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Scurvy and the Ontology of Natural Kinds

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Abstract

Some philosophers understand natural kinds to be the categories which are constraints on enquiry. In order to elaborate the metaphysics appropriate to such an account, I consider the complicated history of scurvy, citrus, and vitamin C. It may be tempting to understand these categories in a shallow way (as mere property clusters) or in a deep way (as fundamental properties). Neither approach is adequate, and the case instead calls for middle-range ontology: starting from categories which we identify in the world and elaborating their structure, but not pretending to jump ahead to a complete story about fundamental being.

1. Natural kinds as constraints on enquiry

Some of the categories that we employ reflect just our arbitrary or conventional ways of organizing things. Others are categories which we must include in our taxonomy in order to attain scientific success in a given domain. The latter categories are especially fit for enquiry.

Which categories are fit for enquiry in this way and which are not—that is not a matter determined just by how we organize our enquiry. Rather, as I have written elsewhere, "the world condemns a great many taxonomies to failure" (Magnus 2012, 50). To consider it from the side of the world rather than from the side of enquirers, the objects and phenomena themselves impose constraints on enquiry. Some philosophers have taken this kind of constraint to be the defining feature of natural kinds.

In a late statement of his view, Richard Boyd begins from the basic idea that "natural kinds are, in some sense, kinds apt for induction and explanation" (2021, 2868). Successful enquiry fits to the causal structure of the world in the right way, and reference to natural kinds is part of that success. Boyd's term for this is *accommodation*. Distinguishing some categories as natural kinds reflects how employing those categories "contributes to the accommodation of the inferential architectures of scientific (and other) disciplines to relevant causal structures" (2021, 2887–8).[1]

[1] Boyd's complex and subtle account of natural kinds was developed over decades in a series of papers; see Boyd (1982, 1991, 1999a, 1999b, 2021).

As I once wrote, "[c]onstraint from the world is what makes identifying natural kinds the discovery of structure in the world, rather than merely the imposition of a set of labels onto things that are undifferentiated in nature" (Magnus 2012, 50). That is, "[a] natural kind is a category that scientists are forced to posit in order to be scientifically successful in their domain of enquiry" (Magnus 2012, 47). I elaborated this as two related conditions: Employing those categories must support successful scientific enquiry, and it must be the case that the categories are more-or-less indispensable.

Laura Franklin-Hall writes that "natural kinds are those categories that well-serve both our actual epistemic purposes—such as those of prediction and explanation—and those of a large range of inquirers relatively like us" (2021, 191). These categories are "bottlenecks" in the sense that both us and enquirers different than us would all be led to distinguish them (Franklin-Hall 2015, 940).

Although these accounts differ in a number of respects, they share the general picture of natural kinds as categories which are especially fit for enquiry and as the corresponding structures which constrain enquiry.[2]

It is somewhat contentious that these constraints on enquiry should be called *natural kinds*. Nelson Goodman gives two reasons for using the phrase *relevant kinds* instead (1978). More recently, Ingo Brigandt offers similar reasons against the modifier "natural." Brigandt instead just calls them *kinds* (2022, 19).

First, "natural" might seem to exclude psychological and social phenomena. As Goodman puts it, "'natural' is an inapt term to cover not only biological species but such artificial kinds as musical works, psychological experiments, and types of machinery" (1978, 10). As Brigandt suggests, "the continuing use of 'natural' kinds (as a sheer term) propagates [a] problematic connotation that obscures the involvement of human aims" (2022, 19). However, humans are part of the natural world— not things hovering outside it. So there is a sense in which music and technology are just as natural as beehives and planetary orbits. Calling such kinds 'natural' underscores this fact, and refusing to do so propagates a problematic dualism of human versus natural. So rather than one usage being simply better, it is a choice in emphasis between one problematic connotation and another.

Second, "natural" can suggest overly strong metaphysical commitments. As Goodman puts it, "'natural' suggests some absolute categorical and psychological priority, while the kinds in question are rather habitual or traditional or devised for a new purpose" (1978, 10). Brigandt writes similarly that "'natural kind' erroneously suggests that the kind has a physicochemical or narrowly biological basis such as to problematically convey that the kind is historically invariant as opposed to (in some cases) involving *contingent social* processes" (2022, 19, emphasis in original). However, dropping the modifier "natural" for this reason would lose track of the distinction between arbitrary kinds (which we might adopt or reject willy-nilly) and enquiry-constraining kinds (which we need to adopt to make sense of things). Even among categories which are traditional or adopted for some purpose, we can distinguish the ones which are mere conveniences from the ones which are indispensable. We lose

[2] Franklin-Hall self-identifies as an anti-realist while also classifying both Boyd and me as anti-realists. For our part, Boyd and I self-identify as realists. Untangling what "realism" means here is beyond the scope of this paper, but see Magnus (2018b).

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that distinction if we adopt Goodman's phrase "relevant kinds" or Brigandt's suggestion to stop distinguishing among kinds at all.

So we need some way to distinguish the categories identified by Boyd (as meeting accommodation demands), by me (as meeting the success and restriction conditions), and by Franklin-Hall (as categorical bottlenecks). Rather than coin some new jargon—like *enquiry-constraining kinds*—I will persist in calling these *natural kinds*.[3]

Olivier Lemeire argues that criteria like these cannot serve to distinguish natural kinds. He writes that "'being constrained by the world' cannot really be what constitutes the naturalness of kinds" (2021, 2922). Practical success is also constrained by the world, he says, but the categories which support practical success are not natural kinds. This is a tricky point, because systematic practical success can reveal natural kinds. There is no sharp boundary between pure and applied science, and understanding the causal structure of the world is equivalent to knowing a wide range of intervention counterfactuals. However, isolated practical success may be too superficial—more on that below.[4]

The conception of natural kinds as enquiry-constraining categories suffices to determine which kinds are natural kinds and which are not. Nevertheless, there must be more to say than the mere fact *that* a particular category is a natural kind. One might ask the further question of *what* exactly there is in the world that does the constraining.

The distinction between these two questions has not gone unnoticed. Hawley and Bird distinguish the question of *naturalness* from the question of *kindhood* (2011). I have called these the *taxonomy* and *ontology* questions (Magnus 2014; 2018c). In those terms: The conceptions of natural kinds I have discussed so far are answers to the naturalness or taxonomy question. The further question of kindhood or ontology is more metaphysical.

For the remainder of the paper, I want to pursue this *what* question. Rather than focus on well-explored examples like chemical elements or biological species, let's consider the example of scurvy and vitamin C.

2. Scurvy and shallow ontology

Scurvy, now understood to be a deficiency of vitamin C, has long been known.[5] Summing up the impact:

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[3] It may be tempting to adopt Franklin-Hall's phrase and call them *categorical bottlenecks*. I do not do so because (first) I mean to be talking about the general conception shared by all three of us rather than her account in particular, and (second) she offers it as a definition of *natural kind*.

[4] Lemeire also argues that there is no compelling argument that indispensability-for-enquiry is the mark of the natural. He writes that "philosophers with essentialist inclinations" would not accept the criterion and, moreover, that there is no way to convince them (2021, 2922). However, even though they would not accept scientifically important kinds as being ipso facto natural, essentialists like Wilkerson (1995) and Ellis (2001) still think that the class of scientifically important kinds is significant; see Magnus (2012, 20–21). So the difference is not over whether there is an important class of categories distinguished by their indispensability-for-enquiry but just over whether we should label those with the phrase *natural kind*. As indicated above, I am ambivalent about the phrase but adopt it for the sake of discussion here.

[5] Hemilä provides a concise summary of the relevant history (2012). See also Bown (2003) and Lamb (2017).

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> Scurvy killed more than two million sailors between the time of Columbus's transatlantic voyage and the rise of steam engines in the mid-19th century. The problem was so common that shipowners and governments assumed a 50% death rate from scurvy for their sailors on any major voyage. (Price 2017)

The relevant natural kinds are *scurvy* itself and *anti-scorbutic foods* (ones which are proof against scurvy).

The discovery that citrus can serve as proof against scurvy in the 18th century is standardly given as a milestone of the scientific method. In 1747, James Lind conducted a trial of various anti-scorbutic measures on twelve men, with two each assigned to six different treatment groups. The group given oranges and lemons did best. A typical description of Lind's experiment describes it as "a triumph of the scientific method" (Thomas 1997, 54). Lind is hailed as "a forerunner of the modern clinical investigator" and "the father of the controlled clinical trial" (Thomas 1997, 50).

In 1795, Gilbert Blane (on the basis of Lind's work) convinced the British admiralty to issue a daily ration of lemon juice to all the sailors in the British navy. The effect was far-reaching: The use of citrus led to a British sailor—or a Briton generally—being referred to colloquially as a "limey" (shortened from "lime juicer"). In 1805, when Horatio Nelson defeated the French and Spanish navies at the Battle of Trafalgar, it was in part because his fleet was less ravaged by scurvy.[6]

It looks as if these developments can be handled entirely with shallow metaphysics. Lind, observing the antiscorbutic power of citrus, learned of a stable connection between various properties. This knowledge was sufficient to underwrite a successful scientific intervention and change the course of history. Although philosophers may say that these stable connections correspond to kinds or sociable property clusters, this adds little to the knowledge that Lind, Blane, and Nelson already had. The important developments were just scientists and administrators doing their thing.

This gives a superficial description of kinds as clusters of observable properties. Let's call this *shallow ontology*—in contrast with deep ontology, which sees natural kinds as comprised of something metaphysically fundamental. One might take these clusters in the world to be Franklin-Hall's categorical bottlenecks, reified as posits about the world. Or one might understand them in terms of Anjan Chakravartty's semirealism. For Chakravartty, natural kinds correspond to clusters of properties and relations that tend to occur together. The properties associated with a kind are, he says, "systematically 'sociable' in various ways" and "'like' each other's company" (2007, 170).[7]

This superficial approach is similar to what Steven French calls shallow realism. On this approach, "we choose our best theories; we read off the relevant features of those theories; and then we assert that an appropriate relationship holds between those features and the world" (2014, p. 48).[8] Shallow metaphysics, French complains, could amount to nothing more than selectively echoing some of what scientists have to say

[6] Bown argues for this connection (2003).

[7] Matthew Slater's "cliquish stability" can be seen as an elaborated version of Chakravartty's systematic sociability (Slater 2015).

[8] See also French (2014, 55 fn. 11; 2015; 2016).

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about a domain. French's objection to shallow realism resembles the complaint James Ladyman et al. make against John Dupré's *promiscuous realism*.[9] Promiscuous realism, they write, "amounts to abandonment of the metaphysical ambition for a coherent general account of the world" and is a "denial of the possibility of philosophy" (2007, 194, 196). French and the others thus demand that philosophy provide—or at least try to provide—an account in terms of fundamental ontology. In the words of William Caldwell, "the business of philosophy is to study reality and reduce it to its fundamental terms" (1900, 439). I will return to that pursuit in a moment.

The problem with superficial ontology in this case is not that *philosophy* needs more depth than this, but that science itself does. If we examine history further, we find that Lind's success was not so clearcut.

In 1860, for economic reasons, the British navy changed from using citrus sourced from the Mediterranean to citrus from the West Indies. The new limes had substantially less vitamin C, and the procedures used to prepare and store the juice removed most of what vitamin C they did have. Scurvy was not a problem for the navy, however, because ships became fast enough that they could usually carry a supply of fresh food.

Polar expeditions in the early 20th century were not able to resupply as well, and they were devastated by scurvy. Robert Falcon Scott led Antarctic expeditions in 1901–4 and 1910–12 in an attempt to reach the South Pole. Both expeditions suffered terribly from scurvy. The dominant medical account at the time was that scurvy resulted from ptomaine produced in spoiled food. Despite the navy's overcoming scurvy more than a century before, it had not been clearly recognized that the cause of scurvy was lack of a crucial nutrient. Champions of citrus like Lind thought of it as a treatment, rather than as removing the cause of the condition itself. For his part, Lind thought scurvy was chiefly caused by moist air.

The upshot is that the shallow gloss is only made plausible by overlooking the respects in which it mattered that they did not have a deeper understanding of scurvy. With more of the history filled in, we are left with what John McMichael aptly describes as "observations of convincing and repeatable accuracy made and lost" (1965, 105). Lind's practical success, although constrained by the world, was tenuous and failed to reliably track natural kinds.[10]

3. Vitamin C and deep ontology

Vitamin C was chemically identified even before it was clear that scurvy was a deficiency disease. In 1928, Albert Szent-Györgyi isolated a molecule which he named *hexuronic acid*. After further enquiry, he found that it cured scurvy in guinea pigs. So it came to be called *ascorbic acid*. Genuine understanding of scurvy, as McMichael writes, required "the invention of a word (vitamin) and the final precise chemical identification of the substance, ascorbic acid" (1965, 105).

[9] See Dupré (1993; 2002).

[10] Catherine Kendig and John Grey, arguing against Slater (2015), give examples of scientists misidentifying natural kinds when making the wrong metaphysical assumptions (Kendig and Grey 2021). In their examples, like in the case of scurvy, scientists got the sociability of certain properties right but made the wrong inferences on that basis.

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So it can be tempting to identify vitamin C with a chemical formula. This lends itself to essentialism, a deep ontology which identifies intrinsic microstructure as the fundamental nature of the kind. There is a long tradition of thinking this way, running from ancient atomists, through modern corpuscularians, to modern essentialists like Brian Ellis (2001). The approach has an easy time with chemical elements. Gold, for example, is identified with bodies of atoms with an atomic number of 79. At least in schematic terms, it can be extended to chemical compounds and mixtures. Water, we are told, just is H_2O.[11] And vitamin C is ascorbic acid.

However, the essentialist move which identifies the natural kind with a chemical formula is too quick for at least two reasons.

First, one does not need to ingest molecules of ascorbic acid in order to get vitamin C. Various mineral salts are used as vitamin C supplements. The essentialist may reply that the salts become ascorbic acid in the course of metabolism. That seems fine as long as we focus on vitamin C, but other vitamins are not specific molecules in this way. In general, a vitamin is a class of different *vitamers* (specific chemical forms which can do the vitamin work). For example, "[t]he term 'vitamin A' is used as a generic descriptor for retinoids exhibiting qualitatively the biologic activity of retinol" (Olson 1996, 222). So being a vitamin is a matter not of having a specific chemical formula but of being able to exert the vitamin activity. That vitamin C is less varied does not change the fact that the relation—and not some intrinsic feature of vitamin C itself—is what matters.

Second, hexuronic acid is only *ascorbic* (it only provides proof against scurvy) because animals like us need it to avoid scurvy. Szent-Györgyi reported, of his attitude before his discovery, "Vitamins were, to my mind, theoretically uninteresting. 'Vitamin' means that one has to eat it. What one has to eat is the first concern of the chef, not the scientist" (Hemilä 2012). A molecule with the same structure might form around a lifeless star, but ascorbic acid is not a natural kind for astrophysics or orbital dynamics. It is a natural kind only for a domain like nutrition—and not just any nutrition. Most creatures that need ascorbic acid for various biological functions can synthesize it themselves. Primates, guinea pigs, and fruit-eating bats are rare exceptions. This is contingent on an evolutionary history in which our ancestors had diets so rich in vitamin C that offspring who lost the ability to synthesize it could survive and proliferate.

So being a vitamin is relational in two important respects. First, it is not identified as a specific intrinsic microstructure but instead as any structure that can do the vitamin work. It is in relation to a biological context. Second, the vitamin work only needs to be done in specific organisms. It is in relation to the animals that need to eat it. So vitamins are not readily understood in terms of some modally robust essence, and I do not see any other obvious way to construe them as features of fundamental metaphysics.

Goodman and Brigandt see this sort of relativity and contingency as reasons not to talk in terms of natural kinds. However, distinguishing vitamin C is not merely a tradition of nutritionists. A vitamin tablet might contain ascorbic acid and be shaped like a cartoon character, but its nutritional value is determined by the contents and not by the shape. The tablet's membership in the kind vitamin C is crucial, but its

[11] This identification is contested. See, e.g., Needham (2000) and Chang (2012).

membership in the kind cartoon depiction is incidental. Nutrition, as an enquiry, had best recognize vitamin C (as a nutrient) and scurvy (as a nutrient deficiency). These are natural kinds, in the enquiry-constraining sense that I discussed in the first section.

4. Middle-range ontology

The categories *scurvy* and *anti-scorbutic* are natural kinds relative to domains like human nutrition and metabolism. Without the category of scurvy, there is a lot of ill-health and suffering that we would be unable to understand. The discovery that scurvy is a deficiency disease introduces the corresponding category of the anti-scorbutic—foods (pills, etc.) that provide what is missing.

There are, of course, enquiries that get along just fine without these categories. Above, I gave the examples of astrophysics or orbital dynamics.[12] Nevertheless, these are not just natural kinds for nutrition. They also constrain what superficially seem like totally unrelated enquiries. For example, because of the importance of the British victory at Trafalgar, a history of the Napoleonic Wars is also constrained to mention scurvy and the anti-scorbutic effect of citrus.

We care about domains like nutrition and history, but scurvy would occur and certain foods would be anti-scorbutic even if we did not. The categories are constraints on potential enquiry even if we do not conduct it. So they are natural kinds, in the enquiry-constraining sense I discussed in section 1. In sections 2–3, I argued that they are not readily understood either by shallow ontology (in terms of observable clusters) or by deep ontology (in terms of fundamental essences). What is needed, instead, is what I call *middle-range ontology* (Magnus 2018a; 2018c).

The idea of middle-range ontology is to begin with natural kinds which we think we have found in some part of the world. We can elaborate what it is in those domains which makes those kinds natural. Some general patterns will emerge from this, so that we can say that many kinds across many domains are ontologically similar. We also discover that other kinds in particular domains are different in important respects.

Note the *middle-range* here is not a matter of scale, as if the structure in question were something smaller than a sailor but bigger than a molecule of vitamin C. Instead, it reflects two contrasts. First, middle-range ontology goes beyond shallow ontology by requiring more than just what enquirers themselves might have to say. It cannot simply be read off existing practice. Second, middle-range ontology makes no claim of fundamentality. We can identify vitamin C in terms of causes and functions, without claiming that causes and functions are metaphysically fundamental. The middle-range account is not framed in terms of essences, necessities, or any of the other heavy-hitting apparatus of metaphysics.

Middle-range ontology may get deeper as it goes along, but its initial posits will modestly extend the picture offered by successful enquirers. If it were to arrive at metaphysically fundamental elements which explain how all the natural kinds are natural, it would have to do so the hard way. It thus reflects what Matthew Brown has

[12] If primates, guinea pigs, and fruit-eating bats were all to go extinct, then whatever enquirers we imagine in that post-apocalyptic scenario could even do biology and nutrition without positing these categories.

called the "No Shortcuts" Rule. That is, philosophers should not pretend to knowledge that jumps ahead of what could be established by scientific or secular methods.[13] So middle-range ontology looks, in some respects anyway, like just doing more science. But it is not refusing to do philosophy or just echoing whatever practicing scientists say.

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[13] My point here is similar to Kit Fine's claim that *naïve* metaphysics is epistemically prior to *foundational* metaphysics (Fine 2017). However, both shallow and middle-range ontology count as naïve in Fine's sense.

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