We are particularly interested to document below the different publics and user communities imagined by BOLI advocates, so that we can explore their characteristics, their relationship to BOLI and to BOLI’s ideas of democracy.

Our approach derives from Science and Technology Studies (STS) and Sociology of Scientific Knowledge (SSK) perspectives, which have already produced a more general multidisciplinary literature on the public dimensions of science and technology (Callon, 1994; Callon and Rabeharisoa, 2004; Evans and Plows, 2007; Felt and Wynne, 2007; Hayden, 2003; Irwin, 1995, 2001; Irwin and Michael, 2003; Jasanoff, 2005; Latour and Weibel, 2005; Reardon, 2005, 2007; Rose, 2007; Stengel et al., 2009; Sunder Rajan, 2006; Wynne, 2001, 2003, 2005, 2006). This body of literature represents a broad spectrum of approaches to the relationships between science and its publics, yet all of it converges on questions of knowledge and politics in scientific culture and practice, and the corresponding engendering of society itself. Here, “publics” are not only being imagined or reflected upon, but brought into being, or performed, through this nexus. However, it has also been noted that this evocation of publics often involves a reduction, or even an erasure, of their diversity, and of the politics of their intersection with science (Reardon, 2007; Wynne, 2007, Wynne, forthcoming).

More specifically relating to barcoding, we contribute to a growing body of sociological and natural scientific literature that critically appraises BOLI (Dupre, 2006; Hollingsworth, 2006; Holm, 2006; Larson, 2007). Some of this literature asks about how certain of BOLI’s assumptions about the public are already shaping its innovatory pathways and thus potentially bringing that same imagined public into material being. Larson, Dupre and Hollingsworth, for example, all ask in different ways whether we can assume that society will benefit from DNA barcoding if public engagement with biodiversity is reduced to digital species-level information as a surrogate for the full liveliness of a broader experience of the natural world. Our argument differs somewhat (though it can be read in a similarly questioning light): we will go on to suggest that in order to support its democratic and information-based ideals, BOLI needs to nourish an active crafting of varying, diverse publics. This has implications for its techno-scientific development.

In exploring BOLI’s crafting of publics in greater depth below, our intention is not simply to highlight science’s lack of attention to its own social manoeuvrings, but to invite reflection on the part of social and natural scientific actors on the implications of these dynamics. In this

respect, we situate ourselves together with BOLI, albeit from a different perspective, as committed “modest witnesses” (Haraway, 1997), reflecting upon the co-productive shaping of taxonomic science together with its corresponding imagined publics. We recognize, in this reflexive mode, that we are “in the action ... finite and dirty, not transcendent and clean” (Haraway, 1997: 36), and accountably so. This inevitably bears consequences; we might also play a role, through dialogue with BOLI, in the crafting of its publics.

Below, we draw upon interview data, as well as documentation, that highlights ways in which the DNA-barcoding community is discursively articulating an abstract generalized and global “public.”² As we explain, we distinguish this rather nebulous “general public” from two further “publics” imagined for this techno-science. We go on to integrate analysis of DNA barcoders’ discourses of its (present and projected) publics, with the political theory of Dewey (1927) and Laclau (2005), in particular (neither of whom have been specifically interested in *science* in relation to democracy). This theory provides valuable conceptual insight about publics that can be related to contemporary science, insights we believe to be under-developed in Public Understanding of Science (PUS) research. One point we develop later is that the publics we document here are strictly speaking fictional (Laclau, 2005), thus conventional sociological fieldwork with them would be a contradiction in terms.

Our approach differs significantly from that explored in closely related literature on the “public engagement with science,” where material publics are normally selected and organized for such engagements; no such publics, nor uninvited ones (Wynne, 2007), exist for DNA barcoding of life. Yet a key point of this article is that this does not mean that there is no public in the techno-science of DNA barcoding of life.

2. The Barcoding of Life Initiative

BOLI took root in the early 2000s when a team of systematists and bioinformaticians from the University of Guelph, Canada, judged that there was enough base-pair variation in half a mitochondrial gene, Cytochrome Oxidase 1³, to be able to indicate species-difference and hence species-identity initially for the whole animal kingdom, and potentially for biodiversity in its entirety (Hebert, Cywinska et al., 2003; Hebert, Ratsingham et al., 2003). Since then, DNA barcoding has developed rapidly, involving a heterogeneous cast of characters. A number of individuals are recognized, however, as having led both in “inventing” the barcode and in steering its technological development and subsequent high-throughput scaling up. The scientist leading the research was Dr. Paul Hebert. His pivotal role was soon supported by a number of other influential advocates of barcoding technology. These include Dr. David Schindel and Dr. Scott Miller, Executive Director and Chair, respectively, of the Consortium for the Barcoding of Life (CBOL) working at the Smithsonian Institution. One of the most powerful and palpable influences upon the development of BOLI, however, has been the ecologist Daniel Janzen. Hailed by many as the “dean of tropical ecologists” (Guha, 1997), Janzen is something of a global celebrity in the world of nature conservation. In particular, his somewhat alarmist writings on the rapid decline of humanity’s knowledge of and care for biodiversity—encapsulated by the concept of “bio-illiteracy”—are fast becoming part of conservation discourse (Janzen, 1986; see also Ben-Ari, 2000; Guha, 1997; Janzen, 2004a, 2004b).⁴

Janzen’s contributions to BOLI have taken both visionary and material forms. On the one hand, his labor-intensive task of inventorying the biodiversity of the Area de Conservacion de

Guanacaste (ACG) in Costa Rica, together with his life-partner Winnie Hallwachs, has generated vast quantities of specimens in need of rapid and high-resolution identification. Parts of Janzen and Hallwachs's collections (moths and butterflies in particular) were the subject of some of the first trials using CO1 in Paul Hebert's laboratory and became indispensable for testing the databasing and automated technologies involved in the scaling up of barcoding. Subsequently, their wider collections have been sent to Paul Hebert and to the Smithsonian's Laboratory of Analytical Biology for high-throughput sequencing and have thus contributed to the wider effort to sequence and bank global biodiversity.

On the other hand, Janzen's work with the ACG's local resident population and the training of a selection of individuals as "parataxonomists" has, we suggest, been instrumental in demonstrating to BOLI—and the world—the benefits of a real-time "experiment" in transforming what Janzen characterizes as a "bio-illiterate and biodiversity-trampling community into one which has (re)ignited its biophilic—or nature loving—tendencies." The "parataxonomists" of the ACG have become biologically literate thanks to Janzen's training programs in species identification and specimen preparation—a process that has also fuelled BOLI's need for fresh specimens for sequencing and analysis. Janzen's own efforts to foster a bio-literacy conversion among the people of Guanacaste, his experience, and the repeated narration of it in barcoding circles and publications, has fostered a wider vision—that through BOLI, an imagined and as-yet non-existent "general public" might be re-connected with the natural world.⁵

DNA barcoding and the future of taxonomy

It is worth noting that BOLI emerged out of a specific set of conditions affecting taxonomy globally around the turn of the twenty-first century. Taxonomy was widely recognized to be in "crisis" globally at this time: as a subdiscipline of biology its fortunes and status had dwindled over previous decades, its plight in part exacerbated by the rising success of the molecular and genomic sciences, with whom taxonomists shared scarce funding resources. Practitioners from all parts of the globe were concerned about deficits in taxonomic expertise and the difficulties of using dispersed and inaccessible taxonomic knowledge, just when biodiversity policy and science seemed to need it most (House of Lords Select Committee on Science and Technology, 2002; Royal Society, 2003). Hebert et al.'s publications in 2003 were among a number of radical proposals to reinvent taxonomy for the twenty-first century, to capitalize on recent developments in information and genomic technologies, and to unify global taxonomic methods, making taxonomy both accessible for end-users and more attractive to potential funders (see also Godfray, 2002; Miller, 2007; Tautz et al., 2003).

Taxonomists have, however, been using patterns and rates of nucleotide base-pair substitutions as characters with which to understand evolution and relationships between species since the 1950s (Avise, 1994). What was potentially revolutionary about Hebert and colleagues' proposal was that the short gene segment could: (a) flag species identity; and (b) be easily represented, through sequencing and related technologies, as a simple, digitally scannable barcode. It therefore hailed the use of a standardized digital code to "name" and catalogue known species, against which unidentified specimens and new, unknown species might be examined. The finding led to the creation of the Barcoding of Life Database (BOLD), which meant that barcode banking and species identification could be fully mobilized. The ambition is for barcodes to link this database with a further new technology, a hand-held sequencer and species identifier, "the barcoder," which at present only exists in its early design stages.

For many taxonomists, DNA barcoding presented an attractive and viable solution to the problems facing the taxonomic and biodiversity sciences. Firstly, it offered a unifying focus of method and purpose within taxonomy—a field characterized by passionate but fracturing debate that at times has rocked its very foundations as a discipline (Hull, 1990; Nelson and Platnick, 1981). Second, it answered, or claimed to answer, the widely acknowledged taxonomic deficit. The global and industrial scale, speed and efficiency of DNA barcoding, it was argued, would help society to know and understand the 90% of global biodiversity which remains unidentified (Royal Society, 2003), hence providing human knowledge of the planet's rapidly dwindling biodiversity as a presumed essential prerequisite for its protection.

Several publications in the scientific literature after 2003 addressed the approach of Hebert et al. In many papers, critical and supportive, DNA barcoding was assumed to be competing (in theory and in practical resource-driven terms) with descriptive morphological analysis, leaving aside important questions and principles concerning character analysis and hypothesis-driven taxonomy (Cameron et al., 2006; Lipscomb et al., 2003; Mallet and Wilmott, 2003; Moritz and Cicero, 2004; Will et al., 2005). What most concerned many taxonomists were Hebert et al.'s initial claims that genetic barcodes could be used to delimit species relationships. These taxonomists felt that half a mitochondrial gene could not possibly contain enough information to encompass such deep and complex relationships. In the face of continuing disagreement, BOLI decided, somewhat strategically, to promote the role of DNA barcoding not strictly as a tool for systematics, but as a very useful, practical and cheap tool for ascertaining species identity and diversity only (and not relationships between species). One advantage of this simplification is that it brackets questions about the highly contentious and slippery “species concept” itself, and seeks only to delimit similarity and difference between specimen organisms. Most importantly for our purposes, DNA barcoding's emphasis on rapid and accurate species diagnosis and its envisaged mobile, standardized technologies for sequencing, barcoding, and databasing, acted to reconfigure taxonomy as a service-industry for multiple different non-taxonomic users.

Taxonomy—at your service!

The director of one of the sites of industrial-scale DNA barcoding, one that receives global tissue samples daily, expressed its ethos thus: “We should be prepared to be donkeys for the rest of the world.”⁶

In evoking the “rest of the world,” barcoders differentiate between at least three different kinds of imagined or potential user communities, all of whom are believed to partake in and contribute to the “biodiversity commons”—a term used to suggest the access of all humanity to information derived from nature, and to nature itself. The first community is most commonly identified as the taxonomic community itself, for whom industrial-style rapid species diagnosis is freeing up valuable time for more complex pursuits than simple organism identification. The second user community tends to be characterized, broadly speaking, as non-taxonomist professionals with a need for rapid species diagnosis. This second, globally-distributed community ranges from ecologists to forensic scientists, border-inspectors, agricultural pest-control and public health agencies—those concerned about threats to the economy, biosecurity and human health presented by “risky” biodiversity including, for example, alien or illegally-traded species, crop pests and disease vectors such as the malarial mosquito. The third and most difficult to define user community for DNA barcoders—and the community we will focus upon—can be encompassed by the notion of a global, but so-far virtual, “general public.”

Barcoding's "general public"

In barcoding discourse, the “general public” is invoked through terms ranging from “a kid” (Hebert, 2007), “every child” (Janzen, 2004b: 731), “every farmer” (Janzen, 2004b: 731), “anyone” (Hebert and Gregory, 2005: 856), “anybody,”⁷ “everybody,”⁸ to “people all over the world,”⁹ “any one person at any one time” (Janzen, 2004b), “a significant pool of humans,”¹⁰ “society, global society, everyone” to “the bulk of humanity” to “all humanity” (Janzen, 2004b: 731) to “lay people, the person on the street,”¹¹ to “society at large,” or “the general populace.”¹² These publics include just about everyone; and through the obligatory passage-point of DNA barcoding, they are imagined to have a particular agency: “it won’t be long before *everyone, from experts to amateurs*, will be able to scan the world’s flora and fauna as if they were checking out groceries at a supermarket” (O’Connell, 2008).

The most striking feature of these characterizations of the public is that they assume and produce a vision of a vaguely composed, “nowhere-but-everywhere” global community. As we discuss later, whilst such an act of homogenization might be necessary for democracy, paradoxically it simultaneously deletes the heterogeneity and difference that democracy, by definition, should support. This is important to grasp as the so-called “general public” is arguably the populace upon which the democratization of taxonomy and biodiversity most heavily depends. We believe that the rhetorical evocation by BOLI of the “general public” poses questions to us as social scientists, but also to BOLI’s proponents, concerning the relationship between science, publics and democracy. In the light of its aspirations to ‘democratize’ the taxonomic and biodiversity sciences, it seems important for BOLI to take seriously the implications of its own discursive actions.

As social scientists, we see this discursive crafting of the general public as much more than a mere rhetorical language-game. Such rhetoric has material, social, political and epistemic—dimensions and possible consequences. This is not only because the rhetoric of the general public is pivotal to an imagined and energizing relationship between human communities, new databases, sequencing technologies (including hand-held devices) and nature; but also because such rhetoric opens up a very interesting space for thinking about the relationship between science, politics (especially the notion of democracy) and society (Laclau, 2005). In the following section, we illustrate ways in which BOLI is (rhetorically and actively) bringing a certain public into being in the name of the democratization of biodiversity.

Barcoding democracy—bio-literacy and the biodiversity commons

The following passage is a demonstration of the playfulness, imagination and creativity of BOLI visions:

The spaceship lands. He steps out. He points it around. It says “friendly–unfriendly; edible–poisonous; safe–dangerous; living–inanimate”. On the next sweep it says “*Quercus oleoides – Homo sapiens – Spondias mombin – Solanum nigrum – Crotalus durssus – Morpho peleides – serpentine*”. This has been in my head since reading science fiction in ninth grade half a century ago. I am sure it was in the heads of Linnaeus, Alexander the Great, and Timid the Mastodont Stomper. And it has been on the wish-list of every other human confronted with the bewildering blizzard of wild biodiversity at the edge, middle and focus of a society.

Imagine a world where every child’s backpack, every farmer’s pocket, every doctor’s office and every biologist’s belt has a gadget the size of a cell-phone. A free gadget. Pop

off a leg, pluck a tuft of hair, pinch a piece of leaf, swat a mosquito, and stick it on a tuft of toilet tissue. One minute later the screen says *Periplaneta Americana*, *Canis familiaris*, *Quercus virginiana*, or West Nile virus in *Culex pipiens*. (Janzen, 2004b: 731)

In two paragraphs, Janzen, eloquently—and only part-playfully—encapsulates a vision of a number of communities, ranging from children, farmers, doctors, to biologists themselves, all connected to a particular nature-of-the-future, all participating in a knowledge-community that is producing and using biodiversity information in prolific quantities. Today, this vision has been materialized in quite explicit ways. It has directly influenced the two technological developments integral to the barcoding enterprise: the projected pocket-sized, hand-held “barcoder,” and the Barcoding of Life Database, which banks all validated barcodes and, following publication of research, places them in the public domain.

But such visions and their technological embodiment also, we suggest, involve an imagined public. With characteristic vision, another key player in DNA barcoding described it as “an enterprise that promises to remake our relationship with life.”¹³ He elaborated as follows:

Remaking our relationship with life was based on the fact that what barcoding is going to do is make it possible for anyone like me to go out into any natural environment and read the organisms that are there for the first time. That’s remaking it ... I believe that there will be a significant pool of humans that will have a more intimate relationship with nature because of barcoding. I absolutely believe that and I absolutely believe its going to happen within my lifetime.¹⁴

There are two issues we would like to highlight here. The first is the assumption that today’s general public does not enjoy any intimate relationship with nature because of its ignorance of species-level information. The second is the allusion to biological literacy by referring to a future improvement of human knowledge resting on its technologically-provided ability to “read” nature.¹⁵ Note here not only the knowledge increase, but also the imagined shift of engagement.

Arguably, BOLI requires these depictions of today’s “general public” as different from the taxonomic community (in possession of species-level biodiversity knowledge) in order to be able to promote DNA barcoding as a tool for democracy through public engagement with this kind of biodiversity knowledge-practice. The suggestion is that such technologically-mediated bio-literacy will enable a transformation from a public disconnected from nature, to one that thrives on a close epistemic (and ethical) proximity to the natural world. The question that concerns us here is how this “othering” of the public (as biologically illiterate, disconnected, even uncaring about life on earth) is conceived with little real knowledge as to whether such a portrayal of the general public is accurate and as to what potential it may allow for, and what potential it denies. As we shall suggest, the instrumentality of the vision of an illiterate public that can be converted to literacy, undermines the many real and complex (including caring, and diversely knowing) connections that people have with the natural world. This is not just a problem of negative thinking about others, it is a problem of denying BOLI the vision of connectedness between nature and society that has been well documented in the social sciences (see below), and upon which it could build.

3. STS, publics and democracy

BOLI’s contemporary and future publics are already being imagined and engaged with (and by) the techno-science of interest through the design of the BOLD, the idea of the hand-held

“barcoder” and the Barcoding of Life Initiative itself. At first glance, BOLI’s merging of the needs for democratized information access with the possibility for enhanced biodiversity protection, through what is essentially a technical fix (barcoding) is both a laudable and simply logical marriage of ideas and approaches. However, from an STS perspective concerned with the kinds of publics that science brings into being—BOLI’s idea of democratization requires further thought.

Hayden has described efforts to reorder the relationships between science and society over the last two decades as a “remarkable carnival of ‘public participation’” (2007: 732). She also describes the varying ways in which science and its publics have experimented with new forms of interaction, as forms of “political sociality.” She thus effectively indicates that such relationships, whether founded upon dialogue or other forms of public engagement with science, work at the intersection of different, maybe conflictual epistemic, social and political commitments. The active search for ways to enhance public engagement with science (rather than the implicit inclusion of publics only on science’s terms) has been described more generally as a marked shift away from a style of science–public relations based upon science’s free reign to speak as “public authority” to one that attempts to be receptive to public needs and expectations (Goven, 2006; House of Lords Select Committee on Science and Technology, 2000; Irwin, 1995, 2001; Jasanoff, 2005; Wilsdon and Willis, 2004; Wynne, 2007, Wynne, forthcoming).

Critiques of public engagement initiatives as they play out in practice, however, suggest that science (embodying as it does, powerful interests or premises) often remains sovereign as a form of knowledge and normative commitment. Experiments in democratizing science have ironically served to reinstate the authority of science by subtle means involving erasure of the very publics being invited to participate (Wynne, 2006).

A second, related critique within science studies has been to examine the way that particular versions of publics, society or cultural norms are implicitly imagined as “natural,” “built into,” or co-produced with the fabric of scientific methods, experiments, innovations and claims (Ackrich, 1995: 167-184; Haraway, 1989; Jasanoff, 2005; Reardon, 2005). Here the focus is less upon models by which science imagines democratizing its own practices, and more on examining taken-for-granted and implicit models of the public within existing and nascent scientific logics and practices. In her book, *Primate Visions* (1989), for example, Haraway highlighted the way that dominant social ideas and conventions relating to gender were built into the very framing of experiments in primatology and psychology. Such features of the social or cultural order are woven into natural knowledge as further, supposedly “natural features.” Reardon, to give another example, shows how understandings of human similarity and difference built into population models for the Human Genome Diversity Project were imagined in such crude and contentious terms that the entire project suffered controversy and failure as a result (Reardon, 2005, 2007).

Irrespective of the various forms these more-or-less interactive performances of publics might take, STS researchers have observed that scientific articulations with publics tend to assume or imagine a collective, namely “the public,” as a preconstituted entity with which to find new ways to interact. Wynne (2001, 2007) notes how such imaginaries of publics become embodied in the very culture of scientific and policy institutions, potentially leading to the alienation of the very publics that science aims to engage.

The publics we are describing in this article, however, are not publics that are explicitly invited to participate in dialogue with the taxonomic expert community. Nor are they publics portrayed as marginal, distrustful players who might be invited to “participate.” They do not constitute a particular or general social body attempting to voice interests or concerns to DNA barcoding. They are, rather, publics imagined to be waiting in the wings to

receive the kind of biodiversity information and practical skills (and corresponding moral reorientation) defined as relevant and necessary for them by a specific sector of the taxonomic science community.

Our analysis of BOLI's crafting of publics in the name of democracy attempts partially to answer Reardon's call to put to one side certain assumptions about the general benefits of democratizing science and attend to "the more subdued task of analyzing how democratization happens; what logics underlie it, what practices make it up" (2007: 241). "Democratization" is a concept that is frequently used by the barcoding community (and by other scientific communities), but we examine this term from a different perspective with particular historical, social, political, and philosophical questions that continue to fuel intense debate (Benhabib, 1996; Barber, 1996; Habermas, 1996). The barcoding community's borrowing of a vocabulary and associated ideals invested in the concept of democracy (equality, access to information, distribution of agency, rights, and responsibility) allows us to think more about some key questions of political science relevant to STS: what roles do 'publics' play in the idea of democracy, and what are the dynamics that accompany these roles? We pose these kinds of political scientific questions in the specific context of a global techno-science's development, because we want to understand better the way in which *scientific cultures* such as BOLI are enacting their own imaginaries of democracy, through *their own* envisaged relationships with collectives such as 'publics'.

We bring together STS with political theory, with the key premise that social categories such as "public" are abstract entities that "do not pre-exist the relational complex, but are constituted through it" (Laclau, 2005). This relational understanding of publics is important, and deserves explanation below. It not only offers important extra insight into the case analyzed here, but we suggest its inclusion would also add important new resources for the wider field of PUS.

4. Democratic political theory and public techno-science

We have so far suggested that the vision of "democracy" articulated by leading BOLI scientists is one in which global nature would be protected at the grassroots, as it were, through a fully distributed, global "epistemic community" (Haas, 1990). This vision of democracy in turn implies a "public" with corresponding properties. In important respects, science and its imagined publics bring this (version of a) public into being; that is, they perform it. This was Dewey's (1927) concept of a constructed "public" in relation to the political institution of the state and its public officials. As Dewey put it, the state and its officials *needed* there to be a public, defined by particular imputed public concerns and needs, which public officials could then devote themselves to serving. There was no abstract collective agent, "the public," that actually pressed these needs, there were only diverse and even conflicting mobilizations of the concerns of specific groups (and the non-mobilization and effective silencing of others), out of which impossible incoherence, politicians and their officials had to make practical if always temporary sense. Building upon these insights, in an empirically strict sense, "the public" as a unit does not exist; it is a fiction. Yet in other senses it is real because "it" has real conceptual and material effects. It is a necessary functional myth, or heuristic.

What comes into view here is an essential but potentially confusing tension between, on the one hand, a necessary reference to, and practical performance of, a unitary and homogeneous fiction "the public," and on the other, the sheer diversity, partiality, teeming conflict, flux, and potential incoherence of real, identifiable components of that abstraction. Drawing

on the work of Ernesto Laclau (2005) and Dewey (1927), as already rehearsed, we seek to clarify here how these tensions inhabit an emerging major techno-scientific field such as BOLI being developed with genuine and global “public good” intentions.

Dewey’s insight regarding the strictly fictional character of the public, led him to emphasize that this did not at all render “the public” substantively unreal, in social or moral terms. Laclau explains how in democratic process, abstract collectives such as “the public” as agent, are strictly empty categories, or “empty signifiers,” because they refer to things which cannot be found empirically. They purportedly signify a unitary and totalistic universal. This can be dismissed as vacuous, yet at the same time, as Laclau insists, for any collective such as democracy to be sustained, these unifying collective “fictions” are essential. The key problem is not their imagination and discursive articulation as such. It is that their essential ambiguity (born of the intrinsically relational, emergent and contested basis of the human subject as citizen of such collectives tends to fade from view (Mouffe, 1996). As Laclau explains it, there is an essential tension between the necessarily abstract universal, homogenous signifier (“the public”) and real public diversity, endless interactive revision, and difference, in which authentic meanings and social relations are grounded. Democracy and democratization cannot be nurtured without either part of this essential tension.

Examined through the lens of Laclau’s insights, BOLI’s “general public” constitutes a universal and totalizing community. As he underlines, this totalizing reference always fails against its own implied claims. Herein lies one of the perhaps unavoidable problems of the construction of this general public. For in the commitment to bringing it into being (an entirely necessary part of the *techno-scientific* innovatory project in BOLI), public diversity is denied. It becomes an abstraction, and, as such, homogenous and indeed, in some key senses, *vacuous*. To place Laclau’s deep examination of the tension between universalism and particularity in the construction of a public into BOLI terms, recall that the general public, hailed as future users of BOLD and the hand-held “barcoder,” is defined in opposition to the taxonomic community. Its imagined qualities (bio-illiteracy, ignorance, carelessness for nature) render them ready for the innovations promised from the taxonomic community. But these imagined qualities also perform a globally unitary, indeed totalitarian general public identity.

5. Differentiating publics

Some of BOLI’s rhetoric implies that all populations of the world have the same actual (empty, uncaring) and potential (full, through barcoding) relationships with nature, and that this is static—the social-relational dynamics as well as the differences in people’s relationships with nature are not imagined. But the practical intelligence of the BOLI project is more sophisticated and sensitive than this in its global dealings with many diverse user- and stakeholder-groups, each of which in turn has its own diverse further stakeholders, or public actors. The extensive situated stakeholder negotiations that reach out through these diverse networks actually encounter a very different “public” from that imagined, projected, and performed in the universalist BOLI discourse of democratization-through-barcoding.

Thus the BOLI discourse of *democratization* effectively denies this aspect of its own practical social intelligence. It also denies the existence of alternative, differentiated publics who might or might not yet constitute the very publics presently being crafted by BOLI. Humanities and social scientific research has long established that diverse human communities have varied and meaningful relationships, not “with” something separate and singular

called “nature” but in, and as part of, the socio-natural worlds in which they participate (Ingold, 2000). Thus, even at the basic conceptual level, the idea that a universal general public is waiting in the wings for the relevant digital tools and technology (BOLD and the hand-held “barcoder”) with which to identify nature in a globally standardized fashion through a particular technological-infrastructure form seems an idea that has developed in ignorance or denial of the rich and manifold ways in which diverse human cultures and societies are (already) found to be entwined and interdependent with various, equally diverse natures (Castree and Braun, 2001; Clark, 2003; Cronon, 1996; Ellis and Waterton, 2004, 2005; Hinchcliffe, 2007; Hinchcliffe et al., 2005; Jasanoff and Martello, 2004; Thompson, 2002; Whatmore, 2002). Some of these communities have indicated their own independent knowledge, and independent needs and conditions that imply different technical choices in the construction of DNA-barcoding as a global science. If we go wider, we see an immeasurably richer and more diverse global human cultural ferment of practiced relationships with and knowledges of nature. Many of these, should their knowledge-cultures ever intersect with that of DNA barcoding, would almost certainly imply technical negotiation over how their different situated needs, conditions, and purposes would translate into choices of indicator gene-segments, what degrees of standardization or differentiation in technical (and social) components of the system would be appropriate, and other issues affecting the technical development of barcoding.

In Laclau’s terms, these contradictory aspects of BOLI and its public(s) need to be brought into constructive and sustainable conversation. This is difficult, because BOLI’s homogenized, unified abstract public is, we argue, a product of barcoding’s own specific need for universalism (for example, in its technical standardization processes) at this point in its history. BOLI’s selective characterization of a (rather degenerate) global public is categorically singled out in such a way as to bear the weight of representing a universal global population, which this universalizing scientific endeavor will serve (and transform). This abstract universal public—as bio-illiterate and in urgent need of barcoding’s aid—is tightly coupled with a future, knowing, caring and responsible public that would emerge through barcoding. However, the former is a “failed totality” in Laclau’s terms, because it cannot represent the whole of global society. According to Laclau, even the future public, if materialized, would be unable to represent the whole, as it would still be no more than a part, and as an abstract total category; another failed representation.

We are in no way suggesting that BOLI deliberately and instrumentally produces false categories of the public. We argue instead that the characterizations of public we have identified are ones that clearly differentiate and then place barcoders and the imagined “general public” in a mutually-constitutive relationship that embodies universalistic assumptions about a present and future public. We suggest that the objectification of imagined publics in this way might be insensitive to the dynamics that Laclau describes as essential to democracy, in that they objectify certain assumptions about the “general public” without considering how these compromise the essential role of diversity in democracy. They could thus ironically undermine the very idea of the democratization of taxonomy, as an internal self-contradiction. Lastly, we suggest that the parallel existence of alternative, *differentiated* publics that so far have not been demarcated or characterized requires more attention.

The question remains: how might this particular mode of imagining and performing its public affect the form of the science itself? And, conversely, if the science is developed globally without openly considering such questions as its own discourse suggests, then will the global techno-science end up undermining its own aim of diverse democratic public uptake?

6. Concluding reflections

We have offered an STS analysis of an important global techno-scientific field in-the-making, one with huge implications for global biodiversity protection. As a key part of this we have tried to show how political theory can give such STS analysis greater depth in understanding of the public dimensions of such sciences. This also potentially adds greater depth to our resources for properly delineating the context of public engagement with science exercises. One of us (Wynne, 2007, forthcoming) has already argued that reflective analysis of the “science” in play should always be a key part of any public engagement process. This rarely occurs. The kind of preexisting “publics” that we have identified here as already integral to the science’s global development would clearly be important to understand and question if any kind of ‘public engagement’ exercise were launched as part of BOLI. The tensions (and opportunities) we have identified using Dewey and Laclau are also an important prior fabric from which any constructive future of DNA barcoding of life, as a democratic public science important for future global sustainability, would have to be further woven.

One of Laclau’s central ideas, which has helped us in understanding the relationship between barcoding’s publics and its possible democratization, is the inability of the category of the “people” to accommodate society’s essential heterogeneity, an inability that, as Laclau reminds us, Rancière (1999) has called the “paradoxical magnitude.” Both Rancière and Laclau are exploring the tensions inherent in doing democracy and the implications of recognizing that society is composed of more pluralities than reference to its totality can ever accommodate. For Rancière and Laclau this essential tension is what creates the very space needed by the “political.” Summarizing Rancière’s ideas on democracy, Dillon explains his position: “If the world did add up, there would be no need for politics” (2005: 436). Our point is here that human politics are a necessary and lifegiving part to any innovation that requires commitment to a particular idea of the public. A new technology cannot properly take the place of such politics, even though, as Barry (2007) explains, modern politics is increasingly conducted through and shaped by technologies.

Dillon’s reflections on Rancière’s “paradoxical magnitude” provide a positive tone on which to end. He suggests that a hopeful expectant waiting is always at the root of attempts to do democracy, in that the potential for real equality and engagement is of spectral quality—it is always “to come” (2005: 430), and, crucially, it is always relational, thus never under “our” complete control. It is intrinsically contingent, and necessarily so, otherwise it would not be democracy. We would like to support this idea of an innocent and hopeful future always in-the-making, in this case with techno-sciences such as DNA barcoding emerging and being shaped mutually with their social and institutional correlates, including their relevant social reference groups, and “democratic publics.” However, some conditions suggest themselves: first, that the barcoding community avoid the possibility of inadvertent emptiness in the categories of public being evoked; second, that the possible future democracy-to-come, and its constituent techno-science, is open to question in the present; and third, that we allow room for accountable reflection about what needs to be in place, including what forms of techno-science, in order for such hopes to bear fruit.

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Notes

- 1 The question of whether DNA-based “barcoding” involves the relatively simple identification of known organisms, or whether it involves the (re-)classification of organisms, has been a sensitive matter of debate within the barcoding and taxonomic communities (see Hebert et al., 2003a; Vogler and Monaghan, 2006).
- 2 The analysis and reflections of this article derive from a three-year ESRC funded research project, ‘Taxonomy at a Crossroads’. The methodological approaches used included ethnography, interviews, consortium building (see Duret et al., 2000) and textual analysis. This article focuses on our interpretation of BOLI’s discursive formation of its own prospective publics by drawing upon interview transcripts and documentation in the literature. See Waterton et al. (forthcoming) for more detailed multi-methods analyses of BOLI.
- 3 The barcode is the sequence of 648 base pairs of Cytochrome Oxidase 1 or CO1.
- 4 The concept of “bio-literacy” can be perceived as a particular version and reduction of ‘biophilia’ (Kellert and Wilson 1993; Wilson, 1984, 1991). Whilst “biophilia” conveys a broad sense of human connection and affiliation with the natural world, the emergence of the concept of “bio-literacy” promotes the idea that true love and connection is best enabled through an ability to differentiate between and hence name and identify natural species.
- 5 See also Bassett et al (2000) for an account of experience with parataxonomists in Papua New Guinea and Guyana.
- 6 Interview Transcript November 2006.
- 7 Plant Taxonomist, Interview Transcript, November 2006.
- 8 Database Manager, Interview Transcript, October 2006.
- 9 Vertebrate Taxonomist, Interview Transcript, November 2006.
- 10 Invertebrate taxonomist, Interview Transcript, November 2006.
- 11 Plant taxonomist, Interview Transcript, November 2006.
- 12 Bioinformatician, Interview Transcript, November 2006.
- 13 Invertebrate taxonomist, letter to research team, 4 November 2004.
- 14 Invertebrate taxonomist, Interview Transcript November 2006.
- 15 See also Cameron et al. (2006) for a critique of this assumption.

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