1 Introduction: Lessons from the Scientific Butchery

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1 Carving Nature at Its Joints

1.1 Tao and the Art of Knife Maintenance

Good chefs know the importance of maintaining sharp knives in the kitchen. What's their secret? A well-worn Taoist allegory offers some advice. The king asks about his butcher's impressive knife-work. "Ordinary butchers," he replies "hack their way through the animal. Thus their knife always needs sharpening. My father taught me the Taoist way. I merely lay the knife by the natural openings and let it find its own way through. Thus it never needs sharpening" (Kahn 1995, vii; see also Watson 2003, 46). Plato famously employed this "carving" metaphor as an analogy for the reality of Forms (*Phaedrus* 265e): like an animal, the world comes to us predivided. Ideally, our best theories will be those which "carve nature at its joints."

While Plato employed this metaphor to convey his view about the reality of Forms, its most common contemporary use involves the success of science—particularly, its success in identifying distinct *kinds* of things. Scientists often report *discovering* new kinds of things—a new species of mammal or a novel kind of fundamental particle, for example—or uncovering more information about already familiar kinds. Moreover, we often notice considerable overlap in different approaches to classification. As Ernst Mayr put it:

> No naturalist would question the reality of the species he may find in his garden, whether it is a catbird, chickadee, robin, or starling. And the same is true for trees or flowering plants. Species at a given locality are almost invariably separated from each other by a distinct gap. Nothing convinced me so fully of the reality of species as the observation . . . that the Stone Age natives in the mountains of New Guinea recognize as species exactly the same entities of nature as a western scientist. (1987, 146)

Such agreement is certainly suggestive. It suggests that taxonomies are *discoveries* rather than mere *inventions*. Couple this with their utility in scientific inference and explanation and we have compelling reason for accepting the objective, independent reality of many different *natural kinds* of things. The members of such kinds would be the meat between the joints along which good theories cut. The goal of this introductory essay is to survey some important contemporary trends and issues regarding natural kinds, filling in the picture with key historical episodes. We conclude with a synopsis of the essays contained in this volume.

1.2 Applying the Metaphor

Not everyone appreciates Plato's metaphor. Some dislike its bloody connotations: perhaps we should refocus on garment-deconstruction and speak instead of "cutting nature at its seams." Others find it difficult to make much sense of the metaphor itself: even if actual butchery, past or present, bears out the Taoist ideal of the knife that never needs sharpening, what sense can we give to "nature's joints"? While there is undoubtedly much agreement about how to classify nature, it is not always clear how to interpret this. As Rosenberg (1987) reminds us, even impressively widespread cross-cultural classificatory prejudice might reflect our shared way of seeing the world—a human prejudice—rather than the reality of the divisions themselves.

Moreover, while agreement is common, so is *disagreement*. For example, the dispute about the proper definition of biological species has persisted long enough to have acquired a name: the *species problem*. This leads many to suggest that there are various acceptable ways of carving up biological reality, none of which is privileged over the others. If this is so, do we lose reason for thinking there are natural kinds, at least at this level of granularity? Though the metaphysical status of species has been a key battleground over questions about natural kinds, many related questions are discussed below and in the following essays. In general, we might want an answer to what Ian Hacking has called a "gentle metaphysical question": "are there natural kinds—real or true kinds found in or made by nature?" (1990, 135).[1]

Broadly speaking, philosophers have pursued two strategies for fleshing out an answer to this last question. First, we may ask after the *metaphysics* of natural kinds. What (to press Plato's metaphor further) is the "skeletal structure" of nature? Joints are gaps: what are they gaps *between*? At first blush, it would seem that natural kinds are defined by similarity (Quine

1969). Things that are perfect duplicates would seem to be paradigm cases of members of a pristine natural kind. But there are several problems with this line of thought. First, the criterion is too loose. Perfect similarity is not sufficient for making the similar objects a natural kind. Imagine a factory stamping out perfect copies of a widget: few would wish to say that these widgets *thereby* form a natural kind. Second, the criterion is too strict. Requiring perfect similarity among instances of a natural kind would leave us without many of the kinds to which we are pretheoretically committed. 'Metal' or 'tiger' each plausibly names a natural kind of thing, yet we do not expect all metals or tigers to be perfect duplicates of one another. What we need, it seems, is a sense in which things can be similar enough to one another in a scientifically relevant way.

This leads us to a second strategy for identifying natural kinds: look toward their use. As we shall see, this strategy can come in either pure or mixed varieties. Let's start with the mixed (we'll purify in the next section), letting the *purposes* to which we put natural kinds inform our approach to their metaphysics. Consider Hempel's observation that

> [t]he vocabulary of science has two basic functions: first, to permit an adequate description of the things and events that are the objects of scientific investigation; second, to permit the establishment of general laws or theories by means of which particular events may be explained and predicted and thus scientifically understood; for to understand a phenomenon scientifically is to show that it occurs in accordance with general laws or theoretical principles. (1965, 139)

In addition to aiding conceptualization and communication, grouping particular things on the basis of shared properties, regularities, dispositions, natural laws, and so forth enables understanding and control. We seek generalizations about what properties things have in common—what they *do*, how they behave. Establishing "general laws" which apply not only to particular objects but to *kinds* of objects allows us to explain and predict. On this model, large swaths of "the vocabulary of science" will necessarily become bound up with general laws. Ernest Nagel noted this connection when he wrote:

> The statement that something is water implicitly asserts that a number of properties (a certain state of aggregation, a certain color, a certain freezing and boiling point, certain affinities for entering into chemical reactions with other kinds of substances, etc.) are uniformly associated with each other. (1961, 31 n.32)

Thus, a more nuanced metaphysical picture of natural kinds emerges: kinds as the extensions of *nomic predicates*—predicates that would appear in statements of natural laws.

Though appealing for a number of reasons, the nomic-predicate approach has its difficulties. First, though there are several competing accounts of natural laws,[2] philosophers seem far from reaching consensus over which is correct. Second, many of these accounts do not apply to rather large swaths of science—even where we suspect that there may be natural kinds. But while few recognize the existence of laws concerning particular species (see Lange 1995, 2004; Mitchell 2000; Woodward 2001), many would like to regard them as natural kinds. Then again, many would *not*. Finding an adequate account of natural kinds is thus complicated by disagreement both over what natural kinds should ideally *do* for us—both in and out of science—and whether categories of things are in fact natural kinds. Before addressing this strategy and its complications in more detail, we shall mention one further confusion encouraged by the phase '*natural* kind'.

1.3 The "Naturalness" of Natural Kinds

Recall that Hacking's gentle question asked whether there were kinds "found in or made by nature." It is not entirely clear how this modifier should be interpreted; nor is it clear that the modifier is appropriate. Granted, it commands some plausibility. As LaPorte notes, adhering to something like it countenances paradigmatic kinds like *tiger*, *elm*, and *water*. "*Toothpaste*, *lawyer*, and *trash*, on the other hand, fail to qualify as natural kinds" (2004, 16). But further reflection reveals that "being found in nature" is implausible as either a necessary or sufficient condition for being a natural kind:

> Not all human-made kinds fail to be natural kinds. Humans have produced minerals, such as quartz and diamond, in the lab. Humans have also produced elements. Technetium is a synthetically produced element that has not been found to occur naturally on Earth. And humans have created new species of plants by inducing polyploidy. Not only are not all natural kinds produced in nature, but not all kinds in nature are natural kinds: Consider *mud*, *dust*, or *shrub*. These are too close to toothpaste and trash kinds to count as natural. Natural kinds are not distinguished by being found in nature. (LaPorte 2004, 18)

To foreclose on a system's objectivity due to "contamination" by human activity in general would be rash, even if certain kinds of human activity tip us off about such obviously nonobjective cases. It seems to be something about the character of those classification systems more than our simple complicity in their formation. Whatever one thinks of the underlying ontology, *systems* of classification are undeniably human artifacts—we are certainly involved in their creation.

More likely, the 'natural' compliment refers to some collage of a kind's being a nonarbitrary, nonsubjective, relatively elite grouping of things that is important to science. However, as we shall explain in more detail in section 4.3, there may be reason to want to free natural kinds from the exclusive dominion of science. Perhaps there are *social kinds* or *ethical kinds* or *metaphysical kinds* that also, somehow, deserve to be called 'natural'. For now, though, let us continue to focus on natural kinds in science and turn to their role in inductive inference.

2 Natural Kinds and Inductive Inference

Quine reintroduced the concept of a natural kind into philosophical discussion as part of an agreeably unified treatment of two paradoxes of confirmation: Hempel's (1945) ravens paradox and Goodman's (1983) "New Riddle of Induction." The ravens paradox can be generated by two plausible claims about confirmation: first, that positive instance of a generalization lends some support to that generalization; and second, that something which confirms a statement also confirms anything that is logically equivalent to it. The first claim is sometimes called "the instantial model" of confirmation. For example, if I'm trying to confirm the hypothesis that all ravens are black, it helps to find an *instance* of that generalization: a black raven. So far so good. Now the statement that all ravens are black is equivalent to the statement that all non-black things are non-ravens. The instantial model says that every instance of a non-black non-raven—a red fire truck, a blue suede shoe, and so on—confirms it. But since this generalization is equivalent to our all ravens are black hypothesis, these miscellaneous things apparently confirm it too, opening the door for "indoor ornithology." That seems wrong.[3]

Goodman's "New Riddle" also infects that plausible instantial model of confirmation. Suppose we define a predicate 'grue' as applying to anything that is either green and observed before now or blue and unobserved. Assuming all observed emeralds have been green, they've all *also* been "grue" and thus on the instantial model support the conclusion that all emeralds are grue. Assuming that some emeralds are as yet unobserved, this entails the conclusion that some emeralds are *blue*.

Quine's solution in both cases was to call upon natural kinds as the extensions of "projectible predicates" to restrict the instantial model. Certain predicates—'raven' and 'emerald' among them—are posited to be distinguished in science by being confirmable by their instances. While 'raven' might name a natural kind, its complement—'non-raven'—does

not. Likewise, 'green' might name a natural kind of color, whereas 'grue' does not. Rather than seeking some metaphysical foundation for projectibility and letting *that* define natural kinds (what we are calling the "mixed approach" above), the present strategy puts all of the emphasis on projectibility and has that direct our approach to the metaphysics of natural kinds.

Quine's move seems productive. There does seem to be something suspiciously "unnatural" and miscellaneous about the grue things and the non-ravens that might interfere with their operating straightforwardly with our confirmatory practices. But as we saw above, it is difficult to say precisely what the compliment 'natural' amounts to. Without an answer to this question, we merely replace one difficult problem with another: identifying which predicates are *projectible*. Hacking puts this point nicely: "'Projectibility' becomes the name of an as yet unanalyzed feature of predicates, namely that they are and can be used inductively. Then the new riddle of induction achieves a succinct formulation, 'Which predicates are projectible?'" (1995, 202). But this just prompts the question again: what is it to be a natural kind? On the other hand, construing natural kinds simply as the extensions of projectible predicates leaves the problem of induction untouched. It looks as though we must choose which bird to pelt with our stone.

Quine toys with the former route, construing natural kinds in a manner Goodman painstakingly avoided: in terms of overall similarity.[4] Ravens are relevantly similar to each other; non-ravens are not. Though in general cautious about kinds and the allied notion of comparative similarity, he believed the latter notion to be ready to hand in chemistry:

> Comparative similarity of the sort that matters for chemistry can be stated outright in chemical terms, that is, in terms of chemical composition. Molecules will be said to match if they contain atoms of the same elements in the same topological combinations. . . . At any rate a lusty chemical similarity concept is assured. (Quine 1969, 135)

Quine saw the objectivity of chemical kinds as secured by their common chemical structure. This is, presumably what makes emeralds, but not non-emeralds, projectible. The italicized qualifier—"of the sort that matters for chemistry"—is important here. Presumably, what matters for chemistry is what matters *for chemists*: the particular reactivity of various chemical stuffs. And clearly, the topological structure of chemical substances' basic components is here of considerable importance. As we shall see below, Quine's thought found fertile ground with Kripke (1980) and Putnam

(1975), who revitalized a form of *essentialism* about natural kinds that can be traced back to Aristotle. Free from Quine's antiessentialist scruples, they developed a modern version of the Lockean distinction between real and nominal essences. Natural kinds, they claim, are indeed individuated by hidden real essences. Unlike Locke, however, they were quite sanguine about our ability to *discover* such essences. For them, this was the bedrock upon which objective taxonomies could be built. In the next section, we trace some of this story.

3 The Question of Essentialism

Let us speak for a moment just about the qualitative features of objects—what philosophers typically call their *properties*. Properties can be possessed in different ways. Ordinarily, that some object has a property *P* is an "accidental" matter—not in the sense of being *regrettable* or a *fluke*, but in that it might well *not* have had that property. For example, while Roger Federer is in fact a tennis player, he might not have been: he could have pursued a different career (and still have been the same person). Federer is also *rational*. But it is far less clear that he could have lacked this quality (while remaining the same person). If this is right, we say that the quality of rationality is *essential* to Federer, whereas that of being a tennis player is merely accidental. In general, the essential properties *E* of an object are those that determine what that object is. In other words, *E* includes those properties upon which the understanding of the object rests. It also includes *some* of the properties on which its existence depends (there may be others, which are non-essential, and on which its existence also depends.) In the Western tradition, the concept of an essential property dates back to Aristotle; it enjoyed much fortune in medieval and early modern philosophy, and is still somewhat in vogue.[5]

3.1 Aristotle on Essences

Setting his tennis prowess aside, Federer is still a unique individual—there is literally no one else who is he.[6] On the other hand, he is many things that other people are as well. For example, he is a professional tennis player: one of the many who compete in tournaments. He is also *a* person: one of the many who inhabit the globe. So we have *one* individual—Federer—who is at the same time *many* things: he is one but he is also many. And thus we have "the problem of the one and the many." To solve this problem is tantamount to giving an explanation of kind-membership (or at least of possessing a property).

Plato tried to make sense of kind-membership by positing a relation of "taking part" or "participation" in a kind or a property (what Plato called "Forms"). For example, Mary and Hannah are both human as they participate in the *form of humanity*—an abstract, ideal, nonconcrete entity. This is how Plato proposed to understand the "jointedness" of nature: nature's joints are defined by the Forms. Yet Plato himself presented formidable objections to this project in the *Parmenides*—some of which seemed more compelling than the view itself. For this reason, perhaps, Aristotle set out to provide a different metaphysics. But as Karl Popper once put it, while Aristotle denied "Plato's peculiar belief that the essence of sensible things can be found in other and more real things . . . [Aristotle] agreed with him in determining the task of pure knowledge as the discovery of the hidden nature or Form or essence of things" (Popper 1950, 34). A pillar of the novel metaphysics was Essentialism, upon which Aristotle elaborates most famously in the *Categories*, the *Metaphysics*, and the *Posterior Analytics*.

In *Categories* 2 and 3, Aristotle draws some distinctions which provide the logical foundation for postulating the existence of essences. First of all, he claims that there are two kinds of predications: *to say of* and *to be in*. If B can be *said of* A, then B's definition can be predicated of A. On the other hand, if B cannot be said of A but it *is in* A, then B's definition cannot be predicated of A. For example, we can *say of* Rubi that he is a dog because whatever defines being a dog also defines Rubi. On the other hand, whiteness *is in* Rubi but cannot be said of Rubi, as he is not defined by whiteness, though of course, something else—for instance, snow—may be defined by whiteness. Although it appears that the focus of the *Categories* is to furnish guidelines for classificatory purposes, the distinction between "saying of" and "being in" is already a hint of the essentialist attitude more explicitly advocated in other works.

From here, Aristotle distinguishes four kinds of entities:

> Of things themselves some are predicable of [i.e., said of] a subject, and are never present in a subject . . . Some things, again, are present in a subject, but are never predicable of [said of] a subject . . . Other things, again, are both predicable of [said of] a subject and present in a subject . . . There is, lastly, a class of things which are neither present in a subject nor predicable of [said of] a subject, such as the individual man or the individual horse. But, to speak more generally, that which is individual and has the character of a unit is never predicable of a subject. (*Categories* 2)

Following the standard scholastic interpretation of the "ontological square," we can devise: (i) *primary substances*, such as Rubi, that can neither

be *said of* nor *be in* other entities; (ii) *secondary substances*, such as dogness, that can be *said of* some other entities but that cannot *be in* other entities; (iii) *universal accidents*, such as whiteness, that can both *be said* and *be in* other entities; (iv) *individual accidents*, such as Rubi's whiteness, that can *be in* other entities but cannot be *said of* other entities.

From this analysis of predication Aristotle draws the conclusion that individuals (what he refers to as "primary substances") are the ultimate constituents of reality because they cannot be predicated, in any way, of other entities. You can say:

(1) Socrates is wise

but you cannot meaningfully say:

(2) Wisdom is Socrates

because Socrates is a kind of entity (i) that cannot be predicated, in any way, of other entities. Essences belong to (ii), while accidents may belong to (iii) or (iv). The distinctions drawn here, however, were meant mostly for classificatory purposes. How did Aristotle justify the postulation of essences in metaphysical terms?

To answer this question we should look into the *Metaphysics*, one of Aristotle's more mature works, especially books VII and XII, where the distinction between form and matter emerges more starkly. Here too he portrays the essence of an individual as that which defines it and without which it could not exist: "For the essence is precisely what something is . . . Therefore, there is an essence only of those things whose formula is a definition" (*Metaphysics* VII, pt. 4). But a new piece is added to the view: essences are now related to forms, "and so Plato was not far wrong when he said that there are as many Forms as there are kinds of natural objects" (*Metaphysics* XII, pt. 3). Yet Aristotle holds that Plato was wrong in claiming that forms *by themselves* are enough: "and so to reduce all things thus to Forms and to eliminate the matter is useless labour; for some things surely are a particular form in a particular matter, or particular things in a particular state" (*Metaphysics* VII, pt. 11). Thus, Aristotle sketches a theory of essences and individuals that will survive until present times.

In the *Posterior Analytics* Aristotle refines his theory of essences in the context of providing a secure path to knowledge. He puts forward a model of scientific explanation known as the Connecting Term Model according to which the fact *A* explains the fact *C* in virtue of another fact—*B*—which connects *A* to *B* and *B* to *C*. Why does eating sugar (*A*) necessarily make you gain weight (*C*)? Because eating sugar (*A*) necessarily increases your

bodily fat (*B*) and increasing your bodily fat (*B*) necessarily makes you gain weight (*C*). Aristotle's view stresses the necessity of the tie between the *explanandum* and the *explanans*, thus bringing what he regarded as decisive evidence in favor of essentialism: "Demonstrative knowledge must rest on necessary basic truths. . . . Now, attributes attaching essentially to their subjects attach necessarily to them. . . . It follows from this that premisses of the demonstrative syllogism must be connexions essential in the sense explained: for all attributes must inhere essentially or else be accidental, and accidental attributes are not necessary to their subjects" (*Posterior Analytics* I.6).

Aristotle's model for scientific explanation had a great impact on the future understanding of scientific method and constituted a knockdown argument against those who took a skeptical attitude toward essentialism: in a way, it proved that if scientific findings increase to any extent our knowledge, then they must do so by means of necessary connections; and said connections require essential attributes if they can be deemed necessary at all.

3.2 Locke on Essences

The tremendous success of Aristotle's metaphysics down the centuries secured the prominence of essences, granting them a chief role in the explanation of kind-membership. Along this path, philosophers' understanding of essences (and philosophical appreciation of their virtues and vices) changed dramatically. We don't have the space here to even survey these changes apart from a modern doctrine of essence whose import is still felt: that of John Locke.

During the early modern period epistemological issues undermined much of the scholastic philosophical tradition—and the Aristotelian doctrine of essences was no exception. Despite its previous success, it was newly on the brink. Even while granting that essential properties play a key metaphysical and conceptual role in delineating nature's joints, the means through which we come to gather information *about* these essences seem obscure. After all, it's by his accidental properties (elegant appearance, calm demeanor, tennis prowess) that Federer is known as an individual. Likewise, it seems that different natural kinds are regularly, though imperfectly, associated with their merely accidental properties. Gold, for example, is ordinarily identified by certain superficial properties: it's the stuff that's a shiny yellow ductile metal for which people will pay dearly. Are any of these properties *essential* to gold? Just how, in general, should we tell the difference between accidental, superficial properties and those

which are *essential* to their bearers? How do we distinguish between what merely happens to be so and what *must* be so?

Locke took these questions seriously and advanced a novel proposal. First of all, he defined a quality of a subject as "the power to produce any idea in our mind" (*Essay* II.8.8). Next, he distinguished between *primary* and *secondary qualities*: the former being "utterly inseparable from the body, in what state soever it be" (II.8.9), the latter being the powers of the objects "to produce various sensations in us by their primary qualities" (II.8.10). Intuitively, the superficial properties of gold are its secondary qualities—the way it looks to us when we first encounter it in everyday experience. The primary qualities, on the other hand, are those which remain hidden to our senses but which specialized reasoning might reveal. Locke listed "solidity, extension, figure, and mobility" (II.8.10); we might now list a certain atomic structure, a typical charge or specific weight, and so on. Locke also considered a third category of qualities, bare powers—powers of objects to modify other nonmental objects, such as the power of a key to open a lock. But we shall focus on the first two categories.

Locke's division among qualities of objects took its impetus from epistemic considerations. By definition, a quality is that which produces an idea in the mind. A champion of empiricism, he believed that if you cannot reliably come to know something through experience, you cannot say that it exists. This allowed him a fresh start also with respect to scientific essentialism, the stronghold of Aristotelian essentialism. Locke distinguished between a substance's *nominal* essence—"The measure and boundary of each sort or species, whereby it is constituted that particular sort, and distinguished from others, is that we call its essence, which is nothing but that abstract idea to which the name is annexed" (*Essay*, III.6.2)—and its *real* essence—"that real constitution of anything, which is the foundation of all those properties that are combined in, and are constantly found to co-exist with the nominal essence" (III.6.6). He then argued that our *ideas* of substances associate only with their nominal essences: "take but away the abstract ideas by which we sort individuals, and rank them under common names, and then the thought of anything essential to any of them instantly vanishes" (III.6.4). Precisely for this reason, he himself seemed ambivalent about our ability to fully grasp real essences. After all, our *ideas* of substances associate only with their nominal essences since we lack "microscopical eyes" to see real essences. Thus with Locke a new form of essentialism came into the picture, one which sees essences as abstract ideas that are applied to individuals—that is, a view which sees essences as *sorts* of things. As we shall see, we can identify a

parallel distinction between a sortal understanding of essences and an Aristotelian one in contemporary philosophers' treatments of these matters.

Almost a century after Locke published his *Essay*, David Hume's empiricism began to determine the philosophical fate of essentialism in England (and much of continental Europe) over the next two centuries. The cultural environment in which early twentieth-century philosophers of science wrote, steeped in post-Humean empiricism, had little truck with such seemingly occult notions as essence. The only sort of necessity worth having was a purely linguistic matter. It is relative to this trajectory that we can appreciate how dramatic was the revival of essentialism in the second half of the twentieth century. Two quite distinct branches can be identified in this revival: on the one hand we have the sortal tradition (sec. 3.3), and on the other the Kripkean–Putnamian one (sec. 3.4).

3.3 A Metaphysical Rebirth of Essentialism

The intuition that nature can be carved up into different *sorts* of things and that each thing is something of some *sort* lies at the basis of a widespread, metaphysically motivated revival of essences. Still revered by many, this *sortal* tradition, which flourished primarily in England, engrained a Lockean approach to essential properties and the close analysis of natural language.[7] But the underlying doctrine is less homogeneous than it might first appear. Indeed, even if many defended a theory of *sortals*, few agreed on the meaning of that term. Following Feldman (1973), we can distinguish three necessary requirements that a predicate *P* has to satisfy to be a *sortal*:[8]

i. A predicate *P* is a sortal only if *P* singles out an individual.
ii. A predicate *P* is a sortal only if *P* is the partial or whole essence of the individual it singles out.
iii. A predicate *P* is a sortal only if, when *P* applies to an individual *x*, *P* cannot belong to any proper part *y* of *x*.

Arguably, (i), (ii), and (iii) serve different metaphysical purposes, yet there is no agreement between sortal theorists as to which of them a *sortal* should satisfy.[9] At any rate, we may leave this issue to one side, as the sortal tradition had a considerably smaller impact on the debate over natural kinds than did the tradition initiated by Saul Kripke and Hilary Putnam, to which we now turn.

3.4 A Scientific Rebirth of Essentialism

In the 1970s, Kripke (1972, 1980) and Putnam (1975) independently defended the existence of essences—via rather different considerations. At

that time, Kripke was trying to offer a theory of reference which would account for, among other things, the way in which natural-kind terms function. His theory revamped the idea that the identity of an individual is necessary, that it is fixed in every possible scenario. Essences offered a handy explanation of this: the identity of an individual is fixed because it has some essential properties. As we have seen, however, at this point we face the epistemic challenges that confronted Locke.

Here lies Kripke's main innovation. He conjectured that essential properties are directly linked to our linguistic practices (such as naming) and our scientific concepts (such as genetic identity). Whereas previous theories of reference had it that names referred to individuals by way of descriptions, Kripke argued instead that a name reaches its bearer *directly* and continues to refer even if the properties we *in fact* use to identify it are missing. The name 'Federer' does not merely refer to that calm, elegant, person of Swiss origin who has won a certain number of tennis tournaments, but to *that guy*. The idea is that there is something *essential* about Federer since the first time we called him that name—perhaps something about his genetic makeup or origins (having the parents he did). Kripke moved to extend this plausible idea about proper names to natural-kind terms. When we first referred to 'water', say, we refer not to whatever satisfies certain characteristic properties (being clear, potable, liquid at standard temperature and pressure, and so on), but to *that stuff*. And when scientists discovered that that stuff was H_2O, they discovered *the essence* of water. Kripke produced an elegant proof that all identities were *necessary identities*.

Putnam's considerations on essences also proceeded from semantic considerations. Specifically, they grew out of the attempt to furnish a broader theory of meaning. In a deeply influential paper, "The Meaning of 'Meaning'" (1975), he distinguishes between two types of content: *narrow* and *wide*. Narrow content reflects the psychological state of an individual in isolation, whereas wide content includes content which is not part of that individual's thoughts but is nevertheless entailed by them. The existence of wide content suggests the existence of essential features of reality. For if the meaning of what we say about certain natural kinds (water, for example) is fixed in part by the *essence* of that kind, then we have good reason for accepting the existence of essences. Suppose we talk about this glass of water: its identity is not just fixed by the perceptual experience that you are having or what qualities you generally associate with water, but also by the very *essence* that the stuff we call "water." What is that essence? Well, one very plausible answer is that it is the properties which

explain the co-occurrence of those superficial, "nominal" properties, whose essence is presumably (partially) captured by the molecular formula H_2O.

After Kripke and Putnam's contributions, the discussion of essential properties within the philosophy of science got a fresh start. They were able to bring back this notion in a way that was *prima facie* immune from the suspicion surrounding much of the ancient, Scholastic, and modern usages of it. Whether this is so is still a matter of much debate.

Let us consider one further twist in the story of essentialism about natural kinds. Plausibly, the role they play in scientific endeavors turns on their association with lawlike behaviors: we see the names of natural kinds habitually turn up in statements about natural laws. One might deny that this is coincidental and simply claim that kinds are law-involving, or *nomic*, predicates. But then the questions become: *What is it to be a nomic predicate? What are laws in general and what explains their apparent generality and necessity?*

Scientific essentialism attempts to answer this second question. The label first appeared in "The Philosophical Limits of Scientific Essentialism" (1987), by George Bealer. In that article, Bealer criticized Kripke-style essentialists, according to whom essential properties can be discovered *a posteriori*. Despite Bealer's aims, a number of influential authors embraced scientific essentialism and refined its metaphysical underpinnings (Bigelow, Ellis and Lierse 1992; Ellis and Lierse 1994; Ellis 2001; Bird 2007). In its present form, scientific essentialism is a hardcore metaphysical view, according to which kinds exhibit lawlike behaviors as manifestations of the *dispositions* which define them. Dispositions, roughly speaking, are abilities to act in one way or another given certain circumstances. On this view, laws of nature are *immanent* to the entities possessing certain dispositions. Although Kripke and Putnam never ventured into these sorts of metaphysical speculations, the gist of scientific essentialism owes a great deal to their revival of essentialism and to Kripke's suggestion that the essences of natural kinds may be discovered *a posteriori*.

By construing laws as manifestations of the essential dispositional natures of different natural kinds of things, scientific essentialists effectively solve two problems about laws of nature and their relation to natural kinds. First, the vague intuition that natural kinds were somehow implicated in natural laws becomes precise and understandable. Second, by making the laws expressions of the *essential* nature of different kinds, scientific essentialists dispense with one of the most difficult problems in giving an account of natural laws: making sense of their apparently "intermediate" strength of necessity.[10] Essentialists thus hold that not only are

the laws somehow more robust than accidental generalizations, but that they *had* to be just the way they are.

4 Applications

4.1 Physico-Chemical Kinds

Chemical kinds have long been a favorite example of essentialists. For as both Quine and Putnam noted, it seems quite plausible that the sort of similarity that would matter for this domain would be molecular structure: the arrangement of certain kinds of atoms. Putnam claims that the essence of water—what it is to *be* water—is to have the molecular structure denoted by 'H_2O'. The superficial properties we *associate* with water—for example, its being a good solvent for certain types of compounds—are explained by its structure. More specifically, the structure *plus* the character of its constituent atoms gives rise to these properties.

How then should we understand what divides *atoms* into different kinds? An analogous story seems likely: the arrangements of subatomic particles (viz., protons, neutrons, and electrons) explains why oxygen covets electrons and why hydrogen is comparatively willing to give them up. But then we need a story about the character of these subatomic constituents. What explains why protons have the charge and mass that they do? According to the Standard Model of particle physics, the answer lies in its composition of quarks and *their* dispositions. Thus, we have a recursive picture of the identity of physico-chemical kinds. The identity of a kind at a certain level of compositional complexity is fixed by arrangements of things at a lower level of complexity. One might wonder at this point whether it is, so to say, "turtles all the way down" or whether complexity bottoms out. Contemporary physics seems to support the latter view. It treats certain kinds (such as quarks and electrons) as *fundamental* in that they apparently lack structure. They are part of the bottom level of physical complexity and thus kinds whose essence can no longer be understood structurally. On the other hand, the very use of the word 'atom' (meaning "something that is partless") for one of these intermediate levels suggests that we ought be cautious about identifying a particular level as fundamental!

While the foregoing sketch may look quite plausible and unproblematic, there are deep and persistent issues involved. We have not discussed *how* reference to physical or chemical kinds is achieved. Is it, as Kripke and Putnam suggest, a *direct* matter? Reference aside, we might also wonder whether the proffered essences are plausible. Take any glass of water: it is filled with many things that are not composed of H_2O. In addition to

various isotopic forms of water (various "heavy waters," for instance), there are doubtless other impurities (e.g., minerals, trace elements, dissolved gasses, even microorganisms). The same could be said for the sample initially "baptized" as water. What makes it the case that this initial dubbing fixed on the H_2O sameness relation?[11]

4.2 Biological Kinds

Such worries notwithstanding, the essentialist view of natural kinds has seemed compelling enough to extend to higher levels of organization. Hopes initially turned toward extending kindred notions of structure to the biological realm: perhaps tigers have a certain genetic structure which alone makes them tigers. We cannot "define" tigers as, say, *fierce striped feline quadrupeds* because some tigers lack these qualifications (Kripke 1980, 119–120). Just as water behaves differently in different conditions, tigers get maimed or adapt certain behavioral patterns in different environments. Tigers are not easily *genetically* maimed, though, and their genetic structure is causally upstream from their stripes and fierceness. Insofar as genetic structure remains stable—serving as an explanation for our habitual association of a certain nominal essence with tigers—it seems an admirable candidate for the office of "real essence of tiger." As Robert Wilson characterizes this view: "species essence is not constituted by [observable] morphological properties themselves, but by the genetic properties—such as having particular sequences of DNA in the genome—that are causally responsible for the morphological properties" (1999, 190).[12]

But again, while initially tempting, this view faces several objections. First, even if we are impressed by the structural account of physicochemical kinds, we should bear in mind that "genetic structure" and "molecular structure" do not play the same causal role. An organism's genetic structure does not determine its superficial properties in nearly as direct a way as molecular structure does the superficial properties of homogeneous chemical kinds (see Lewontin 2000 for a nice discussion of this point). Second, the fact of evolution and the considerable diversity of species raises the question of whether there even *is* a genetic essence that all and only the members of a particular species share (see Devitt 2008; Okasha 2002; Walsh 2006; Wilson 1999). And third, many philosophers of biology (e.g., Dupré 1981; Kitcher 1984; Mishler and Donohue 1982) have concluded that we ought be *pluralists* about biological classification (at least at the rank of species). How might this affect a conviction that species divisions carve nature at its joints?

There is much to say in response to these worries (and there are others besides), and the philosophical community remains largely divided. Some suggest that we can reconfigure our understanding of natural-kinds essentialism in light of the majority view in systematics to accommodate "historical essences" (Griffiths 1999; LaPorte 2004; Okasha 2002). What makes a tiger the kind of thing it is is not some intrinsic genetic property, but a historical property concerning its origin—its location on the tree of life, say. Others take the common practice of treating species historically as suggesting a radically different metaphysical approach to species. Rather than treat species as *kinds*, perhaps we should understand them as *individuals*—spatiotemporally extended objects, "hunks of the genealogical nexus"—perhaps as a way of resisting pluralism about species or rendering it a purely pragmatic issue (Ghiselin 1974; Hull 1978). Others may be content to simply abandon the attempt to extend Plato's metaphor of natural joints to the biological realm. Hacking's "gentle metaphysical question" is general: it can receive a positive answer without natural kinds being particularly common in science. One could conceivably be pushed all the way back to construing only the fundamental physical particles as natural kinds.

Yet this smacks of parochialism. As Dupré remarks, biology "is surely the science that addresses much of what is of greatest concern to us biological beings, and if it cannot serve as a paradigm for science, then science is a far less interesting undertaking than is generally supposed" (1993, 1). Whether or not one agrees with Dupré's assessment, it seems plausible that many biological categories do play an inferential and explanatory role commonly associated with natural kinds. This puts pressure on the traditional essentialist view of natural kinds.

A number of philosophers have been pursuing a suggestion of Richard Boyd's (1991, 1999): that there may be a class of phenomena accurately described as "homeostatic property clusters."[13] This apparently non-essentialist understanding of natural kinds appears better able to make sense of biological diversity. Roughly speaking, Boyd eschews essential properties which "hold together" and explain the co-occurrence of the various superficial properties associated with a kind, suggesting instead that a cluster of properties might secure *its own* stability, constituting a sort of homeostatic mechanism. Insofar as such homeostatic property cluster (HPC) kinds accommodate our inductive and explanatory practices, we are within our rights to regard them as *real* (see Neil Williams' essay below for further discussion).

4.3 All Kinds of Kinds

Thus far, we have restricted our scope to scientific kinds—and a rather limited swath there. Might our concepts also carve nature at *other* joints? In addition to natural kinds of *things*—particles, organisms, and so on—might there be natural kinds of events, processes, forces, laws, states of affairs, and so on? Even within the biological sciences, we see quite a diversity of classificatory concepts being employed. Biologists (both implicitly and explicitly) draw upon a rich stock of biological categories (e.g., "predator," "decomposer," "muscle tissue," "afferent neuron," "neurodegenerative disease") in deepening our knowledge of the organic world.

And what about kinds outside of the natural sciences—for example, from the social sciences and beyond? There seems to be no a priori reason to exclude these farther-flung applications. For even nonscientific kinds often seem to come with particular dispositional behaviors which are entrenched in different kinds of relations. In the social sciences, we might wonder whether there are genuinely different *kinds* of people, societies, economic systems, and so on. There is currently a vigorous debate in the philosophy of science concerning the status of racial divisions: do race terms name natural kinds of people (Andreasen 1998; Kitcher 1999; Zack 2002; Pigliucci and Kaplan 2003; Hacking 2005; Glasgow 2009)?

Psychology offers a particularly rich set of examples. Griffiths (1997) has explored the question about whether emotions and other psychological states might be natural kinds. Boyd (1999, 155) even flirts with the notion that the categories "feudal economy" and "capitalist economy" might name natural kinds, finding no difficulties in principle with construing unabashedly human creations as nevertheless *natural* in the relevant sense.

What about other conventional-seeming categories? At some point, we may wish to distinguish between *natural* and *social* kinds. Consider a citizen *versus* an illegal alien, a sole proprietorship *versus* a limited liability company, a not-for-profit organization *versus* a for-profit business. These are examples of classifications that can play key roles in a society, and their roles are governed not by *natural laws* but by laws in the more familiar and mundane sense—each is associated with different rights, duties, and privileges. But there are examples that might be less clearly identified as "natural" or "social." Consider, for example, the kinds that you find in front of you every day on supermarket shelves or on your plate—*food kinds*. A chicken can be *free range*, an egg *certified organic*. Although it may be disputed that vernacular expressions are able to pick out natural kinds (Dupré 1993, 26ff.), nonetheless they pick out kinds that are important for practical purposes.

Returning to the philosophical terrain, those key *formal relations*—such as identity, parthood, membership (in a set), spatiotemporal location—can be regarded as kinds within the metaphysical realm (Sider 2009). Might there even be natural kinds of *absences*? On the other hand, consider the role of kinds in ethics (Boyd 1988): moral realists may wish to say that wrong actions comprise a natural kind (or even a hierarchically nested series of natural kinds).

We humans love to draw lines around different portions of the world, so there should be no shortage of fascinating possibilities to consider when we ask whether we are, in so doing, carving nature at its joints.

5 The Essays

So much by way of introduction. Hopefully you are eager to read the fine essays you have before you.

As we saw above, one of the central roles philosophers have attributed to natural kinds is that they serve as the metaphysical basis for inductive inference. Only predicates in whose extensions stands a natural kind are "projectible"—a theme sounded in different ways by Quine and Goodman. Godfrey-Smith, in "Induction, Samples, and Kinds" (chap. 2) challenges this orthodoxy by suggesting that there are in fact two varieties of inductive inference that have been run together. In only one of these varieties does the "naturalness" of kinds play any significant role: at stake in these inferences are generally dependence relations linking properties. As such, the number of samples is, in principle, irrelevant to the strength of the inference. If we can establish the dependence relation by examining only one positive instance, we can get the generalization in all of its glory. But there is another strategy of inference in which the strength of the inference to a generalization depends on the quality of our sampling: in particular, that it is broad and random. Here apparently pathological cases, like Goodman's "grue," can be explained away in familiar terms as certain kinds of "observation selection effects." Godfrey-Smith argues that distinguishing these two inductive strategies can go a long way toward relieving some longstanding philosophical (perhaps innate!) confusions about induction.

Marc Lange turns his sights on the growing support for scientific essentialism in his essay, "It Takes More Than All Kinds to Make a World" (chap. 3). As we pointed out above, elementary physical particles appear to be admirable candidates for natural kinds, if anything is. Assuming something like the Standard Model is correct, they are intrinsic duplicates defined by

a small collection of properties (such as charge and spin). But, Lange points out, if there is something to the modern physical practice of recognizing different "tiers" of natural laws—if, for example, there are symmetry principles that abstract away from particular laws like Coulomb's law—we need to make sense of certain "counterlegals," that is, counterfactuals involving breaks of laws. Scientific essentialists contend that the essence of charged particles such as electrons give rise to Coulomb's law. But how can the essentialist make sense of counterlegals such as 'Had Coulomb's law failed to be true, the fundamental dynamical laws would still have held'? What essence could possibly account for this subjunctive fact? This is the sense in which it takes more than all of the *actual* kinds in order to make a world complete with laws. The scientific essentialist would need far more.

Along the way, Lange elaborates a view on the relation between laws and subjunctives that he defended in *Natural Laws in Scientific Practice* (2000) and more recently in *Laws and Lawmakers* (2009), and discusses the vexed question of what makes some properties "natural," offering the very interesting suggestion that it might be that a property could be natural in one possible world and unnatural in another.

In "Lange and Laws, Kinds, and Counterfactuals" (chap. 4), Alexander Bird questions one of the key contentions in Lange's essay: that if there had been kinds of particles other than the actual kinds, the force laws (and laws connecting fundamental and derivative properties) would still have held. One reason for not accepting this, suggests Bird, is that we don't yet know *what* the fundamental laws are. Perhaps whatever these turn out to be are not as independent from the existence of certain kinds of particles as we are tempted to suppose. Moreover, in at least *some* cases, we find interesting connections between the existence of certain kinds and fundamental laws. For example, the non-existence of certain conceivable particles (e.g., Helium-2) seems to be governed by fundamental forces (e.g., the strong force). As Bird explains, a natural way of resisting his skepticism involves forbidding "backtracking" reasoning about counterfactuals. But this plausibly both undermines the inference from the claim about the independence of laws and fundamental kinds to other results claimed by Lange and leads to some odd consequences (e.g., that the first event—the Big Bang, possibly—would have a kind of physical necessity). More generally, Bird suggests that the idea of a hierarchy of laws formed by Lange's proposal about laws is not quite as secure or important as Lange thinks. This debate will no doubt continue.

As we mentioned above, one way of thinking about the dispute between those who see laws as necessary and those who believe them to be

contingent involves investigating their connection with kinds or properties. Noa Latham pursues the thread in his paper, "Are Fundamental Laws Necessary or Contingent?" (chap. 5), arguing against the grain that there is in fact no significant distinction between necessitarian views of laws (espoused by the scientific essentialists) and contingentist views (those like Lange who deny that laws are metaphysically necessary). These views are best understood as notational variants of a single view. Latham's argument turns on claims about the metaphysics of property-individuation—for one, that it makes no sense to think about stripping away all of the nomological features of a property, leaving a sort of contingent shell. But from this extreme contingentist view about property-identity, there is much leeway—and possibly no fact of the matter—about how much we should pack into our concept of properties. There might still be reasons for locating oneself at one end of the spectrum (e.g., the necessitarians do not face the difficult problem of multiplying senses of necessity; contingentists have a more linguistically natural view), but Latham claims that these reasons fall short of the kind of metaphysical strength that their proponents have in mind.

Shifting gears somewhat, Roy Sorensen's essay, "Para-Natural Kinds" (chap. 6), flirts with rejecting the prevalent view that only *substances* can be natural kinds. What about absences (gaps in an electron shell, craters in the moon)? What about shadows? On reflection, even these "nothings" evince classificatory possibility. Sorensen calls them *para-natural kinds*: absences *defined* by natural kinds. It's not surprising that we might have been tempted to treat certain absences as natural kinds, for like reflections they take on many of the hallmark features—lawfulness, projectibility, and so on—possessed by the natural kinds which define them. Such features allay general worries about the "subjectivity" of absences. The absence of a chapter in this volume on what kind of doughnut Plato would prefer is a subjective absence salient only to those who might have expected one. In contrast, Sorensen contends that para-natural kinds are mind-independent.

The road to essential properties passes through the individuation of their bearers: if something has an essence, then it is *something*. In his essay, "Boundaries, Conventions, and Realism" (chap. 7), Achille Varzi questions the existence of boundaries between individuals and events of all sorts, thereby disputing the existence of essences' bearers. His argument moves from the distinction between *artificial* and *natural* boundaries (also labeled *fiat* and *bona fide*, respectively). When we uncover a *natural* boundary (one that is *not* merely fiat), we thereby have a reason to believe that we are in

the presence of a genuine individual (or event). On the other hand, when confronted with artificial boundaries, the suspicion of being in the presence of a genuinely artificial individual (or event) surfaces. In his essay, Varzi surmises that all boundaries are artificial, and he substantiates such a thesis by surveying a host of examples—from geography to geopolitics to biotechnology. From this it follows that every individual (or event) is, to some extent, artificial; but from this it does not also follow that anything goes. He concludes by reassuring us that artificial boundaries are, in the end, all that we need "to solve, in an arbitrary but efficient way, coordination problems" of all sorts, and that such a stance is compatible with rigorous metaphysics, such as those advanced by Putnam or Goodman.

But suppose that one were to resist Varzi's challenge in the name of some form of "realism" about natural kinds and essences; what does it take—Michael Devitt wonders in his essay "Natural Kinds and Biological Realisms" (chap. 8)—to be such a realist? Moving from the species problem as a case study, Devitt defines realism as that view according to which certain entities play a role that is causally significant *because* of the kind of thing they are (i.e., things that "cut nature at its joints"). This understanding of realism should, however, be kept distinct from two other notions: one according to which realism is committed to the mind-independent existence of certain entities; and another according to which realism is committed to the existence of universals. Devitt thus shows that we ought to keep separate issues about the realism of certain *taxa* (i.e., the groups of organisms themselves) from issues about the realism of *categories* (a second-level issue). This sets the stage for considering recent debates over Mark Ereshefsky's (1998) "pluralistic anti-realism" and the "pluralistic realism" of philosophers like Philip Kitcher (1984) and John Dupré (1993). Devitt argues that the clash between these views is merely apparent: at stake is not the mind-independent existence of species, but rather whether species categories have a sufficiently robust *explanatory significance* compared to other scientific kinds. Devitt's suggestion is that the plausibility of the pluralist position with respect to the species problem is evidence of their minor explanatory role. He concludes by arguing that higher taxa play an even more modest explanatory role and, thus, that the Linnaean hierarchy should be dispensed with.

We noted above the controversy about biological essentialism. In his essay, "Three Ways of Resisting Essentialism about Natural Kinds" (chap. 9), Bence Nanay argues that contemporary biological practice decisively legislates against it. He notes first that essentialism about biological kinds involves three central tenets: that all and only members of a certain

kind possess a common essence, that such *real* essences give rise to the *nominal* essences of a kind, and that essences facilitate our inferential practices by causing the co-occurrence of the various superficial properties associated with the kind. The first tenet seems to commit the essentialist to the existence of property-*types*. Thus one could resist it by adopting nominalism about properties. This way of arguing, as Nanay remarks, needn't carry much weight—especially if it is motivated by controversial metaphysical rather than biological commitments. Instead, he argues that we should see Ernst Mayr's influential (now nearly ubiquitous) idea of the biological realm being best described by "population thinking" as pushing us toward nominalism about property-types. This move puts Nanay in position to block the second and third tenets of kind-essentialism as well: property-types play no causal role in evolution; they are statistical abstractions. As such, they cannot explain or facilitate anything—contra the second and third tenets.

Taking the prize for best title, Neil Williams's essay "Arthritis and Nature's Joints" (chap. 10) attempts to throw another log on essentialism's funeral pyre. Many diseases, he argues, seem poorly accommodated by essentialism. Rheumatoid arthritis, for example, is presently defined in an exclusively clinical way (as presenting with four of seven diagnostic features). Now while it might turn out that these symptoms possess a common cause, it seems a bit implausible to claim that if they are *not* we should be forced to relinquish our practice of construing arthritis as a single disease kind. Williams draws upon the resources of Boyd's homeostatic property cluster account of kinds in order to make sense of disease kinds. In many ways, diseases seem an ideal test-case for the HPC account. Williams essay thus contributes both to our understanding of disease classification and an apparently flexible approach to natural kinds.

Species *taxa* play a key role in predicting how populations evolve. The methods employed to carry out such predictions, however, are not free from theory-laden assumptions. In his essay, "Predicting Populations by Modeling Individuals" (chap. 11), Bruce Glymour addresses the so-called "dynamic" and "statistical" interpretations of evolutionary theory, showing that they mistakenly take their outcomes to model populations while they are in fact modeling individuals. Glymour argues that the central concept at stake in predicting populations is selection. This is measured by monitoring either selection differentials or selection gradients, where the former is understood as the difference in fitness among classes of individuals. When considering this method, the way 'fitness' is defined assumes a central role; the model of selection is, in this case, a population genetic

model. The latter is a more complex notion, tracing the probability that a certain trait has of causing modifications in phenotypic or genotypic traits—selection gradients are defined at the individual level and they do not depend on fitness. When adopting this method, the model of selection will be tailored to specific populations, monitoring the causes of survival and reproductive success for its individuals. Glymour argues that the method of following selection gradients has epistemic advantages over methods based on selection differentials, as the former can more easily account for differences at a higher level (populations) in terms of differences at the lower level (individuals).

Another essay in the volume regarding the species problem, Jason Rheins's "Similarity and Species Concepts" (chap. 12), focuses on the role the similarity relation plays in sorting out species. Rheins's argument starts with a characterization of the similarity relation: since it is always relative to a *respect* or *parameter*, similarity is a more ductile theoretical tool than sameness. Rheins then introduces the metaphysical distinction between *immoderate* and *moderate* realism. The first envisages that any universal trait is existentially *independent* of the existence of any individual. On this view, universals may be said to exist as unrepeatable entities, which are numerically one and the same. The other form of realism, by contrast, sees universals as existing immanently in individuals. A universal cannot exist independently of the existence of some individual which instantiates it. And when the same universal is found in more than one individual it is because we have a repetition of instances. After introducing realist versions for three of species concepts—biological, ecological, and evolutionary—Rheins argues that the similarity relation is more suitable than simple qualitative sameness in accommodating such views. Indeed, according to Rheins, the fact that species are divided by a similarity relation does not entail that they are not real. Species concepts based on similarity are consistent with moderate realism based on an objective type of qualitative similarity, whose specifics vary from case to case and provide us with a satisfactory explanatory and predictive power.

The effects of the way organisms are classified into species are felt not only in biological circles but—most remarkably—in ethics as well. In their essay, "Species Concepts and Natural Goodness" (chap. 13), Judith Crane and Ronald Sandler discuss Philippa Foot's account of natural goodness, according to which an organism's worth is based on the potential it has for flourishing in ways that are proper for members of its species. Endorsing a pluralist conception of species, Crane and Sandler explore how well Foot's account sits with our biological findings and their most direct

philosophical consequences. After introducing the various species concepts that have been advanced by biologists and philosophers of science, the authors argue that Foot's account rests on what they label the axiological species concept (ASC). Central to this is the idea of "life form"—clearly reminiscent of Aristotelian doctrines and often regarded as synonymous with "species"—which expresses those traits that are distinctive of the way in which members of a given species live. Although ASC is ultimately deemed a viable species concept, Crane and Sandler argue that its endorsement needs to be backed up by normative commitments that are foreign to biology, such as those coming from ethology, from the thesis that vice and virtue involve emotions and desires (beyond physiological phenomena), or from the conviction that ethical norms may apply across (very) different environments and cultures. Thus, a natural goodness approach cannot be justified only on the basis of biological findings, but rather calls for some meta-ethical and normative commitments that are independent of them.

The volume concludes with an essay by Kadri Vihvelin, "How to Think About the Free Will/Determinism Debate" (chap. 14), which considers a lurking issue in the natural kinds business. Suppose that we sharpen our conceptual cutlery so much that we attain an accurate knowledge of *all* the joints of reality and, hence, of the laws governing them. Regardless of whether such laws are probabilistic, we might then be in a position to predict, for any instant of the world, what the next future instant can be like, in a way which is independent of the agents' deliberations. This is a way of capturing the idea that nature might unfold *deterministically*. On the other hand, the way in which we represent (most of) our actions assumes that, for any of those actions, there is a metaphysical possibility of choosing whether or not *to do it*—in these cases we represent ourselves as *free agents*. But if determinism is true, this representation is false. A certain variety of natural kinds realism thus seems to clash with the idea that we are free agents. According to Vihvelin, the problem of free will versus determinism is indeed the problem of explaining whether this apparent conflict is genuine. In her essay, she first discards a number of misguided ways in which free will and determinism have been conceived. According to her, the problem of free will versus determinism stems from two obvious facts: first, that determinism *prima facie* denies that natural kinds realism and freedom of the will are compatible; and second, that indeterminism *prima facie* leaves room for the two being compatible. Vihvelin's proposal reconciles these facts. In her view, determinism is compatible with free will, as freedom does not rest on an agent's actually

doing something, but on her ability to so act. In other words, we are free any time we are counterfactually *able* to do otherwise, even if we do not exercise such an ability.

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Notes

1. Hacking calls this question "gentle" to differentiate it from a sterner one: "can natural kinds be characterized by essential properties? The gentle question is about what there is, the stern one, about what must be" (1990, 135).

2. There are, among others, nomic-necessitation approaches commonly associated with the work of Dretske (1977), Tooley (1977), and Armstrong (1983), best-systems approaches associated with Ramsey (1978) and Lewis (1973), primitivist approaches (Carroll 1994; Maudlin 2007), subjunctive approaches (Lange 2000), essentialist approaches (Bird 2007; Ellis 2001), and eliminativist approaches (Cartwright 1980, 1999; Giere 1999; van Fraassen 1989).

3. Hempel was quick to point out that it merely *seemed* wrong: for the statement that all ravens are black is, in a sense, a statement not just about ravens, but about the entire universe.

4. He rejected the thought that natural kinds would serve any permanent role in scientific investigation for precisely this reason, being somewhat cautious of a theory-neutral notion of overall similarity—but that's another story.

5. It should be noted that "essence" acquires a very different meaning in other philosophical contexts, most notably: in Hegel's philosophy, where it stands for the deeper structure of reality, in contraposition with the superficial "phenomena"; in Husserl's phenomenology, in which essences are the content of eidetic intuitions; and in the Existentialist tradition, where it is bestowed a negative connotation in opposition to "existence." We shall, however, leave these uses of the term aside as they are not relevant to the philosophical context here under consideration.

6. Even an identical twin or a doppelgänger would not *be him*.

7. It includes among its advocates well-known philosophers such as David Wiggins, Michael Dummett, John Wallace, and Robert Ackermann.

8. Because they are unnecessary for present purposes, we will ignore here some of the distinctions between kinds of sortals, such as the distinction between "phase" and "proper" sortals. The first is predicated of a phase of an entity—for example,

"child" is predicated of a phase of a human being's life, namely their childhood. The latter is predicated of the entire life of an entity—for example, "person" is predicated of a human being for his entire life.

9. Thus, Wiggins (1979, 1986) seems to defend (i), Brody (1980) defends (ii), and John Wallace (1965), Robert Ackermann (1969), and Jonathan Lowe (1998) defend (iii)—a view that Wallace attributes to Frege.

10. Natural laws are not *logically* necessary: there is no contradiction or incoherence in imagining that, say, the law of universal gravitation is false. And yet, it seems clear that laws are somehow "more necessary" than mundane, accidental facts (e.g., that all the coins in my pocket are made of copper). See Lange 2009 for an accessible and insightful discussion into this issue.

11. Abbott (1997), LaPorte (1998), and Brown (1998) discuss the impurity problem. For critical discussion of Putnam's views of natural-kind term reference, see Zemach 1976; Mellor 1977; Devitt and Sterelny 1987; LaPorte 1996; and Stanford and Kitcher 2000.

12. Kitcher also provides an illustration of the pull of genetic essences. "Structural explanation" often involves investigation into the genetic basis of morphological features—for example, viral protein sheaths. "We learn that the features that originally interested us depend upon certain properties of the viral genome. At this point our inquiries are transformed. We now regard viruses as grouped not by the superficial patterns that first caught our attention, but by similarities in those properties of the genome to which we appeal in giving our explanations. . . . The achievement of an explanatory framework goes hand in hand with a scheme for delineating the 'real kinds' in nature" (1984, 321–322). Kitcher admits, of course, that this example "mixes science with science fiction"—as we shall see, the general strategy faces other serious problems.

13. See Kornblith 1993, Wilson 1999, and Chakravartty 2007.

References

Abbott, B. 1997. A note on the nature of water. *Mind* 106:313–319.

Ackermann, R. 1969. Sortal predicates and confirmation. *Philosophical Studies* 20:1–4.

Andreasen, R. O. 1998. A new perspective on the race debate. *British Journal for the Philosophy of Science* 49:199–225.

Aquinas, T. 1997. *De Ente et Essentia*. Trans. R. T. Miller. Internet Medieval Source Book. <http://www.fordham.edu/halsall/Sbook.html>.

Aquinas, T. 1998. *De Principia Naturae*. Trans. J. Bobik. Notre Dame: University of Notre Dame Press.

Armstrong, D. M. 1983. *What Is a Law of Nature?* Cambridge: Cambridge University Press.

Bealer, G. 1987. The philosophical limits of scientific essentialism. *Philosophical Perspectives* 1:289–365.

Bigelow, J., B. Ellis, and C. Lierse. 1992. The world as once of a kind: Natural necessity and laws of nature. *British Journal for the Philosophy of Science* 43:371–388.

Bird, A. 2007. *Nature's Metaphysics: Laws and Properties*. Oxford: Oxford University Press.

Boyd, R. 1988. How to be a moral realist. In *Essays on Moral Realism*, ed. G. Sayre-McCord. Ithaca: Cornell University Press.

Boyd, R. 1991. Realism, anti-foundationalism, and the enthusiasm for natural kinds. *Philosophical Studies* 61:127–148.

Boyd, R. 1999. Homeostasis, species, and higher taxa. In *Species: New Interdisciplinary Essays*, ed. R. A. Wilson. Cambridge, Mass.: MIT Press.

Brody, B. 1980. *Identity and Essence*. Princeton: Princeton University Press.

Brown, J. 1998. Natural kind terms and recognitional capacities. *Mind* 107 (426): 275–303.

Carroll, J. W. 1994. *Laws of Nature*. Cambridge: Cambridge University Press.

Cartwright, N. 1980. Do the laws of physics state the facts? *Pacific Philosophical Quarterly* 61:75–84.

Cartwright, N. 1999. *The Dappled World*. Cambridge: Cambridge University Press.

Chakravartty, A. 2007. *A Metaphysics for Scientific Realism*. Cambridge: Cambridge University Press.

Devitt, M. 2008. Resurrecting biological essentialism. *Philosophy of Science* 75 (3): 344–382.

Devitt, M., and K. Sterelny. 1987. *Language and Reality*. Cambridge, Mass.: MIT Press.

Dretske, F. 1977. Laws of nature. *Philosophy of Science* 44:248–268.

Dupré, J. 1981. Natural kinds and biological taxa. *Philosophical Review* 90:66–90.

Dupré, J. 1993. *The Disorder of Things*. Cambridge, Mass.: Harvard University Press.

Ellis, B. 2001. *Scientific Essentialism*. Cambridge: Cambridge University Press.

Ellis, B., and C. Lierse. 1994. Dispositional essentialism. *Australasian Journal of Philosophy* 72:27–45.

Ereshefsky, M. 1998. Species pluralism and anti-realism. *Philosophy of Science* 65:103–120.

Feldman, F. 1973. Sortal predicates. *Noûs* 7:262–282.

Fine, K. 1994. Essence and modality. *Philosophical Perspectives* 8:1–16.

Fine, K. 1995. Senses of essence. In *Modality, Morality and Belief*, ed. W. Sinnott-Armstrong. Cambridge: Cambridge University Press.

Ghiselin, M. 1974. A radical solution to the species problem. *Systematic Zoology* 23:536–544.

Giere, R. 1999. *Science without Laws*. Chicago: University of Chicago Press.

Glasgow, J. 2009. *A Theory of Race*. New York: Routledge.

Goodman, N. 1983. *Fact, Fiction, and Forecast*, 4th ed. Cambridge, Mass.: Harvard University Press.

Griffiths, P. 1997. *What Emotions Really Are: The Problem of Psychological Categories*. Chicago: University of Chicago Press.

Griffiths, P. 1999. Squaring the circle: Natural kinds with historical essences. In *Species: New Interdisciplinary Essays*, ed. R. A. Wilson. Cambridge, Mass.: MIT Press.

Hacking, I. 1990. Natural kinds. In *Perspectives on Quine*, ed. R. B. Barrett and R. F. Gibson. Cambridge: Blackwell.

Hacking, I. 1995. Entrenchment. In *Grue! The New Riddle of Induction*, ed. D. Stalker. LaSalle: Open Court.

Hacking, I. 2005. Why race still matters. *Daedalus* 134:102–116.

Hempel, C. 1945. Studies in the logic of confirmation. *Mind* 54:1–26, 97–121.

Hempel, C. 1965. *Fundamentals of Taxonomy.* In his *Aspects of Scientific Explanation*. New York: The Free Press.

Hull, D. 1978. A matter of individuality. *Philosophy of Science* 45:335–360.

Kahn, M. 1995. *The Tao of Conversation*. Oakland: New Harbinger.

Kitcher, P. 1984. Species. *Philosophy of Science* 51:308–333.

Kitcher, P. 1999. Race, ethnicity, biology, culture. In *Racism*, ed. L. Harris. Amherst: Humanity Books. Reprinted in his *In Mendal's Mirror*. Oxford: Oxford University Press, 2003; citations are to the 2003 version.

Kornblith, H. 1993. *Inductive Inference and its Natural Ground*. Cambridge, Mass.: MIT Press.

Kripke, S. 1972. Naming and necessity. In *Semantics of Natural Language*, ed. G. Harman and D. Davidson. Dordrecht: Reidel.

Kripke, S. 1980. *Naming and Necessity*. Cambridge, Mass.: Harvard University Press.

Lange, M. 1995. Are there natural laws concerning particular biological species? *Journal of Philosophy* 92 (8):430–451.

Lange, M. 2000. *Natural Laws in Scientific Practice*. New York: Oxford University Press.

Lange, M. 2004. The autonomy of functional biology: A reply to Rosenberg. *Biology and Philosophy* 19:93–109.

Lange, M. 2009. *Laws and Lawmakers*. New York: Oxford University Press.

LaPorte, J. 1996. Chemical kind term reference and the discovery of essence. *Noûs* 30 (1):112–132.

LaPorte, J. 1998. Living water. *Mind* 107:451–455.

LaPorte, J. 2004. *Natural Kinds and Conceptual Change*. Cambridge: Cambridge University Press.

Lewis, D. 1973. *Counterfactuals*. Cambridge, Mass.: Harvard University Press.

Lewis, D., and R. Langton. 1998. Defining 'intrinsic'. *Philosophy and Phenomenological Research* 58:333–345.

Lewontin, R. C. 2000. *The Triple Helix*. Cambridge, Mass.: Harvard University Press.

Lowe, J. E. 1998. *The Possibility of Metaphysics: Substance, Identity, and Time*. Oxford: Clarendon Press.

Maudlin, T. 2007. *The Metaphysics within Physics*. New York: Oxford University Press.

Mayr, E. 1987. The ontological status of species: Scientific progress and philosophical terminology. *Biology and Philosophy* 2:145–166.

Mellor, D. H. 1977. Natural kinds. *British Journal for the Philosophy of Science* 28:299–312.

Mishler, B. D., and M. J. Donohue. 1982. Species concepts: A case for pluralism. *Systematic Zoology* 31 (4):503–511.

Mitchell, S. 2000. Dimensions of scientific law. *Philosophy of Science* 67:242–265.

Nagel, E. 1961. *The Structure of Science: Problems in the Logic of Scientific Explanation*. New York: Harcourt, Brace, and World.

Okasha, S. 2002. Darwinian metaphysics: Species and the question of essentialism. *Synthese* 131:191–213.

Pigliucci, M., and J. Kaplan. 2003. On the concept of biological race and its applicability to humans. *Philosophy of Science* 70:1161–1172.

Popper, K. 1950. *The Open Society and Its Enemies*, rev. ed. Princeton: Princeton University Press.

Putnam, H. 1975. The meaning of 'meaning'. In his *Mind, Language, and Reality: Philosophical Papers*. Cambridge: Cambridge University Press.

Quine, W. v. O. 1969. Natural kinds. In his *Ontological Relativity and Other Essays*. New York: Columbia University Press.

Ramsey, F. 1978. *Foundations*. London: Routledge & Kegan Paul.

Rosenberg, A. 1987. Why does the nature of species matter? *Biology and Philosophy* 2:192–197.

Sider, T. 2009. Ontological realism. In *Metametaphysics*, ed. D. Chalmers, D. Manley, and R. Wasserman. New York: Oxford University Press.

Slater, M. H. 2005. Monism on the one hand, pluralism on the other. *Philosophy of Science* 72 (1):22–42.

Stanford, P. K., and P. Kitcher. 2000. Refining the causal theory of reference for natural kind terms. *Philosophical Studies* 97 (1):99–129.

Strawson, P. F. 1959. *Individuals: An Essay in Descriptive Metaphysics*. London: Methuen.

Tooley, M. 1977. The nature of laws. *Canadian Journal of Philosophy* 7:667–698.

van Fraassen, B. 1989. *Laws and Symmetry*. Oxford: Clarendon Press.

Wallace, J. 1965. Sortal predicates and quantification. *Journal of Philosophy* 62:8–13.

Walsh, D. M. 2006. Evolutionary essentialism. *British Journal for the Philosophy of Science* 57 (2):425–448.

Watson, B. (trans.). 2003. *Zhuangzi: Basic Writings*. New York: Columbia University Press.

Wiggins, D. 1979. *Sameness and Substance*. Oxford: Blackwell.

Wiggins, D. 1986. On singling out an object determinately. In *Subject, Thought, and Context*, ed. P. Pettit and J. McDowell. Oxford: Clarendon Press.

Wilson, R. A. 1999. Realism, essence, and kind: Resuscitating species essentialism? In *Species: New Interdisciplinary Essays*, ed. R. A. Wilson. Cambridge, Mass.: MIT Press.

Woodward, J. 2001. Law and explanation in biology: Invariance is the kind of stability that matters. *Philosophy of Science* 68:1–20.

Zack, N. 2002. *Philosophy of Science and Race*. New York: Routledge.

Zemach, E. 1976. Putnam's theory on the reference of substance terms. *Journal of Philosophy* 73 (5):116–127.