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# Natural kinds

By Kendig, Catherine

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## Article Summary

Natural kinds are widely understood to be the real classifications of things that actually exist in the world. Natural kinds are the categories we tend to aim for when we seek to understand the world, as it really is. Discovering what these real classifications are is often considered to be the project of scientific research in many fields from astronomy and agronomy to zoology and zymurgy. When we discover something unfamiliar to us and we want to know what sort of thing it is, we might ask: 'what kind is that?' For instance, in a physics class, we might ask: 'what kind of quark is that?', where the answer might be: 'that is a charm quark'. In biology, we might ask: 'what kind of plant is that?', with the answer being: 'it is a Venus flytrap (*Dionaea muscipula*)'. Or, in chemistry, we might ask: 'what element is that?', with the answer being: 'lithium'. Knowing that the thing we asked about is a member of that particular kind tells us a lot about it if it is a natural kind. Membership in a natural kind tells us that the thing in question shares many important characteristics with other things that are in the same natural kind category. For example, consider the category of Venus flytraps. All plants that belong to that category share many important characteristics; among these include: perennial flowering, carnivorous eating habits, capable of thigmonastic responses (closing their 'trap' when prey alight on their trichomes), ability to photosynthesise, belonging to the family Droseraceae and the kingdom Plantae. Some of these important characteristics and properties have been referred to as 'essential' by philosophers because they are the properties that are thought to be necessary for the thing to be a member of that natural kind. That means that if the thing does not have those necessary properties, then it cannot be a member of that natural kind.

When we ask the question: 'what kind is that?', we do not always discover natural kinds.

Sometimes when we ask: ‘what kind of thing is that?’, we find out, for instance, that this thing that we are asking about is green. This means we find out that it belongs to the category of green things. The category of green things is a kind category, but it is not a natural kind. The category of all green things includes the Venus flytrap but also green traffic lights, green tea, guacamole, collards, and dark jade-painted 1978 Ford Mustang sportscars. What all of these things have in common is that they are all green. However, they do not share any other properties or characteristics apart from being green. Green kinds of things are not natural kinds like those mentioned earlier. The kinds that are picked out by the classifications of charm quark, Venus flytrap, and lithium are considered to be very different from the classification of green things. Whilst all charm quarks, all Venus flytraps, and all samples of lithium are each considered to be classifications of natural kinds, the category of green things is not. The philosophical question that arises is: ‘what makes classifications like that of the natural kind that includes all charm quarks natural and classifications like that of all green things not natural?’ Put a different way: ‘what makes something a natural kind and how can we tell the difference between natural kinds and what we might call “artificial kinds”, like the grouping of green things?’ A popular answer to this question is that natural kinds pick out natural groupings whose existence in the world is not dependent upon human interests or activities, whereas artificial kinds pick out groupings whose existence in the world is dependent upon human interests or activities. However, others have provided substantial evidence challenging this claim, arguing that there are at least some natural kinds that are dependent upon human activities and practices for their existence.

In addition to questions concerning what qualifies as *naturalness* in natural kinds and what is the distinction between natural and artificial kinds, philosophical discussion also focuses on the metaphysics of natural kinds and the epistemic value of natural kinds. A perennial question widely debated is whether the classifications used in scientific disciplines – physics, chemistry, biology, neuroscience, geology, linguistics, anthropology, and more – really do map on to a natural classification that really exists in the world. That is, are the ways we partition elements in chemistry, organisms in biology, or quarks in physics, the same partitionings that naturally exist? A lot of the literature on natural kinds relies on using examples that are thought to be quintessential natural kinds, like biological species and chemical elements. But others argue that there is clear evidence that many, if not most, biological species and chemical elements are not natural kinds, especially if membership within a natural kind requires possession of an essential property. Within the discussion of natural kinds, there are also questions with regard to the conditions of membership that challenge the view that

natural kinds membership is determined by the possession of a particular essence. Instead of the possession of a particular essence, some argue that membership in a natural kind may instead be determined by the possession of a cluster of properties, a relationship, or something else. In many of these discussions, Plato's metaphor of *carving nature at its joints* is used to describe the mapping of natural classifications onto natural kinds by the implied comparison to the butchering of an animal along its natural divisions (knuckles, limbs, etc.) rather than partitioning it in a way that does not coincide with the animal's body structure. Whilst the metaphor helps explain the nature of natural kinds, it does so by assuming nature is that which is pre-partitioned.

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## 1. Natural kinds and the metaphor of *carving nature at its joints*

Philosophical discussions centring on the existence of natural categories that exist in the world have a long history that rely not only on putative examples of what are thought to be quintessential natural kinds, but also on a popular descriptive metaphor. How can we understand what are and what are not natural kinds? Natural kinds are those kinds that *carve nature at its joints*, according to Plato's metaphor which has been widely used to explain what natural kinds are, the source of their naturalness, and why they are important kinds to discover ([Plato 1925](#)). The carving of nature (as the metaphorical meat carcass of an articulated limbed animal) at its natural joints is a bit gruesome, especially if you are a vegan (vegans, think about breaking a garlic bulb into its cloves). The metaphor is meant to capture the idea that there are natural partitionings or joints and natural kinds pick out those partitionings or joints. It is an easy metaphor. As any hunter or cook knows, the best way to butcher an animal is to cleave the beast at its joints – or to break the bulb of garlic into its cloves – as these are the weaker more easily severed (separated) points of the carcass (bulb). By partitioning or joint-cutting, one can process the animal or vegetable more quickly and in a way that it is partitioned along its body plan. Cleaving nature at its joints borrows from both the idea of a *Bauplan* – of a tetrapod or vegetable bulb – and the notion of part-whole relationships, which are thought to determine the cleaving (see [Evolutionary developmental biology](#)). The metaphor of *carving nature at its joints* is metaphysically compelling in virtue of its appeal to a world that appears to be one where nature comes pre-segmented.

Traditional realism versus antirealism debates share apparent agreement that mind-

independence/dependence is the standard litmus test for which side of the debate you are on, whether it be about natural kinds or anything else (see [Scientific realism and antirealism](#)). But some philosophers object to this as well as the assumption that the reality of natural kinds is grounded in the pre-carved up foundational structure of the world. They instead consider how we arrived at the reality of the natural kinds we rely upon within the various scientific disciplines as well as outside of them.

While controversial, some have suggested that in order to understand natural kinds, we need to do more than consider the existence claims of natural kinds, what is or is not the source of their naturalness, and their membership conditions. We also need to be looking at the activities of people interacting with natural kinds, attending to how those activities contribute to the resulting [categories](#), as well as why these are conceived of as natural kinds by those people using them (see [Kendig 2015](#), and the chapters within). Paying attention to who is using them and how these natural kinds are grounded in different ontological categorisations shifts the focus of the discussion of natural kinds from just studying putative natural kinds to also studying the activities and people who use them and value them ([Kendig 2020](#)). Philosophers working alongside scientists have focused on the role of different practices in the making of concepts, the interactive nature of investigation, and on the practices through which kinds are made, revised, or discovered which have been collectively referred to as 'kinding activities' ([Kendig 2015](#)). These kinding activities include tinkering ([Jacob 1977](#)), intervening ([Hacking 1992, 1995](#)), retuning ([Pickering 2005](#)), reengineering ([Wimsatt 2007](#)), and epistemic iteration ([Chang 2015](#)).

In considering the role of human activities in the kinding of natural kinds, Plato's metaphor of *carving nature at its joints* could be tweaked in a way that accommodates the role of practice in investigations of natural kinds. Instead of carving nature at its joints being a metaphor that trades on the assumption of a carvable world whose partitionings do not rely on human activities, a retooling of the metaphor would not only include attention to carved joints and the nature of their naturalness, but also to the carving practices and the role of the carver as well as their modes of carving. This retooling provides a new suite of natural kind-oriented questions: who is the carver? What are they intending with their carving? How are they identifying the joints they carve? What are they carving? How do they see it as carvable? The suggestion mooted here is simple – that the discussion of natural kinds shifts to include a discussion of the activities of kinding and kinders ([Kendig 2015, 2020](#)).

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## 2. The distinction between natural kinds and artificial kinds

When philosophers talk about the naturalness of natural kinds, they often mean that the group of entities or processes that are being discussed as a natural kind exists in the world. Natural kinds are sometimes thought to pick out categories whose existence is not dependent upon human interests or activities. On this view, examples of natural kinds would include: water, gold, puppies, and *Dionaea muscipula* (Venus flytrap). The modifier 'natural' is intended to distinguish them from 'artificial kinds'. In contrast to the existence of natural kinds, the existence of artificial kinds is thought to be dependent on human interest or activity. Examples of artificial kinds would include: cryptocurrencies, libraries, musical ensembles, and spam.

Attempts to discriminate natural from artificial kinds often rely on trying to identify what it is that makes natural kinds natural. Some philosophers discuss the origins, causes, and even mechanisms of this naturalness as well as what it means to be natural and how this naturalness can be known ([Kripke 1972](#), [Putnam 1975](#)). Others have focused on what makes the clusters of entities or processes considered to be natural kinds stick together in a way that leads us to identify them as stable natural kinds ([Slater 2015](#), [Magnus 2018](#), see [Lemeire 2021](#) and [Kendig and Grey 2021](#) for criticism).

Early justification for the naturalness of natural kinds was linked to what were thought to be essential properties that were shared among all members of the kind. If an entity possessed this essential property, it meant that the entity belonged to the natural kind. In this way,

essential properties were considered diagnostic for membership in a natural kind. Consider gold. The chemical element, gold, is often treated as a quintessential example of a natural kind, and one that [Saul Kripke \(1972\)](#) discusses at length. Kripke argues that all gold things, in order to qualify as members of the natural kind, cannot simply be all things that are coloured metallic yellow, or those things jewellery can be made out of, or even those things that can pass, or be mistaken for, as gold things, like fool's gold (iron pyrite). Kripke argues that this is because the condition for membership in the natural kind gold is the possession of the atomic number 79, the chemical element that is signified Au. This disqualifies similar-looking yellow metallic things, like pyrite, since pyrite does not have an atomic number 79. Pyrite is not an element and is instead a composition of iron sulfide FeS<sub>2</sub>. Similarly, Kripke says that the same thing is true of species of animals. Animals also have essences. Kripke invites us to consider the possibility of discovering an animal that looked like another but we later found out was something else entirely. For instance, suppose we were walking along the coast and came upon what looked to be a flamboyance of flamingos. We would think that these flamingos belonged to the natural kind flamingo. However, we discover that these animals were in fact not flamingos, but instead they were actually a quiver of cobras. Once we empirically discovered the nature of the cobras, we would then agree that they did not belong to the natural kind flamingo but instead to the natural kind cobra.

There have been a lot of [thought experiments](#), like the one above, that are used in philosophy to attempt to help explain the nature of kind membership. These thought experiments are intended to provide a simulated situation that allows us to run an experimental scenario that is not possible in the lab or in the field. Perhaps one of the most well-known thought experiments is [Hilary Putnam's \*Twin Earth\*](#). Putnam invites us to imagine a planet called 'Twin Earth' which is exactly the same in every way to Earth and where there is an exact duplicate of everything, even you, but with one exception. Whereas on Earth you drink water, which is a substance whose molecules contain two hydrogen atoms and one oxygen atom and is signified H<sub>2</sub>O, on Twin Earth you drink a substance with the chemical compound XYZ. XYZ is a clear, potable liquid that freezes at 0 degrees Celsius and sustains life, just as water does on Earth. The question that Putnam's Twin Earth story is meant to raise, is: is XYZ water? Putnam argues that XYZ cannot be water because water is made up of a different microstructurally distinct essence, namely H<sub>2</sub>O. The examples of gold from Kripke and water from Putnam are intended to show that some (but perhaps not all) natural kinds have their natural kindness in virtue of possessing microstructural essences.

Whereas chemical elements and biological [species](#) are still used as exemplars for natural



kinds, there are many philosophers who have argued that locating essential properties or necessary and sufficient conditions for group membership is not as easy as the thought experiments discussed above would suggest (see [Essentialism](#)). It is possible that some biological species could turn out to be natural kinds, something that we could discover through empirical research, but other species might not be natural kinds. They might be sets ([Kitcher 1984](#)), they may share phylogenetic relationships ([Ereshefsky 1992](#), [Griffiths 1999](#)), they might share clusters of homeostatic properties ([Boyd 1999](#)), or they may not, depending on the species ([Dupré 1981](#), [1999](#); [Khalidi 2013](#)) (see [Natural kinds in biology](#) and [Taxonomy](#)). Within philosophy of science, problems with essentialist accounts of natural kinds have been discussed widely with regard to the species problem and adjacent discussions within [philosophy of biology](#).

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## 3. The epistemic value of natural kinds

Classifications exist in many disciplines. They provide indices, catalogues, networks, tables, and taxonomies that define the scope of the discipline. If these classifications pick out natural kinds, it is thought that they will provide justification for making inferences about the properties and characteristics of the members of that natural kind. This means that if you know that the liquid in the bottle in front of you is H<sub>2</sub>O, then you know other things about it because it belongs to the same natural kind as all other instances of water – that in your shower, in the fountain, or in the ice cubes in your freezer. You know that they all have the property of freezing at 0 degrees Celsius and boiling at 100 degrees Celsius, and, of course, you know that you can drink it. This is pertinent to the discussion, because one of the things that scientific investigation aims at is the identification of natural kinds. Discovering natural kinds allows us to make inferences about them like the ones we just made about water. However, some philosophers want to find a way to preserve the knowledge and ability to make inferences and generalisations that are possible using natural kinds but reject the view that the existence of natural kinds is independent of human thought and activities. Some also deny that many of the examples that have been discussed as quintessential natural kinds, including those discussed by Kripke and Putnam, do not in fact share a common essence.

Richard Boyd's Homeostatic Property Cluster Theory (HPC Theory; [Boyd 1991](#), [1999](#), [2000](#), [2010](#)) provides an alternative way of understanding the naturalness of natural kinds that is not based on the assumption that the existence of natural kinds requires a commitment to their mind-independence. Instead of mind-independence being the way natural kinds are grounded in reality, Boyd argues that it is instead the 'epistemic reliability' of natural kinds that makes them natural. A kind is natural if the classification it posits fits the question that is

asked. As such, natural kinds are understood as categories that are epistemically successful ([Boyd 1999](#)). While many have adopted HPC Theory, some have pointed out that relying on epistemic reliability must also require some sort of normative assessment about kinds that can be used to determine which are useful and which are not useful; while others are even more critical of HPC Theory, suggesting that relying on epistemic success must also require attention to the intentions and assumptions of those using natural kinds.

In response to HPC Theory, one popular approach retains the [epistemic value](#) of natural kinds but disposes of the metaphysical commitments ([Slater 2015](#), [Magnus 2018](#), [Ereshefsky and Reydon 2015](#)). These epistemology-only or epistemology-first accounts remain metaphysically agnostic with regard to the nature of kindhood, arguing that all that is required is epistemic commitment to the inferential role of natural kinds in scientific knowledge production. That is, in certain disciplines, natural kinds provide us with a useful conceptual tool. What this means is if natural kinds work, then we should use them, and if they do not, we should not use them. Figuring out why they work or what is the metaphysical basis for their naturalness is not important. If it works, it works.

Some object that these epistemology-only or epistemology-first views only make sense because there are underlying commitments that people use when they say, *if it works, use it*. When they say *it works*, they are saying that the natural kinds that they are discussing are epistemically useful to them (see [Epistemology](#)). But this seems to invite the question: why does it seem to work, for you, in this situation? The natural kind may seem to work for a variety of reasons. For instance, the natural kind may work because it satisfies certain purposes of individuals who are investigating them, or this categorisation aligns with a particular set of criteria that the investigators thought were necessary for natural kind membership. For those wanting to remain metaphysically agnostic, the answers to these questions do not matter when considering the epistemic value of natural kinds. But it would seem that these things might definitely matter, especially in the case where the investigator using a particular natural kind is relying on an erroneous set of concepts or metaphysical commitments to assess whether that kind is epistemically valuable. If we want to say that the investigator could be wrong about the categorisations they think are natural kinds, then the underlying commitments of these investigators that serve to justify their potentially erroneous attributions of natural kindhood must be investigated, and not only the naturalness (or unnaturalness) of the groupings being investigated (see [Kendig and Grey 2021](#) for examples).

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## 4. Metaphysics of natural kinds and the conditions for kind-membership

Natural kinds are traditionally understood to be the natural classifications of the contents of the world into natural [categories](#) of being. When we ask: 'what sort of thing is that, really?', we are asking how it is classified, what type of thing it is, or what makes this thing qualify as being a member of a particular kind. If we know what kind it is and we know what the conditions for its kind-membership are, we also know that other members of the natural kind also share certain properties or relationships. If we know what natural kind a thing belongs to, this gives us other information about what we also might know or infer on the basis of its membership within that kind.

Conversations about what sort of entities and processes exist and how they are (or should be) categorised in the world are a recurring topic in philosophy. Much of the discussion within the branch of philosophy called '[metaphysics](#)' rests on identifying the most general features of reality, like: 'what does it mean to exist?' or 'what kinds of things exist?' and 'to what category do they belong?' Whilst the literature on natural kinds is vast, there are some common views about natural kinds held by those who think natural kinds are real rather than artificial. One of these is the assumption that, for kinds to be natural, they need to be mind-independent. This means that the source of the naturalness of natural kinds is not dependent on what humans think or on any human investigative activities.

Whereas some believe that natural kinds pick out fundamental [properties](#) that exist among all members of the kind ([Kripke 1972](#) and [Putnam 1975](#)), others believe that to be natural

kinds, they must have natural kind essences ([Griffiths 1999](#), [LaPorte 2004](#)), whilst still others believe that natural kinds classify the contents of the world by identifying family resemblances ([Wittgenstein 1973](#)), or clusters of homeostatic properties ([Boyd 1999](#), [2010](#)). In addition to debates over the conditions that need to be met to be a member of a natural kind, there are also philosophical debates about whether or not natural kinds even exist ([Dupré 1999](#), [Hacking 2007](#), [Ludwig 2018](#)), whether there is a category of all natural kinds that is itself a natural kind ([Dupré 2002](#)), and how we should understand the stability, naturalness, and underlying metaphysics that natural kinds are thought to have if they do exist ([Slater 2015](#), [Magnus 2018](#), [Lemeire 2021](#), [Kendig and Grey 2021](#)).

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- Boyd, R.N. (1991) 'Realism, Anti-foundationalism and the Enthusiasm for Natural Kinds', *Philosophical Studies*, 61(1): 127–148. (Introduces the homeostatic property cluster theory in response to Ian Hacking insisting that how we define social kinds affects those things that we study and classify. Boyd defends species as quintessential natural kinds but not because of their shared essences but instead because they are homeostatic cluster kinds.)
- Boyd, R.N. (1999) 'Homeostasis, Species, and Higher Taxa', in Wilson, R.A. ed. *Species: New Interdisciplinary Essays*, Cambridge, MA: MIT Press, pp. 141–186. (Defends his Homeostatic Property Cluster Theory by relying on the concept of accommodation as a way to understand the connection between concepts, practices, and causal structures.)
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situated, and relationally defined conditions for membership.)

- Boyd, R.N. (2010) 'Realism, Natural Kinds and Philosophical Methods', in Beebe, H. and Sabbarton-Leary, N. eds. *The Semantics and Metaphysics of Natural Kinds*, New York: Routledge, pp. 212–234. (Further develops HPC and an anti-foundationalist naturalist approach to natural kinds that aims to be realist without relying on reductionism to do so.)
- Chang, H. (2015) 'The Rising of Chemical Natural Kinds through Epistemic Iteration', in Kendig, C. ed. *Natural Kinds and Classification in Scientific Practice*, London: Routledge. (Examines episodes in the history of chemistry to identify the processes by which classificatory concepts change over time through the activities of generations of scientists correcting and refining the concepts that they continue to use.)
- Dupré, J. (1981) 'Natural Kinds and Biological Taxa', *The Philosophical Review* 90: 66–90. (Criticises Putnam and Kripke's suggestion that general terms like 'tiger' successfully name biological species. The critique shifts the discussion of natural kinds from one that can be resolved within analytic philosophy and philosophy of language to an empirical question that has been adopted within philosophy of science.)
- Dupré, J. (1999) 'On the Impossibility of a Monistic Account of Species', in Wilson, R. ed. *Species: New Interdisciplinary Essays*. Cambridge: MIT Press. (For an accessible introduction to the problem of species and natural kinds. Discusses how species have been thought of as individuals, lineages, sets, classes sharing Wittgensteinian family resemblances, essences, HPC kinds, populations, clades, gene pools, and polyphasic groups, to name only a few.)
- Dupré, J. (2002) 'Is "Natural Kind" a Natural Kind Term?', *The Monist* 85: 29–49. (Argues that even if we consider species as natural kinds, we still need to get clear on what naturalness is and whether or not species qualify as natural since they do not have essential properties. Members of a biological taxa cannot usually be described in any lawlike way, such as all members must possess these particular properties.)
- Ereshefsky, M. (1992) 'Species, Higher Taxa, and the Units of Evolution', in Ereshefsky, M. (ed.) *The Units of Evolution*, Cambridge, MA: MIT Press. (The literature on species is vast but Ereshefsky's chapter and edited collection are good points of entry into the literature. Argues that the assumed distinction between species as being real and higher taxa as unreal is unsuccessful. Both are historical entities, so if there is a difference it is not



because species are individuals and higher taxa are not.)

- Ereshefsky, M. and Reydon, T.A.C. (2015) 'Scientific Kinds: A Critique of HPC Theory and a Proposal for an Alternative Account', *Philosophical Studies* 172: 969–986. (Discusses problems with Boyd's HPC, that it allows theories that are not considered scientific and disallows many that are. An account of natural kinds should track those kinds accepted in science.)
- Griffiths, P.E. (1999) 'Squaring the Circle: Natural Kinds with Historical Essences', in Wilson, R.A. ed. *Species: New Interdisciplinary Essays*, Cambridge, MA: MIT Press, pp. 209–228. (Reconceptualises the notion of essence in terms of its functional role. Rather than restricting essence to a hidden or microstructural property, essence is instead redefined as any property that justifies inductive, explanatory, or lawlike generalisations for a particular theoretical category.)
- Hacking, I. (1992) 'The Self-Vindication of the Laboratory Sciences', in Pickering, A. ed. *Science as Practice and Culture*, Chicago, IL: University of Chicago, pp. 29–64. (Highlights different concepts and activities that shape laboratory activities. Focuses on concepts, like truth, that are relied upon in laboratory sciences and how they have been retained and why and how they have become stable.)
- Hacking, I. (1995) 'The Looping Effects of Human Kinds', in Sperber, D., Premack, D. and Premack, A.J. eds. *Causal Cognition: A Multidisciplinary Debate*, New York: Clarendon Press, pp. 351–394. (Instead of natural kinds, the role of human kinds does a better job at explaining causal processes. Human kinds, such as child abuse, are explained in terms of their looping effects – categories that people can use to define themselves.)
- Hacking, I. (2007) 'Natural Kinds: Rosy Dawn, Scholastic Twilight', *Royal Institute of Philosophy Supplement* 61: 203–239. (Argues the notion of natural kinds has not been as fruitful or useful as proponents promised. Classification in many disciplines provides evidence that natural kinds do not exist.)
- Jacob, F. (1977) 'Evolution and Tinkering', *Science* 19: 1161–1166. (Argues that scientific successes do not always come in the form of revolutionary advances but instead from looking at the same thing from a different vantage point – from partial rather than complete explanations.)
- Kendig, C. (2015) *Natural Kinds and Classification in Scientific Practice*, London: Routledge. (Introduces the notion of 'kinding activities' and argues for why they are important when

considering natural kinds. Contributors discuss kinding practices in use within linguistics, chemistry, neuroscience, comparative biology, sex and gender identity theory, memory research, critical race theory, symbolic algebra, and cartography.)

- Kendig, C. (2020) 'Ontology and Values Anchor Indigenous and Grey Nomenclatures: A Case Study in Lichen Naming Practices among the Sámi, Sherpa, Scots, and Okanagan', *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 84(101340). (Explains why indigenous kinds and institutionalised kinds and the names associated with them are not wholly translatable by examining case studies showing how ecology shapes ontology and differently anchors lichen nomenclatures of the Sámi, Sherpa, Scots, and Okanagan.)
- Kendig, C. and Grey, J. (2021) 'Can the Epistemic Value of Natural Kinds Be Explained Independently of Their Metaphysics?' *British Journal for the Philosophy of Science* 72(2): 359–376. Online first, 31 January 2019 . (Argue it is not possible to evaluate the stability of a cluster of properties as a natural kind without taking stock of the metaphysical picture that is used to account for that stability. People can be wrong about what they think are natural kinds if they rely on inaccurate conceptions on which to justify the groupings they (mis)perceive to be natural.)
- Khalidi, M. (2013) *Natural Categories and Human Kinds*, Cambridge: Cambridge University Press. (Offers an anti-essentialist account of natural kinds by providing evidence in the natural and social sciences, including fluid mechanics and virology, that classification is best conceived of as naturalist rather than essentialist.)
- Kitcher, P. (1984) 'Species', *Philosophy of Science* 51: 308–333. (Advocates for a position of pluralism when discussing the species category. Argues that species are sets and are not individuals as Michael Ghiselin and David Hull argue.)
- Kripke, S.A. (1972) *Naming and Necessity*, Cambridge, MA: Harvard University Press. (Discusses how we use 'gold' as a term that is intended to pick out a sort of thing in the world by a community of speakers. The discovery that gold has atomic number 79 can be understood as an identity that involves a rigid designator and so we can conceive of it as providing an essential property and necessary truth.)
- LaPorte, J. (2004) *Natural Kinds and Conceptual Change*, Cambridge: Cambridge University Press. (Examines how natural kinds and natural kind terms are understood over time and how the meanings of natural kind terms are refined over time. Provides critical accounts

of biological kind terms and chemical kind terms as those referring to the discovery of essences.)

- Lemeire, O. (2021) 'No Purely Epistemic Theory can account for the Naturalness of Kinds', *Synthese* 198: 2907–2925. Online first, 22 May 2018 . (Argues that natural kinds cannot be defined in only epistemic terms and must also include metaphysics in order to justify the use of inductive inferences.)
- Ludwig, D. (2018) 'Letting Go of 'Natural Kind': Toward a Multidimensional Framework of Nonarbitrary Classification', *Philosophy of Science* 85(1): 31–52. (A critical analysis that objects to the retention of natural kinds which uses the case study of ethnobiological classification to highlight its limitations.)
- Magnus, P.D. (2018) 'Taxonomy, Ontology, and Natural Kinds', *Synthese* 195: 1427–1439. (Articulates the difference between the taxonomy question and the category question with regard to natural kinds and argues that many people often confuse the two questions, conflating them into one.)
- Pickering, A. (2005) 'Decentering Sociology: Synthetic Dyes and Social Theory', *Perspectives on Science* 13(3): 352–405. (Discusses the role of tinkering and reciprocal tuning that takes place between science and industry by relying on the discovery of mauve and explaining how the dye industry and technology required for making it was structured by social interactions and vice versa in an history of agency.)
- Plato (1925) 'Phaedrus', *Plato in Twelve Volumes*, Harold N. Fowler (transl.) vol. 9. London: William Heinemann. (Ancient dialogue (370 BCE) between Socrates and Phaedrus. Discusses natural kinds and how these are distinct from other kinds of scattered collections. Natural kinds are the result of 'dividing things again by classes, where the natural joints are, and not trying to break any part, after the manner of a bad carver' (Phaedrus 265e)).
- Putnam, H. (1975) 'The Meaning of "Meaning"', in *Mind, Language, and Reality: Philosophical Papers*, vol. 2, Cambridge: Cambridge University Press, pp. 215–271. (Introduces the reader to the 'Twin Earth' thought experiment in order to show that when we consider the meaning of things, these meanings are not just in our heads. For example, our psychological states do not determine the extension of things like 'water'.)
- Slater, M. (2015) 'Natural Kindness', *British Journal for the Philosophy of Science* 66: 375–411. (Discusses the epistemic role of natural kinds and their stability while remaining

metaphysically agnostic. Outlines what stable property kinds are and why they are important.)

- Wimsatt, W. (2007) *Re-engineering Philosophy for Limited Beings: Piecewise Approximations to Reality*, Cambridge: Harvard University Press. (Presents an empirically informed view of philosophy that highlights the role of methodology, the messiness of the world, and how attention to actual scientific practice is necessary to understand complexity.)
  - Wittgenstein, L. (1973) *Philosophical Investigations* (3rd edn), G.E.M. Anscombe (transl.), New York and London: Pearson. (Argues that meanings and concepts work not because they distinguish between necessary and sufficient conditions for kind membership but instead because they provide patterns of family resemblance. Members do not share all their features with all other members, but they do share some with some.)
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