Letting go of "Natural Kind"
Towards a Multidimensional Framework of Non-Arbitrary Classification

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Abstract: This article uses the case study of ethnobiological classification to develop a positive and a negative thesis about the state of natural kind debates. On the one hand, I argue that current accounts of natural kinds can be integrated in a multidimensional framework that advances understanding of classificatory practices in ethnobiology. On the other hand, I argue that such a multidimensional framework does not leave any substantial work for the notion "natural kind" and that attempts to formulate a general account of naturalness have become an obstacle to understanding classificatory practices. In the case of ethnobiology, different accounts of natural kinds pick out different relevant subsets of ethnotaxa but there is nothing to be learnt from the question which subset should qualify as the set of natural kinds.

1. Introduction

The current state of natural kind debates invites contradicting diagnoses. On the one hand, philosophers of science commonly express skepticism about the notion of natural kind and many of its traditional - e.g. essentialist and monist - interpretations (e.g. Dupré 2002; Gannett 2010; Kitcher 2007; Nanay 2011; Radder 2012). Ian Hacking (2007) has even argued that "the tradition of natural kinds [...] is in disarray and is unlikely to be put together again" (2007, 203). According to Hacking, contemporary natural kind debates are a mess because philosophers use the term in many incompatible ways and "refer to the class of classifications they most admire, as the class of natural kinds" (2007, 206). The result is a "scholastic twilight" of technically sophisticated but obscure definitional debates.

On the other hand, Hacking's criticism of the tradition of natural kinds has hardly been successful in convincing philosophers to move on. On the contrary, his diagnosis of disarray contrasts with recent flourishing of theories of natural kinds in terms of "stable property clusters" (Slater 2015), "categorical bottlenecks" (Franklin-Hall 2015), "nodes in causal networks" (Khalidi 2015), "success and restriction clauses" (Magnus 2012), and so on. Furthermore, "natural kind" remains a core concept for philosophical engagement with countless scientific entities such as apathetic children (Godman 2013), cell types (Slater 2013), depression (Tsou 2013), developmental stages of embryos (Bolker 2013), emotions (Griffiths 2004), gender (Bach 2013), life (Diéguez 2013), maps (Winther 2015), nanomaterials (Bursten 2016), planets (Bokulich 2014), protein molecules (Bartol 2016), soil types (Ludwig 2016a), stars (Ruphy 2010), and so on.

The aim of this article is to develop both a positive and a negative thesis about the state of natural kind debates. On the one hand, I argue for a positive account of non-arbitrary classification that integrates different proposals from the natural kind literature in a multidimensional framework. On the other hand, I argue that such a multidimensional framework does not leave any interesting work for a general notion of natural kind. While philosophers have proposed a large variety of interesting accounts in the decade since Hacking's challenge (e.g. Craver 2009; Ereshefsky and Reydon 2015; Franklin-Hall 2015; Khalidi 2013; Magnus 2012; Slater 2015; Umphrey 2016; Wilson et al. 2007), I argue that this diversity actually reinforces Hacking's worry that general notions of natural kind have become an obstacle for understanding classificatory practices.

I develop both positive and negative claims in the context of the case study of ethnobiological classification. While ethnobiology has been largely ignored in philosophy of science, it constitutes an important challenge for natural kind debates due to the large diversity of ethnotaxa with wildly different demarcation criteria. *Section 2* provides an overview of this diversity by distinguishing between various classes of ethnobiological kinds. *Section 3* develops a positive interpretation of this complex classificatory landscape by proposing a multidimensional account that integrates different proposals from the natural kind literature. *Section 4* develops the negative diagnosis. While the current philosophical literature can help to specify sources of non-arbitrary classification, attempts to privilege a subset of them as "natural kinds" is going to obscure debates rather than providing novel theoretical insights. Once we understand different dimensions of non-arbitrary classification, there is no work left for a general notion of natural kind.

2. Non-Arbitrary Kinds in Ethnobiology

Ethnobiology is commonly defined as "the study of the biological knowledge of particular ethnic groups — cultural knowledge about plants and animals and their interrelationships" (Anderson 2011, 1; cf. Albuquerque and Alves 2016). Focusing on the diverse cultural forms of knowledge about the biological world, classification has always been a core interest of ethnobiology. The aim of this section is to provide an overview of the large variety of ethnotaxa by distinguishing seven classes of ethnobiological kinds that are commonly identified by ethnobiological classifications. These classes typically co-exist in local taxonomies. For example, one will often find some "special purpose kinds" (2.1) such as *poisonous mushroom* that directly depend on utilitarian considerations while other ethnotaxa primarily depend on the recognition of morphological or other biological patterns. Furthermore, the seven proposed classes are not mutually exclusive and many ethnobiological kinds can be usefully analyzed as belonging to several of these classes. Based on this typology of ethnobiological kinds, the following sections 3 & 4 will propose a positive multidimensional framework for non-arbitrary classification and make the negative case against "natural kind".

2.1 *Special Purpose Kinds:* While ethnobiology is a comparably young field that became institutionalized in the second half of the 20th century, the documentation of biological knowledge has a long history in anthropological and ethnographic research (Hunn 2007; Svanberg and Łuczaj 2014). Much of this earlier research presented "primitive" biological knowledge as dominated by immediate practical needs. As Malinowski put it in a famous passage of *Magic, Science and Religion*: "'The road from the wilderness to the savage's belly and consequently to his mind is very short. For him the world is an indiscriminate background against which there stands out the useful, primarily the edible, species of animals and plants'' (1925/1948, 44). In the context of biological classification, this contrast suggested ethnotaxa that are shaped by practical concerns (e.g classifications along criteria such as being dangerous, edible, medically useful, poisonous, or sacred) and therefore diverge from modern biological taxa that are distinguished on the basis of more general criteria such as the ability to interbreed.

Following Berlin et al.'s (1966) later terminology of "special purpose" and "general purpose" kinds, the early utilitarian research assumed that ethnobiological knowledge is largely characterized by its "special purpose" character while modern biological systematics exhibits a "general purpose" structure. To make this notion more specific for present purposes, let us define *special purpose kinds* as kinds whose extension is directly dependent on properties of human use such as being edible or poisonous. In this sense *edible mushroom* would be a special purpose kind while *bolete mushroom* would not. It may be the case that all bolete mushrooms are edible in a certain environment and that the category is of obvious practical significance. However, only the extension of the former is directly dependent on use. Imagine that a non-edible bolete mushroom is introduced in the environment. While this mushroom would obviously be excluded from *edible mushroom* it would still be included in *bolete mushroom.*

Special purpose kinds in the sense of this definition are well documented in many areas of ethnobiology. In the case of mushrooms, for example, Lampman has shown that Tzeltal Maya in Chiapas use a very general category of useless mushrooms *bol lu'* that are otherwise highly disunified. While special purpose kinds can appear as very broad categories such as "useless mushroom", they can also have a more specific character. Lampman (2004, 191) points out that special purpose categories could result from an "allergic reaction to certain types of plant pollen; or they could arise from cultural convention, such as categories of plants that are appropriate for the ceremonies associated with the transition from childhood to adulthood." Given this diversity of potentially relevant properties, we should expect special purpose kinds also to come with varying degrees of non-arbitrariness. In some cases such as "useless mushrooms", there may not be much more to say about the unification of members of the kind. In other cases such as allergies or medical use, usefulness may indicate the presence of other (e.g. chemical) properties that are shared by members of a special purpose kind.

2.2 *General Purpose Kinds.* The emergence of ethnobiology as a field with a distinct identity is closely related to both theoretical and empirical criticism of earlier utilitarian perspectives. Levi-Strauss (1966, 6) challenged utilitarianism with an "intellectualist" perspective according to which classification "meets intellectual requirements rather than [...] satisfying needs". Furthermore, ethnobiological fieldwork clearly showed that a strict utilitarian perspective failed to account for the reality of ethnobiological classification. Conklin's 1954 dissertation *The relation of Hanunoó culture to the plant world* is widely regarded as a watershed moment in ethnobiology as it provided a detailed systematics of Hanunoó plant classifications and included countless taxa that bore no resemblance to Malinowski's "short road to the savage's belly". As Conklin (1962) summarized his results: "Hanunoó classify their local plant world, at the lowest (terminal) level of contrast, into more than 1800 mutually exclusive folk taxa, while botanists divide the same flora - in terms of species - into less than 1300 taxa" (1962, 12).

Not only Western science but also ethnobiology seemed to require acknowledgment of a wide variety of general purpose taxa that are not directly shaped by practical use. In contrast to the last section, we can define *general purpose kinds* as kinds whose extension is not directly dependent on properties of human use (e.g. edible or firewood) but rather on general biological (e.g. morphological and ecological) properties. Following Conklin's groundbreaking studies, ethnobiologists of the 1960's and 1970's largely inverted the utilitarian account of the relation between epistemic and non-epistemic significance of kinds. Utilitarian accounts start with considerations of non-epistemic factors while allowing that special purpose kinds may also be epistemically significant by sharing many other properties (e.g. medical use can track chemical differences between plants). In contrast, intellectualism start with epistemic considerations such as the recognition of "morphologically coherent groups" (Berlin et al. 1968, 269) while allowing that the identification of such groups will be useful from a non-epistemic perspective.

2.3 *Mind-Independent Convergent Kinds.* My definitions of special and general purpose kinds have been minimal in the sense that they only depend on the properties that determine the extension of a kind. From a philosophical perspective, one may wonder whether this is a metaphysically deep distinction. For example, *edible mushroom* would count as a special purpose kind while *mushroom that grows on wood* would count as a general purpose kind. However, it is not clear that we should consider the latter metaphysically more substantial or more natural than the former. On the contrary, we can easily imagine scenarios where use-dependent (e.g. medical) similarities reflect further substantial similarities while use-independent (e.g. color) properties do not lead to the identification of a more substantially unified kind. And indeed, intellectualist ethnobiologists often aimed for something much more ambitious than general purpose kinds in the sense of the last section. Rather than pointing out that the extension of ethnotaxa is often determined on the basis of use-independent (e.g. morphological and ecological) properties, an important part of the early ethnobiological project was the identification of natural kinds in a traditional "mind-independent" sense.

Much of this more ambitious program was motivated by the discovery of convergences between ethnotaxa and modern biological taxa that seemed to directly contradict classificatory relativism that dominated the anthropological tradition. For example, consider Diamond's classical article "Zoological Classification System of a Primitive People" that found convergence between vertebrate categories (ámana aké) of the Fore of the New Guinea Highlands and taxa in biological systematics. Diamond concluded that this convergence illustrates the objectivity of ethnotaxa: "The nearly one-to-one correspondence between Fore ámana aké and species as recognized by European taxonomists reflects the objective reality of the gaps separating sympatric species" (1966, 1102).

While the relation between intellectualist ethnobiology and natural kind philosophy of the 1970's (e.g. Kripke 1972; Putnam 1973) is yet to be discussed in the research literature, the similarities are obvious. Indeed, many ethnobiologists of this time embrace a traditional perspective on natural kinds, from Bulmer's (1970, 1087) claim that the taxonomic "hard core [...] simply has to be 'general' or 'natural' and consist of multi-purpose, multidimensional units which bear a definite correspondence to those applied by the biological scientist" to Berlin's (1992, 9) assumption that "in any local flora and fauna a single pattern stands out from all the rest" and Hunn's (1987, 141) insistence that "that individuals of phylogenetically real groupings share a genetic essence." In developing a typology of ethnobiological kinds, we can therefore define a class of *mind-independent convergent kinds* that follows the traditional philosophical picture of the discovery of mind-independent essences or "joints in nature" that ultimately also lead to convergence across cultures from indigenous societies to modern biological systematics.

2.4 *Cognition-Dependent Convergent Kinds.* While essentialist models of natural kinds soon became criticized in philosophy (e.g. Mellor 1977; Dupré 1981), ethnobiological criticism of the assumption of mind-independent convergence developed largely independent of the philosophical literature. One major challenge came from the increasing influence of the cognitive sciences and more specifically from the assumption that cross-cultural convergence can reflect general characteristics of cognitive processing rather than mind-independent discontinuities in nature. As Atran (1981) put it: "How comes it that cultures belonging to such widely separated times and places invariably produce similar basic groupings? The only conceivable answer is that they employ identical cognitive processing over similar empirical domains."

Atran's point becomes especially plausible in the context of taxa that are found in many causally unrelated cultures around the world but are not recognized by a biological systematics that relies on phylogenetic relations. For example, taxa such as "thistle", "tree", "vine", "bug", "hawk", or "sparrow" are widely recognized as kinds with coherent morphological and ecological forms even if they are not recognized in biological systematics. "People naturally tend to find trees phenomenally compelling because of their evident ecological role in determining local distributions of flora and fauna [...]. Just go into a forest and see" (Atran 1987, 150). Given the importance of general cognitive and perceptual mechanisms (see also Atran and Medin 2010), we can define another class of *cognition-dependent convergent kinds* that are found in many causally unrelated cultures because of the interaction between biological (e.g. morphological and ecological) properties and cognitive mechanisms such as perceptual salience. The point is not that *cognition-dependent convergent kinds* are merely an invention of our own mind but rather that general cognitive mechanisms contribute to the classificatory relevance of properties. Using Reydon's (2015) recent notion of "co-creation", they may be best described as cases where empirically discovered properties of organisms and distinctly human cognitive mechanisms "co-create" a category.

2.5 *Practice-Dependent (Convergent or Divergent) Kinds.* Co-creation in the sense of the last section relies on (e.g. morphological and ecological) properties that are recognized as constituting a relevant category in the context of species-specific human cognition. However, the relevance of properties can also depend in cultural rather than general cognitive mechanisms. For example, Hunn (1982, 837) suggested that "tree" may be recognized cross-culturally because of the "universal practical value of 'trees' rather than [...] the perceptual salience of 'tree.'"

While the the importance of cultural and cognitive factors has been highly controversial in the context of cross-cultural recognitions of "tree" (see Ellen 2006), there are also more straightforward examples for practice-dependent kinds such as Estrada-Medina et al.'s (2013) research on classifications of soil types in Yucatán, Mexico. Estrada-Medina et al. found that local Maya farmers identified soil types that have no extensional equivalent in Western soil taxonomies such as World Reference Base for Soil Resources (WRB): "Many soils identified by farmers could be more than one WRB unit of soil and *vice versa*; in these cases no direct relationship between both classification systems was possible" (2013, 1). Maya classification of soil types utilizes a variety of properties including color, amount of gravel and rocks, hardness, drainage conditions, and soil depth. Rather than simply classifying soils along perceptually salient forms (as in case 2.4), Maya classification of soil types reflects distinctions that matter for local agricultural practices such as "making *milpa*" (a traditional crop rotation system that includes corn, bean, and pumpkin). For example, *Chichlu'um* and *Ch'och'ol* constitute two different Maya taxa of soil but would both be classified as *Hyperskeletic Leptosol* according to the WRB. However, *Ch'och'ol* is used for making *milpa* while *Chichlu'um* is primarily used to grow chilli and sweet potatoes. We can therefore define another class of *practice-dependent kinds* that reflect interaction between empirically discovered properties (e.g. soil color, amount of gravel and rocks, hardness, drainage conditions, soil depth) and their practice-dependent relevance for classification. Note that a characterization of *Chichlu'um* as "practice dependent" does not imply that it is a "special purpose kind" in the sense of 2.1. The extension of the soil type is determined on the basis of properties such as fine gravel and brown color rather than directly in terms of agricultural use (say "soil used for growing pumpkins").

Practice-dependent kinds can converge or diverge across cultures depending on the continuity of relevant practices. In the case of soil types, for example, classification seems to depend on local practices such as making *milpa* and the relevance of specific crops such as chilli and sweet potatoes. However, practice-dependent ethnotaxa can also converge insofar as communities share similar practices in areas such as agriculture and hunting. Furthermore, there is a lot of middle ground between the strictly local and the strictly universal. For example, making *milpa* is an agricultural practice that is used throughout Mesoamerica and may therefore be described as regional rather than locally restricted to Yucatán or universal. In analogy to the cognition-dependent convergent kinds from the last section, the contingency of practice-dependent kinds should not be confused with arbitrariness (Ludwig 2016a). Even if a taxonomy is shaped by the concerns of a local community, it will still rely on empirically discovered (relations between) properties such as soil color, amount of gravel and rocks, hardness, drainage conditions, and soil depth.

2.6 *Environment-Dependent Divergent Kinds.* The locality of Maya soil taxa can be partly explained in terms of equally local agricultural practices that influence the taxonomic relevance of properties and patterns. However, there is also a second mechanism that can lead to taxonomies that are specific to a local community. Local communities do not only engage in different practices but also with different environments that exhibit different regularities. Even if two communities had exactly the same epistemic and social goals, they may still employ different taxonomies simply because there are different properties and patterns to be found in their respective environments.

The example of soil types can also illustrate this case as the Maya soil taxonomy in Yucatán clearly reflects the distinct soil profile of the Yucatán peninsula that involves "repetition of four geomorphic systems all over the area: coastal, karstic, tectono-karstic, and fluvio-paludal, each one showing specific soil-relief patterns" (Bautista and Zinck 2010, 9). Even in other areas of Mesoamerica where Maya agricultural practices such as making *milpa* are common, soil taxonomies can differ because soil profiles differ and communities therefore engage with different clusters of properties. This variability of taxonomies leads to a further type of *environment-dependent divergent kinds* that can be defined through their reliance on properties and patterns that are stable only within the context of a specific environment. While this locality of properties and patterns can lead to equally local taxonomies, environment-dependent divergent kinds are obviously far from arbitrary. For example, *Chichlu'um* comes with a cluster of soil properties from color to drainage conditions that is empirically discovered and stable enough to support agricultural practices even if it is limited to a specific environment such as the Yucatán peninsula.

2.7 *Biosocial Kinds.* Biological kinds often have social (e.g. economic or spiritual) properties. In many cases, however, the social properties are not themselves sources of taxonomic distinctions (Atran 1990, 69). For example, jaguars have a range of spiritual properties across indigenous cultures of the Americas. However, jaguars would arguably be also recognized as a distinct kind if they did not have any spiritual significance whatsoever. In contrast to biological kinds that also happen to have social properties, we can define a more restricted class of ethnotaxa that are recognized only because they also have social properties.

To illustrate biosocial kinds in this narrower sense, consider Bulmer's (1967) classical discussion of the taxonomic status of cassowaries. According to Bulmer, the Kalam (in 1967 still spelled as "Karam") in the New Guinea Highlands employ a taxon *yakt* that includes all birds except of cassowaries - large flightless birds that resemble ostriches and emus. Why are cassowaries not considered birds? Part of the answer are behavioral, ecological, and morphological properties that are shared among typical birds but not cassowaries. As Bulmer explains, cassowaries are characterized by a distinct terrestrial habitat that contrasts with the aerial and arboreal habitat of other birds. This does not only imply behavioral and ecological differences between cassowaries and birds (*yakt*) but also affect anatomical and morphological properties such as "heavy, strong and very human-like leg bones" (Bulmer 1967, 10). However, Bulmer insists that the exclusion of cassowaries from the bird taxon *yakt* cannot be purely understood in terms of biological (anatomical, behavioral, ecological, morphological) properties but requires consideration of the unique social relationship between cassowaries and the Kalam community: "The cassowary is not a bird because it enjoys a unique relationship in Karam thought to man" (Bulmer 1967, 1) and the exclusion of cassowaries from *yakt* "by reference to objective features of its appearance and behaviour alone, could be to miss the point" (19). As Bulmer describes in detail, Kalam understanding of cassowaries is embedded in a complex system of social rules that puts cassowaries closer to humans than birds. For example, killing a cassowary is considered in many ways similar to homicide. In analogy to humans, blood of living cassowaries must not be shed and the hunt therefore requires blunt weapons and is conceptualized in analogy to the struggle between two humans. Hunters who have killed a cassowary enter a ritually dangerous state *asn* that involves further rules such as avoidance of important crops for one month. The same state of *asn* is also entered by killing a human but not by killing *yakt* (birds).

Bulmer's detailed description of these kinds of social relations illustrates another important class of ethnobiological kinds that have to be at least in part understood in terms of their social properties. In contrast to biological kinds that happen to have social properties, *biosocial kinds* can be defined more narrowly by requiring that not only biological but also social properties are constitutive for a kind. Following Bulmer, *yakt* turns out to be a biosocial kind in this sense as the exclusion of cassowaries cannot be understood on the basis of biological properties alone. This does not mean that biosocial kinds are exclusive to ethnobiology and one may find similar phenomena in areas of the life sciences with important social implications. For example, consider debates about classification and species concepts in microbiology. It has become widely recognized in the literature that traditional species concepts are of limited applicability in microbiology and that microbial species often come with vast genetic and phenotypic diversity (Ereshefsky 2010; Franklin 2007; O'Malley 2014). This internal heterogeneity suggests that at least some microbial species may qualify as biosocial kinds in the sense that their recognition as species depends in part on their social significance for medical practice. Indeed, this position is embraced by Suárez (2016) who explicitly argues for the legitimacy of medical concerns in delimiting bacterial species.

3 The Positive Picture: A Multidimensional Framework of Non-Arbitrary Classification

The large diversity of ethnotaxa with wildly different demarcation criteria constitutes an interesting challenge for natural kind debates. In this section, I want to propose a positive framework for philosophical contributions to understanding ethnobiological classification. Much of the recent literature on natural kinds can make substantial contributions to analysing the diversity of ethnotaxa if it is not interpreted as proposing competing accounts of "natural kind" but rather as clarifying different dimensions of non-arbitrary classification. Interpreting the literature along these lines leads to a multidimensional framework of non-arbitrary classification that does not only advance philosophical debates but also links philosophical and empirical research. In the following, I want to outline four relevant dimensions on the basis of four recent accounts of natural kinds (Magnus 2012; Franklin-Hall 2015; Slater 2015; Khalidi 2015).

3.1 *Success and restriction clauses*: Magnus (2012) has proposed an account of natural kinds in terms of categories that are uniquely suited for inductive and explanatory success in a given domain. More specifically, Magnus distinguishes between (1) a *success clause* that requires inductive and explanatory success in a domain of enquiry and (2) a *restriction clause* which requires that alternative taxonomies would be less successful. While Magnus' account adopts some traditional ideas from the natural kind literature such as the focus on induction, it also expands the realm of natural kinds through its emphasis of domain relativity. By insisting that natural kinds have to be understood relative to a domain of enquiry, the framework includes categories with specialized purposes that would be excluded in many other accounts of natural kinds.

This implication is nicely illustrated by Magnus' discussion of Alton Brown's taxonomy of baked goods: "For example, traditional muffins, soda bread, pancakes, and waffles are all prepared using what Brown calls the muffin method. Biscuits, scones, shortcakes, grunts, and pie-crusts are prepared using the biscuit method. Importantly, these methods are not merely a matter of preparation. They also correspond to different ways of leavening. In all the muffin method baked goods, air bubbles are generated by baking soda reacting with acid. In biscuit method baked goods, bubbles are generated by small bits of solid fat which melt during baking." (Magnus 2012, 133). The idea that *muffin* or *biscuit* may qualify as natural kinds sounds radical but is tied to non-trivial conditions. The point is not only that muffins and biscuits have different (e.g. chemical) properties that are outlined by Brown but that the categories must meet Magnus' success and restriction clauses. For example, the category *muffin* would not only have to support the practices of bakers but would also have to be more successful than alternative taxonomies of baked goods. The case of baked goods illustrates that natural kinds in the sense of Magnus may be found in unexpected places but it does not reduce to triviality.

The domain-relativity of Magnus' success and restriction clauses makes them helpful tools for analyzing local ethnotaxa that are unique to specific communities in the sense of 2.5 - 2.7. Local ethnotaxa fail to meet many traditional criteria of natural kinds as they are typically not mind- or interest-independent, lack essences, and diverge from the categories of Western science. While this locality of ethnotaxa often leads to their disqualification (Ludwig 2016b), Magnus' account will recognize many of them as natural kinds. For example, recall the case of Maya soil types such as *Chichlu'um* and *Ch'och'ol.* While these kinds of soil do not correspond to kinds in Western soil taxonomies such as the WRB, they may still meet Magnus' criteria. After all, the WRB aims for a classification that is useful for pedologists in a large variety of environments and does not pay attention to the properties that are particularly relevant for Maya farmers in Yucatán. Again, the point is not only that soil kinds such as *Chichlu'um* are characterized by empirically determined properties such as fine gravels and good water retention. Instead, Magnus' success and restriction clauses require that taxa such as *Chichlu'um* are uniquely suited for inductive and explanatory success in the context of Maya agriculture such as predicting which crops will successfully grow. As such, Magnus provides non-trivial criteria for engaging with local ethnotaxa and for distinguishing them from arbitrary classifications.

3.2 *Categorical Bottlenecks:* Magnus' success and restriction clauses provide helpful tools for engaging with local ethnotaxa in the sense of 2.5-2.7. If we turn from issues of locality to cross-cultural convergence, the restriction clause may also help to understand cases that I have described as "practice-dependent convergent kinds". The restriction clause requires that alternative taxonomies would be less successful in a given domain of enquiry. Assuming that shared (e.g. agricultural or hunting) practices constitute shared domains of enquiry, the restriction clause provides a compelling reason to expect cross-cultural convergence. If there is a category that is uniquely suited for specific inductive and explanatory practices, we should expect its recognition across cultures with sufficiently similar domains of enquiry.

Unfortunately, not all cases of cross-cultural convergence can be explained in terms of shared domains of enquiry such as shared agricultural or hunting practices. For example, consider cases such as *jaguar* that have often been discussed as cases of *mind-independent convergent kinds* in the sense of 2.3. What distinguishes these kinds is that they are recognized in very different taxonomies that serve very different purposes. For example, consider a child in rural Costa Rica who learns about jaguars as a potential threat and a Western biologist who is interested in jaguars in the context of a research project on phylogenetic relations between *felidae*. Even if their domains of enquiry could hardly more different (understanding personal danger or phylogenetic relations), they will both recognize jaguars as a distinct kind. In this context, is seems more helpful to look at other proposals such as Franklin-Hall's (2015, 3) account of natural kinds as categorical bottlenecks. Franklin-Hall's general idea is that natural kinds can be identified with categorical bottlenecks that constrain conceptual options and therefore lead to recognition of the same categories among very different actors. More specifically, she suggests to identify natural kinds with "categories that well serve not only us, but also a variety of agents possessing any of a range of aims and capacities, a range that—though ultimately relative to us—extends well beyond those we presently enjoy" (2015, 2).

Franklin-Hall's account of categorical bottlenecks is clearly more restrictive than Magnus' success and restriction clauses in the sense that it excludes many local ethnotaxa that meet the unique epistemic aims of specific communities. However, it captures an aspect of "stance-independence" (2015, 16) that is important for engagement with ethnotaxa such as *jaguar* that have been traditionally conceptualized as mind-independent convergent kinds in the sense of 2.3 and cannot be completely explained in terms of shared cognitive biases in the sense of 2.4 or shared practices in the sense of 2.5. Given that most philosophers have become uncomfortable with the strong metaphysical ideal of "mind-independent convergence," Franklin-Hall's categorical bottlenecks provide an alternative approach for analyzing surprising cases of cross-cultural taxonomic convergence. On the one hand, categorical bottlenecks are stance-independent to a certain degree because they reflect the "robust cluster structure of our universe" (Franklin-Hall 2015, 14). On the other hand, categorical bottlenecks are still defined relative to (a range of) epistemic aims and "ultimately relative to us" (2015, 3). Franklin-Hall's categorical bottlenecks therefore provide a helpful tool for engaging with ethnobiological evidence about cross-cultural convergence without getting stuck with overly ambitious ideals of complete mind-independence or with attempts to reduce convergence to shared cognitive structures and practical interests in the sense of 2.5 and 2.6.

3.3 Stable Property Clusters: Magnus' and Franklin-Hall's accounts focus on the epistemic features of natural kind categories. Rather than engaging in "deep metaphysics" (Magnus 2015), these accounts assume that natural kinds correspond to categories with certain epistemic features. As Franklin-Hall (2015, 15) puts it: "natural kinds are groupings that match those categories that well serve actual inquirers along with (what I will call) 'neighboring agents'". Starting with epistemic features of natural kind categories can be helpful in analyzing ethnobiological classification by identifying subsets of ethnotaxa with unique epistemic features. While *success and restriction clauses* identify a larger set that includes many local ethnotaxa in the sense of 2.5-2.7, *categorical bottlenecks* identify a more restricted set of taxa that converge across cultures in the sense of 2.3.

However, many accounts in the natural kind literature develop a different strategy by also aiming for characterizations of the metaphysical features of natural kinds. Given that few contemporary philosophers of science endorse traditional natural kind essentialism, much of this literature starts with issues of property clustering as popularized by Boyd's theory of homeostatic property clusters (1991; 2010). For example, Slater's (2015) account of *stable property clusters* (SPCs) provides an inclusive metaphysical framework for "natural kindness" that maintains the common focus on "property clustering" while avoiding metaphysically more ambitious assumptions about homeostatic mechanisms. Slater's SPC account provides a complementary tool for engaging with ethnobiological classification by identifying a large set of ethnobiological kinds that involve stable clustering of properties.

As Ludwig (2017) has argued, such an inclusive SPC account is helpful for making sense of convergence-divergence patterns in ethnobiology. Consider a kind that comes with a stable cluster of properties such as [P, Q, R, S, T, U] and therefore allows probabilistic inferences from one subcluster such as [P, Q, R] to another subcluster such as [S, T]. Following the examples from 2.5 - 2.7, we should assume that many local taxa such as the Maya soil type *Chichlu'um* constitute SPCs in Slater's sense and therefore also support probabilistic inferences. For example, knowledge about some easily observable properties of soil such as [brown color, location on top of a mound, a lot of fine gravel] may be sufficient to make probabilistic inferences to other properties such as [good water retention, suitable for growing chilli]. This SPC analysis is entirely compatible with locality in the sense that these inferences may only matter in the context of certain agricultural practices (2.5) and may only be stable in the context of the Yucatán peninsula (2.6).

While SPCs can be helpful to shed light on local ethnotaxa, they can also be used as a tool for explaining convergence beyond a local context. Consider a cluster [P, Q, R, S, T, U] but two different communities that have knowledge about different subclusters such as [P, Q, R, S] and [R, S, T, U]. In the case of jaguar, for example, it may be that both indigenous and Western scientists have knowledge of certain morphological properties [R, S], only the indigenous scientist has knowledge of certain ecological properties [P, Q], and only the Western scientist has knowledge of certain genetic properties [T, U]. Given that they have knowledge about different subclusters *of the same SPC,* however, it is not surprising that their taxonomies converge (Ludwig 2017).

Although Slater's account does not include all ethnotaxa in the sense of 2.1 - 2.7 (e.g. some "special purpose kinds" and "cognition-dependent kinds" may not involve SPCs), the inclusive character of SPCs makes them helpful tools for understanding convergence-divergence patterns in ethnobiology. While some highly robust SPCs such as *jaguar* are recognized from very different cultural perspectives, other SPCs such as *Chichlu'um* turn out to be more restricted.

3.4 Nodes in Causal Networks. While Slater's inclusive notion of SPCs provides a helpful tool for engaging with diverse convergence-divergence patterns, there are also often good reasons to look beyond mere clustering by focusing on the causes of stable relations between properties. Khalidi has recently proposed an alternative account of natural kinds as "nodes in causal networks" that are "not just concatenations of properties but are ordered hierarchies of properties" (2015, 17). The basic idea is that natural kinds require primary properties that give rise to further secondary properties. In the classic case of gold, for example, Khalidi suggests that "primary causal properties [...] include atomic number 79 as well as a disjunction of mass numbers, which give rise in turn to a cluster of other causal properties (e.g. ionization energies, atomic radius, etc.)" (Khalidi 2015, 18).

Khalidi's causal account of natural kinds reflects the assumption that a simple clustering account is "found wanting mainly because it leaves out the relationships that exist between the properties associated with a kind" (2013, 204). To illustrate this in the context of ethnobiology, consider the observation that many cultures recognize a taxon that includes both bats and birds. While philosophers may be inclined to consider such a bat-bird taxon as only superficially unified, Ludwig (2017, 203) argues that bats and birds actually share a large range of properties: "they fly, have wings, a light bone structure, a keeled sternum, a similar size range, streamlined bodies, high metabolism, migratory behaviour, similar natural enemies, a fruit- and/or insect-based diet, they spread seeds in the environment, reduce local insect biomass, and so on." While a bat-bird taxon may therefore be described as involving some "natural kindness" in the sense of Slater's SPCs, such an analysis leaves the existence of a phylogenetically heterogenous property cluster unexplained. Looking for nodes in causal networks in the sense of Khalidi leads to a more substantial understanding of this classificatory practice as it can causally explain shared anatomical, behavioral, ecological, and morphological properties of bats and birds through shared environmental pressures and adaptation to a flying lifestyle.

While Khalidi's account of natural kinds as nodes in causal networks can often provide a more substantial understanding of ethnotaxa, it is also more demanding in the sense that it arguably excludes a number of kinds that qualify as SPCs in the sense of Slater. As Khalidi points out (2015, 2), "clusters of properties [are sometimes] conventionally rather than causally related" and therefore do not constitute nodes in causal networks. Biosocial kinds in the sense of 2.7 will be sometimes at least partially conventional. For example, recall the exclusion of cassowaries from the bird takon *yakt* (section 2.7) because of both biological differences (e.g. bone structure) between cassowaries and other birds as well as the specific social and spiritual significance of cassowaries. While we could construct a cluster of biosocial properties [P, Q, R, S, T, U] in the sense of the SPC model, such a cluster would exist at least in part because of conventional rather than causal relation between biological and social properties.

Furthermore, locally stable ethnotaxa in the sense of 2.6 may turn out to be SPCs in the sense of Slater but not qualify as nodes in causal networks in the sense of Khalidi. This possibility is especially obvious in the context of higher-order categories that group more specific ethnotaxa together (e.g. Berlin 1992, 138ff.). For example, consider an ethnomycological taxon that includes several more specific mushroom kinds. In addition to morphological properties (say: color, size, and form of the stipe), such a mushroom taxon may be useful because it also allows probabilistic inferences about where and when to find them (say: they tend to grow under pine trees and only between September and December) as well as what to do with them (say: they are all edible but none of them have medical use). While such a category would qualify as an SPC in the sense of Slater, it does not have to reflect causal hierarchies in the sense of Khalidi. Of course, it could be the case that the mentioned similarities all reflect some underlying primary property and that Western taxonomists recognize a co-extensional taxon due to phylogenetic relations between the included mushroom species. However, it could also turn out that a phylogenetic classification would include mushroom species with different ecological and use-dependent properties (say mushrooms that are not edible and do not grow under pine trees). The fact that an ethnotaxon such as a mushroom category constitutes a SPC is not sufficient for its status as a node in a causal network.

To sum up, Khalidi's nodes in causal networks provide a useful tool for engaging with ethnotaxa both because they focus on causal structures beyond the scope of SPCs and because they identify a somewhat more restricted set of causally structured kinds in ethnobiology.

Let us take stock. In this section, I have argued that current accounts of natural kinds provide useful tools for engaging with taxonomic diversity in ethnobiology. The epistemic productivity of local ethnotaxa can often be specified by showing that they meet success and restriction clauses in the sense of Magnus. Taxonomic convergence that has often been associated with a strong metaphysical ideal of mind-independent convergence can be usefully reinterpreted in terms of Franklin-Hall's categorical bottlenecks. Slater's model of SPCs provides a helpful tool for understanding cross-cultural convergence-divergence patterns. Finally, Khalidi's account of nodes in causal networks identifies an important subset of SPCs that are hierarchically structured and causally unified through primary properties.

While each of the discussed proposals provides helpful resources for analyzing ethnobiological classification, none of them will be preferable in all relevant contexts. For example, a broader account in terms of Magnus' success and restriction clauses will not be adequate for analyzing many forms of cross-cultural convergence while a more narrow account such as Franklin-Hall's categorical bottlenecks will be of limited use for analyzing local taxa that are adapted to needs of a specific community. None of this is a problem, however, if the different accounts are not interpreted as competitors but as complements in a multidimensional framework of non-arbitrary classification.

It is precisely this specification of multiple dimensions of non-arbitrary classification that makes the recent natural kind literature valuable for understanding complex classificatory landscapes in ethnobiology. If philosophical accounts of natural kinds preselect one dimension as fundamental, they will often be too static to account for the diverse practices and criteria in ethnobiological classification. By recognizing accounts in the natural kind literature as complementary, however, we gain a more nuanced framework for analyzing classificatory practices. In the context of ethnobiological classification, researchers have often struggled with a polemical contrast between "universalist" perspectives that focus cross-cultural convergence in the sense of 2.3 and "relativist" programs that emphasize locality in the sense of 2.5-2.7 (see Ellen 2006). A multidimensional framework provides resources for moving beyond this simplistic contrast by allowing that an ethnotaxon can be non-arbitrary along some dimensions (e.g. by involving SPCs) but not others (e.g. by lacking categorical bottlenecks).

4. The Negative Picture: Letting go of "Natural Kind"

In the last section I argued that different accounts in the natural kind literature can be integrated in a framework that specifies various dimensions of non-arbitrary classification. However, there is tension between this positive proposal and the ambition of many philosophers to formulate a general account of how to distinguish natural and non-natural kinds. For example, Magnus (2012, 4) presents his account as a "modest definition" of natural kind that provides a useful answer to the "taxonomy question" of "what distinguishes a category which is a natural kind from an arbitrary class" (2015, 1). In a similar way, Franklin-Hall (2015, 47) introduces categorical bottlenecks not only as an interesting class of kinds but rather "argue[s] that natural kinds be identified with 'categorical bottlenecks". Slater (2015, 3) is very clear about his ambition to provide a general account of "natural kindness" and argues that SPCs constitute "an attractive candidate for a general natural kind concept." Finally, Khalidi (2015, 1) begins his discussion of nodes in causal networks by clarifying his ambition to "offer a unified causal account of natural kinds."

Once we focus on this debate about a general account of natural kinds, the recent diversity of proposals actually reinforces Hacking's worry about a "scholastic twilight". In the last section, I argued that all four presented accounts provide helpful resources for understanding ethnobiological classification and identify different subsets of relevant ethnotaxa. However, it remains unclear what could be gained by asking which subset should be identified with natural kinds. On the contrary, there is a clear danger that such a question will obstruct a nuanced debate about different aspects of non-arbitrary classification by shifting attention to an honorific label. While my negative conclusion follows Hacking, the worry becomes even more pressing in the light of the positive picture from the previous section. If the conclusion is only negative, one can easily respond with Franklin-Hall (2015, 2) who argues that we need to recognize a difference between natural kinds "and those not in scientific circulation—from the wildly pathological (e.g., *animals born on a Tuesday*), or the scientifically defunct (e.g., *consumption, hysteria*), to the merely boring." Given the multidimensional framework of the last section, however, we already have a nuanced framework for engaging with these differences. For example, kinds are often not arbitrary because they meet success and restriction clauses, constitute categorical bottlenecks, involve SPCs, or qualify as nodes in causal network. Once we understand all of this, however, there is no interesting epistemic or metaphysical work left for a general notion of natural kind. Aside from attachment to the traditional label, we do not have anything to lose by embracing a more nuanced multidimensional framework and by giving up on the project of a general account of natural kind.

Furthermore, it is not only the case that there is nothing to lose by letting go of "natural kind". Instead, there are good reasons to assume that the aim of a general account of natural kind has become an obstacle that stands in the way of further progress in philosophy of classification. Most importantly, any proposal of a general account of natural kinds will privilege some dimension of non-arbitrariness over others and can therefore lead to an unnecessarily narrow analysis of classificatory practices. In the last section, I argued that it is fruitful to investigate which ethnotaxa meet success and restriction clauses, constitute categorical bottlenecks, involve SPCs, or qualify as nodes in causal network. If we privilege one of these dimensions in a definition of "natural kind", we run in danger of neglecting other important dimensions. While a multidimensional framework can adapt to the specifics of different cases, a general account of natural kinds can easily obstruct philosophical understanding by preselecting one dimension as fundamental. It's not only the case that we do not *lose* anything by giving up on a general account of natural kind, we actually *gain* the necessary flexibility to engage with classificatory practices in diverse settings.

While I want to argue that we should let go of "natural kind" as a coarse grained concept that has outlived its usefulness, one may respond that my eliminativism is an unnecessary overreaction to a problem that can be solved in a more moderate and reasonable way. Even if it is true that accounts such as Magnus (2012), Franklin-Hall (2015), Slater (2015), and Khalidi (2015) can be read as competing general accounts of natural kinds, one could also attempt to integrate them in a pluralist notion. Of course, it is true that we could simply talk about a "multidimensional framework of natural kinds" instead of a "multidimensional framework of non-arbitrariness". If this is only about renaming the multidimensional perspective from the last section, however, it is not really clear what we are supposed to gain from such a strategy.

To illustrate these issues in more detail, consider MacLeod and Reydon's (2013) discussion of Hacking's eliminativism. Addressing Hacking's objection that "natural kind" has many different meanings in different contexts, they suggest that "if we don't accept this unity in the first place then the critique of natural kind concepts failing to apply uniformly to terms like 'phosphorous' or 'tiger' is misdirected." Given that Hacking's (and my) criticism of the natural kind tradition strongly relies on this claim of various meanings, it seems that such a natural kind pluralism is all that is needed for avoiding the eliminativist conclusion.

However, there is an important ambiguity in MacLeod and Reydon's proposal. On the one hand, their examples of phosphorous and tiger can be read as suggesting a rather restricted pluralism in which "natural kind" has different meanings in different disciplines. For example, "natural kind" in chemistry may come with microstructural requirements while "natural kind" in biological systematics comes with historical requirements. In this sense, MacLeod and Reydon argue that "different disciplines may well unpack the notion of 'natural' in different ways" (2013, 96). Insofar as this pluralism is restricted by the assumption that "natural kind" still has a unified meaning within a given discipline, however, it will fail to provide a satisfying account of my case study of ethnobiology that requires attention to different dimensions within very specific disciplinary contexts. As I tried to show in the last section, it will often be necessary to engage with ethnobiological taxonomies by using different accounts. For example, a more liberal account in terms of Magnus' success/restriction clauses will be helpful in engaging with domain-relative local ethnotaxa while a more demanding notion such as Franklin-Hall's categorical bottlenecks is more adequate for analyzing surprising cases of cross-cultural convergence.

Alternatively, one could also interpret MacLeod and Reydon as proposing a more radical pluralism that allows for many different specifications of natural kinds within any given context. Even in a restricted context such as Kalam classification of birds (see 2.7), we should not ask whether a kind is a natural kind in general but rather whether it is a natural kind relative to a relevant dimension. When discussing exclusion of cassowaries from the Kalam taxon *yakt*, we may find that *yakt* still qualifies as a natural kind$_{\text{SPC}}$ but fails to qualify as a natural kind$_{\text{categorical bottleneck}}$ or as as natural kind$_{\text{node in causal network}}$. In contrast, the taxon *kobtiy* (cassowary) would also qualify as natural kind$_{\text{categorical bottleneck}}$ and as natural kind$_{\text{node in causal network.}}$ However, such a reformulation immediately leads back to the worries that I articulated earlier in this section. First, it is not clear what we gain from talking about natural kind$_{\text{categorical bottleneck}}$ or natural kind$_{\text{node in causal network.}}$ etc. rather than about categorical bottlenecks and nodes in causal network directly. It seems that the introduction of "natural kind" just adds a contentious label that does not contribute to our understanding in any way.

Furthermore, such a reinterpretation of natural kind may not only fail to generate positive insights but also lead back to Hacking's worries about unproductive scholasticism. For example, which aspects of non-arbitrary classification would be included in a multidimensional notion of natural kind? Although one may try to include all of them, this would lead to a counterintuitive notion that would also include all special purpose kinds (2.1) or cognition-dependent kinds (2.7). For example, "natural kind" would include categories such as *sacred mushroom* even in absence of any further inductive potential, property cluster, etc. Alternatively, one may also try to come up with a more restricted notion that accepts only some but not all dimensions of non-arbitrariness by adding further requirements such as inductive potential, property clusters, etc. While such a strategy would avoid at least some counter-intuitive inclusions, it would lead straight back to boundary disputes about a general notion of natural kinds. For example, consider the case of biosocial kinds that involve some property clustering but are partly conventional and not causally unified (2.7). While one could have a long debate about the question whether such kinds should be included in a pluralist notion of natural kind, it seems that such a debate would just lead us away from actually analyzing how biosocial kinds work in ethnobiology. We will be better off by letting go of "natural kind" as an unnecessarily coarse-grained concept and by embracing a more nuanced multidimensional analysis of non-arbitrary classification.

5. Conclusion

The aim of this article has been to develop a positive and a negative thesis about the state of natural kind debates. On the one hand, I have used examples from ethnobiology to develop a positive framework that recognizes multiple dimensions of non-arbitrary classification. On the other hand, I have argued that such a framework leaves no interesting philosophical work for a general notion of natural kind. Once we understand a category along different dimensions of non-arbitrariness (e.g. it may involve a SPC and meet success/restriction clauses but fail to constitute a categorical bottleneck or a node in a causal network), there is nothing left to be learnt by asking whether it is a natural kind. Importantly, pessimism about the prospects of a general notion of natural kind should not interpreted as pessimism about philosophical engagement with classifications. A multidimensional framework is not an inferior substitute for a general account of natural kinds but actually provides a much more adequate framework for engaging with classificatory practices in (and beyond) science. By letting go of "natural kind" as a traditional but unnecessarily coarse grained concept, we actually have more reasons for optimism about a nuanced research program that integrates philosophy of classification with classificatory issues that emerge in the empirical sciences.

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