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Species.
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Realism, Essence, and Kind: Resuscitating Species Essentialism?

Robert A. Wilson

NATURAL KINDS AND SCIENTIFIC REALISM

The idea that there are natural kinds has a history in and an aptness for articulating realist views of science. Realists have traditionally held something like the following view of natural kinds: natural kinds are what the sciences strive to identify; they feature in laws of nature and so scientific explanation; they are individuated by essences, which may be constituted by unobservable (or “theoretical”) properties; and they are conceiver-independent classifications of what there is in the world—they “carve nature at its joints.”

The traditional realist view of natural kinds extends the following naive, commonsense view. There are objects and properties that exist independently of human observers. For example, suppose that we have before us a piece of rock. It has properties, such as a certain mass and constitution, and the rock and its properties exist independently of human observers. Scientists investigate such objects, uncover certain relationships between their properties, and develop taxonomies—natural kinds—that make these relationships more apparent. Suppose our rock has the property of being made of molten lava (composed, say, of 50% silica) and so has a certain melting point and various other chemical properties. By taxonomizing it as an *igneous* rock, scientists can both recognize its relationship to other kinds of rock and explore the relationships between the properties that igneous rocks have.

The traditional realist view of natural kinds goes beyond such a commonsense view, chiefly in the depth of its metaphysical commitments. Distinctive is the realist’s view of *why* certain relationships between properties hold and why scientific taxonomies that identify natural kinds reveal further relationships between properties. Some properties are coinstantiated or correlate with one another because they feature in *laws of nature*, and these laws hold because of how nature is structured. In addition, the properties that feature in laws of nature are *intrinsic* properties of the entities that have them: they are properties that would be instantiated in those entities even if those entities were the only things that existed in the world. Natural kinds, then, categorize objects in terms of the intrinsic properties they have: same intrinsic properties, same kind of thing. This in turn explains why taxonomies that

identify natural kinds lead to further revelations about how properties are related to one another, assuming that the most fundamental properties in the world are intrinsic properties. In moving from traditional realism in general to critiques of it within the philosophy of biology—within the literature on the “species problem” in particular—I want to focus on two further aspects of this overall metaphysical conception of natural kinds, *essentialism* and *unificationism*.

Essentialism is the view that natural kinds are individuated by essences, where the essence of a given natural kind is a set of intrinsic (perhaps unobservable) properties, each necessary and together sufficient for an entity’s being a member of that kind. Realists thus say that scientific taxonomy proceeds by discovering the essences of the kinds of things that exist in the world and that this explains, in part, the theoretical and practical successes of science. The endorsement of essentialism provides a way of distinguishing natural kinds from arbitrary and conventional groupings of objects. Natural kinds are *kinds* (rather than mere arbitrary collections) because the entities so grouped share a set of intrinsic properties—an essence—and *natural* (rather than conventional or *nominal*) because that essence exists independent of human cognition and purpose.

The rejection of essentialism about species and, along with it, of the idea that species are natural kinds at all has been central to the claim that species are *individuals* (Ghiselin 1974, 1997; Hull 1976, 1978). According to this view, the traditional realist misconstrues the ontological nature of species: species are individuals rather than kinds individuated by essences. Essentialism about species has also been attacked independently in the philosophy of biology by Mayr (1970) and Sober (1980).

As a general thesis, *unificationism* is the view that scientific knowledge is *unified* in some way; for the traditional realist, it is the view that because natural kinds reflect preexisting order in the world, they are unified or integrated. But realists are not alone in holding some version of unificationism about scientific knowledge. The strongest versions of unificationism were held by the logical positivists as the “unity of science” thesis (e.g., Oppenheim and Putnam 1958) and came with a reductive view of the nature of “higher-level” scientific categories. More recent unificationist views have been nonreductive—cast in terms of the notions of constitution or *realization*, rather than in terms of identity. Traditional realism, whether in its reductionist or nonreductionist guise, implies views about the basis of membership in a given natural kind, the relationship between the various natural kinds and the complexities in nature, and the way in which natural kinds themselves are ordered. We might express these views as follows:

- the *commonality assumption*: there is a common, single set of shared properties that form the basis for membership in any natural kind
- the *priority assumption*: the various natural kinds reflect the complexities one finds in nature rather than our epistemic proclivities

- the *ordering assumption*: natural kinds are ordered so as to constitute a unity

For a traditional realist about species, the commonality assumption amounts to essentialism about natural kinds; the priority assumption points to the world rather than to ourselves as the source of the variety of natural kinds one finds; and the ordering assumption, typically expressed in the view that natural kinds are *hierarchically* organized, says that there is *one* way in which different natural kinds are related to one another.

Pluralists about species reject either the priority assumption or the ordering assumption or both. For example, Mishler and Donoghue (1982) reject the ordering assumption, but maintain the priority assumption when they say that “a variety of species concepts are necessary to adequately capture the complexity of variation patterns in nature” (p. 131). Dupré (1981, 1993), by contrast, would seem to reject both the priority and ordering assumptions in suggesting that “the best way of [classifying species] will depend on both the purpose of the classification and the peculiarities of the organisms in question” (1993, 57; cf. Dupré, chapter 1 in this volume). Kitcher seems to share this view when he says that “there is no unique relation which is privileged in that the species taxa it generates will answer to the needs of all biologists and will be applicable to all groups of organisms” (1984, 317).¹

Traditional realism about species is indefensible, and in the next two sections I indicate just how this view has motivated the individuality thesis (the second section) and pluralism (the third section). But reflection on the similarities between the case of species and the case of neural taxonomy leaves me skeptical about the plausibility of the inferences to these two views about species (the fourth section). Moreover, I argue that the resources afforded by Richard Boyd’s (1988, 1991, chapter 6 in this volume) homeostatic property cluster view of natural kinds provide a view of species that lies between traditional realism, on the one hand, and the individuality thesis and pluralism, on the other (the fifth section). I suggest that rather than rejecting the connection within traditional realism between realism, essence, and kind, we need to complicate those relationships in a way that leaves us closer to traditional realism than we might have expected.

INDIVIDUALITY AND SPECIES TAXA

A natural way to apply traditional realism to species would be to hold that members of particular species share a set of morphological properties or a set of genetic properties, each necessary and together sufficient for membership in that species. Let me take the morphological and genetic versions of this view separately. For example, according to the former of these views, domestic dogs, members of *Canis familiaris*, share some set of observable properties—presumably determinate forms of phenotypes such as having four legs, hair, a tail, two eyes, upper and lower teeth—each necessary and

together sufficient for their being members of that kind. These properties are the essential properties of being a member of *Canis familiaris*. According to the latter of these views, the species essence is not constituted by these 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. In either case, the idea is that there is some set of intrinsic properties, the essence, that all and only members of *Canis familiaris* share—whether this essence be the sort of morphological properties that can be readily observed (and thus available to both common sense and science) or the sort of genetic properties whose detection requires special scientific knowledge of a more theoretical sort. The question answered by those theorists who posit phenotypes or genotypes as essences is this: what are the phenotypic or genotypic properties that an individual must have to be a member of a given species S? The answer to this question, in turn, allows these theorists to answer the question of what distinguishes S from other species.

The chief problem with either suggestion is empirical. In investigating the biological world, we don't find groups of organisms that are intraspecifically homogenous and interspecifically heterogenous with respect to some finite set of phenotypic or morphological characteristics. Rather, we find populations composed of phenotypically distinctive individual organisms; sexual dimorphism and developmental polymorphism are just two common forms of phenotypic variation within species. There simply is no set of phenotypes that all and only members of a given species share. This is true even if we extend the concept of a phenotype so as to include organismic behavior as potentially uniquely identifying properties that mark off species from one another. Precisely the same is true of genetic properties. The inherent biological variability or *heterogeneity* of species with respect to both morphology and genetic composition is, after all, a cornerstone of the idea of evolution by natural selection.

The emphasis on morphology and genotypic fragments as providing the foundations for a taxonomy of species is also shared by *pheneticists* within evolutionary biology, though their strident empiricism about taxonomy would make it anachronistic to see them as defending any version of realism or essentialism. In fact, we might see pheneticism as an attempt to move beyond traditional realism about species by shedding it of its distinctly realist cast. The idea of pheneticism is that individuals are conspecifics with those individuals to which they have a certain level of *overall phenetic similarity*, where this similarity is a weighted average of the individual phenotypes and genetic fragments individual organisms instantiate.

Both pheneticism and the traditional realist view of species focus on shared phenotype or genotype as the basis for species membership. The pheneticist sidesteps the problem—faced by the traditional realist—of intra-specific heterogeneity with respect to any putatively essential property in effect by doing away with essences altogether. However, the pheneticist still

treats species as kinds rather than individuals, but they are *nominal* kinds rather than natural kinds because the measure of overall morphological similarity is a function of the conventional weightings we assign to particular morphological traits or DNA segments.

By contrast, proponents of the individuality thesis respond to the failure of essentialism with respect to species taxa by claiming that species are not natural kinds at all, but individuals or *particulars*—with individual organisms being not members of the species kind, but *parts* of species because a species itself is an individual. Species have internal coherence, discrete boundaries, spatiotemporal unity, and historical continuity—all properties that particulars have, but which neither natural nor nominal kinds have. Viewing species as individuals rather than as kinds allows us to understand how species can have a beginning (through speciation) and an end (through extinction); how organisms can change their properties individually or collectively and still belong to the same species; and why essentialism goes fundamentally wrong in its conception of the relationship between individual organism and species.

PLURALISM AND THE SPECIES CATEGORY

The individuality thesis is a view of the nature of particular species taxa—for example, of *Canis familiaris*. Because I suggested that the individuality thesis was a competitor to both traditional realism and pheneticism, I also think of the latter two views as making claims about particular species taxa. But pheneticism is also often taken as a view about the species *category*—that is, as a view about what defines or demarcates species as a concept that applies to a unit of biological organization. So construed, pheneticism is the view that species are individuated by a measure of overall phenetic similarity, with organisms having a certain level of overall phenetic similarity counting as species, and higher-level and lower-level taxa having, respectively, lower and higher levels of similarity.

Apart from pheneticism, the various proposals that have been made about what characterizes the species category are often divided into two groups: (1) *reproductive* views, which emphasize reproductive isolation or interbreeding as criteria—including Mayr's (e.g., 1982) so-called biological species concept and relaxations of it, such as Paterson's (1985) recognition concept and Templeton's (1989) cohesion species concept; and (2) *genealogical* views, which give phylogenetic criteria the central role in individuating species and are typified by Cracraft (1983) and Wiley (1978). Unlike pheneticism, both of these families of views fit naturally with the individuality thesis as a view of species taxa.

The focus of both reproductive and genealogical views, as views of the species category, is on two questions: (a) what distinguishes species from other groupings of organisms, including varieties below and genera above, as well as more clearly arbitrary groupings? and (b) how are particular species

distinguished from one another? The question that preoccupies pheneticists—namely, what properties of individual organisms determine species membership—receives only a derivative answer from proponents of reproductive and genealogical views. If one answers either (a) or (b) or both, one determines which species individual organisms belong to not by identifying a species essence, but by seeing which group, individuated in accord with the relevant answer to (a) or (b), those organisms belong to. Thus, “belonging to” can be understood in terms of part-whole relations, as it should according to the individuality thesis. Moreover, proponents of reproductive views conceive of species as *populations*, whereas proponents of genealogical views conceive of species as *lineages*, and both populations and lineages are easily understood as spatiotemporal, bounded, coherent individuals, rather than as kinds, be they natural or nominal.

It is widely accepted that there are strong objections to the claim that any of these proposals—pheneticism, reproductive views, or genealogical views—are adequate. These objections have, in turn, motivated *pluralism* about the species category, the idea being that each of the three views, or each of the more specific forms that they may take, provides a criterion for specieshood that is good for some, but not all purposes. The commonality assumption is false because, broadly speaking, phenetic, reproductive, and genealogical criteria focus on different types of properties for species membership, so there is no one type of property that determines kind membership. The priority assumption is also false because the different species concepts reflect the diverse biological interests of (for example) paleontologists, botanists, ornithologists, bacteriologists, and ecologists, so these concepts depend as much on our epistemic interests and proclivities as on how the biological world is structured. And the ordering assumption fails because where we locate the species category amongst other scientific categories depends on which research questions one chooses to pursue about the biological world.

Like pheneticism, reproductive and genealogical views of the species category recognize the phenotypic and genotypic variation inherent in biological populations, so they concede that there is no traditionally conceived essence in terms of which species membership can be defined. But even aside from viewing heterogeneity amongst conspecifics as intrinsic to species, these two views share a further feature that makes them incompatible with the sort of essentialism that forms a part of traditional realism. In contrast with the traditional view that essences are sets of *intrinsic* properties, reproductive and genealogical views of the species category imply that the properties determining species membership for a given organism are not intrinsic properties of that organism at all, but depend on the relations the organism bears to other organisms. Let me explain.

Although we are considering reproductive and genealogical views of the species category, I mentioned earlier that these views have a derivative view of what determines species membership for individual organisms. Reproductive views imply that a given individual organism is conspecific with organ-

isms with which it can interbreed (Mayr), with which it shares a mate recognition system (Paterson), or with which it has genetic or demographic exchangeability (Templeton). Genealogical views imply that conspecificity is determined by a shared pattern of ancestry and descent (Cracraft) or by a shared lineage that has its own distinctive "evolutionary tendencies and historical fate" (Wiley 1978, 80). According to these views, conspecificity is not determined by shared intrinsic properties, but by organisms' standing in certain relations to one another. We can see this most clearly if we consider both views in conjunction with the individuality thesis, since conspecificity is then determined by an organism's being a part of a given reproductive population or evolutionary lineage, where neither of these is an intrinsic property of that organism. Here, we seem a long way from the traditional realist's conception of essentialism.

Any serious proposal for a more integrative conception of species must reflect the inherent heterogeneity of the biological populations that are species, and it is difficult to see how the traditional realist view of natural kinds can do so. Also, given the implicit commitment of both reproductive and genealogical views of the species category to an organism's relational rather than its intrinsic properties in determining conspecificity, the prospects for resuscitating essentialism look bleak.

BETWEEN TRADITIONAL REALISM, INDIVIDUALITY, AND PLURALISM: THE CASE OF NEURAL TAXONOMY

Species is not the only biological category whose members are intrinsically heterogeneous and relationally taxonomized. It seems telling that although traditional realism is rendered implausible for these other biological categories for much the same reasons that we have seen it to be implausible for species, there is little inclination in these other cases to opt either for an individuality thesis about the corresponding taxa or for pluralism about the corresponding categories. The categories I have in mind are *neural* categories, and I shall discuss two of these with an eye to pointing the way to a view of species somewhat closer to traditional realism than might seem defensible, given the discussion thus far.

The first example is the categorization of *neural crest cell* (Hall and Horstadius 1988; Le Douarin 1982, 1987).² In vertebrate embryology, the neural plate folds as the embryo develops, forming a closed structure called the neural tube. Neural crest cells are formed from the top of the neural tube and are released at different stages of the formation of the neural tube in different vertebrate species (figure 7.1). In neurodevelopment, cells migrate from the neural crest to a variety of locations in the nervous system, the neural crest being the source for the majority of neurons in the peripheral nervous system. Cell types derived from the neural crest include sensory neurons, glial cells, and Schwann cells; neural crest cells also form a part of many tissues and organs, including the eye, the heart, and the thyroid gland.

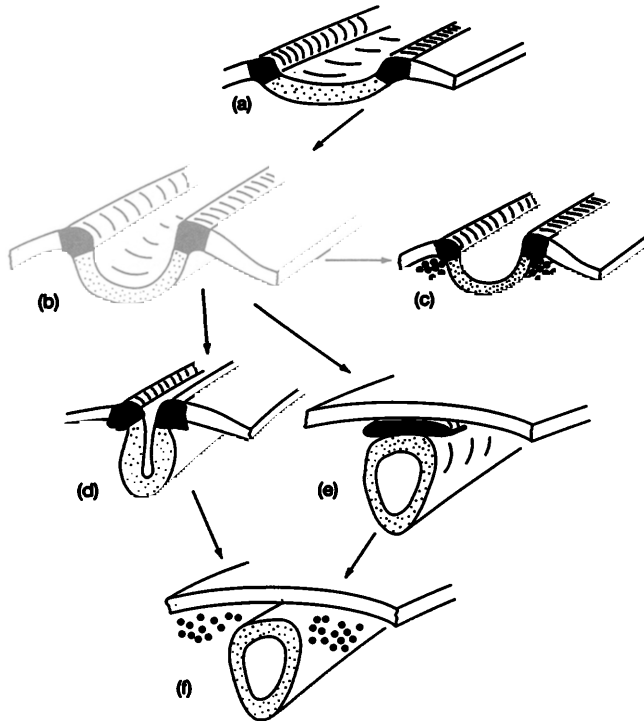


Figure 7.1 The neural crest. A representation of the localization of the neural crest and neural crest cells (black) between neural ectoderm (stippled) and epidermal ectoderm (white) at neural plate (a), neural fold (b, c) and subsequent stages (d–f) of neural crest cell migration to illustrate patterns of migration in relation to neural tube closure in various vertebrates. The time of initial migration varies between different vertebrates and can also vary along the neural axis in a single embryo. In the rat, cranial neural crest cells migrate while the neural tube is still at the open neural fold stage (c). In birds, neural crest cells remain in the neural folds until they close (d), only then beginning to migrate (f), whereas in amphibians, neural crest cells accumulate above the closed neural tube (e) before beginning their migration (f). (Reprinted with permission from Hall and Horstadius 1988.)

Neural crest cells are not taxonomized as such by any essence, as conceived by the traditional realist. The category *neural crest cells* is intrinsically heterogeneous, and individual cells are individuated, in part, by one of their relational properties—their place of origin. But perhaps the category *neural crest cells* is not itself a natural kind, but rather a close to commonsense precursor to such a kind. (After all, not every useful category in science is a natural kind.) The real question, then, would be: By what criteria are refined natural kinds that derive from this category individuated?

I shall focus on the distinction that neuroscientists draw between *adrenergic* and *cholinergic* cells, both of which originate in the neural crest, because this taxonomy of neural crest cells seems initially promising as a candidate for which traditional realism is true. Adrenergic cells produce the neurotransmitter noradrenaline and function primarily in the sympathetic nervous

system; cholinergic cells produce acetylcholine and function primarily in the parasympathetic nervous system. This truncated characterization of adrenergic and cholinergic cells suggests that they may fit something like the traditional realist view of natural kinds: these two types of neural crest cells are individuated by intrinsic properties or *causal powers*—their powers to produce distinctive neurotransmitters—which serve as essences that determine category membership.

Such a view of these neural categories, however, would be mistaken, a claim I substantiate in a moment. But just as mistaken would be the claim that adrenergic cells form an individual rather than a natural kind, or the claim that we should be pluralists about this category of neural cells, claims I discuss further in later sections. Standard taxonomic presentations of the two types of cells (e.g., Hall and Horstadius 1988, Le Douarin 1987) proceed by introducing a list of features that each cell type possesses, including their typical original location in the neural crest, the typical dendritic connections they make to other cells, the neural pathways they take, and their final locations and functions. Adrenergic cells are heterogenous with respect to any single one of these properties or any set of them, and it is for this reason that they do not have an essence as conceived by traditional realists. Yet in normal development, these properties tend to cluster together, and it is this feature of the *form* the heterogeneity takes that allows us, I think, to articulate a view that stops short of individuality and pluralism.

A further fact about neural crest cells dooms any attempt to individuate them in terms of their power to produce certain neurotransmitters: they are *pluripotential* in a sense that I specify in a moment. Because one goal of research into the neural crest has been to understand the paths of migration of neural crest cells, transplantation studies have played a central role in that research. In a standard paradigm, sections of the neural crest from a quail are transplanted into a chick embryo, and the phenotypic differences in development (e.g., pigmentation changes) are noted. One central and initially surprising finding from transplantation studies was that neural crest cells transplanted to a host environment tend to produce the neurotransmitter normally found in that environment, even if the cell transplanted would have produced the other neurotransmitter in its normal environment. This finding implies that factors exogenous to a given cell determine which neurotransmitter that cell produces. The best candidate we have for a traditionally conceived essence for adrenergic and cholinergic neural crest cells—the power those cells have to produce norepinephrine or acetylcholine, respectively—is not even an intrinsic property of cells. The very property we are supposing to be essential for cell type varies from cell to cell not according to facts about that cell's intrinsic properties, but according to facts about the environment in which the cell is located.

As a second example, consider the taxonomy of retinal ganglion cells. These cells receive visual information via the retina and have been extensively studied in the cat and the frog (Rowe and Stone 1980a). Chalupa

(1995) says that “we now know more about the anatomical and functional properties of retinal ganglion cells than we do about any other neurons of the mammalian brain” (p. 37), suggesting that the neural categories here are the product of relatively well-developed neuroscience. Over the last thirty years, a number of taxonomies have been proposed for retinal ganglion cells; some of these taxonomies (e.g., alpha/beta/gamma trichotomy) are based on morphological criteria, such as dendritic morphology and axon size, whereas others (e.g., the Y/X/W trichotomy) are based on physiological properties, such as the size of the receptive field (table 7.1). The functional distinctness of each of these kinds of retinal ganglion cell suggests that they form distinct visual channels that operate in parallel in visual processing.

As with neural crest cells and their determinate kinds, such as adrenergic and cholinergic cells, the taxonomy of retinal ganglion cells proceeds by identifying clusters of properties that each type of cell has. No one of these properties is deemed necessary or any set of them deemed sufficient for classification as a Y, X, or W cell; thus, there is no essence for any of these neural categories. Again, however, I want to suggest that it is implausible to see, for example, the taxa of Y cells as individuals rather than as a natural kind or to claim that this way of categorizing retinal ganglion cells has a pluralistic rather than a unificationist basis. The clustering of the various morphological and physiological properties in these cells again points us to a middle ground here. Large numbers of retinal ganglion cells tend to share many of a cluster of properties in their normal environments. This fact, together with the distinctness of these clusters of properties, provides the basis for individuating retinal ganglion cells into various kinds.

The biological facts in these areas of neuroscience defy philosophical views that posit traditionally conceived essences. Equally clearly they suggest an alternative to the corresponding individuality thesis and pluralism about taxonomy in the philosophy of biology more generally.

HOMEOSTATIC PROPERTY CLUSTERS AND THE REVIVAL OF ESSENTIALISM

The middle-ground position I have in mind is based on a view introduced by Richard Boyd (1988, 1991, chapter 6 in this volume; see also Kornblith 1993), which he calls the *homeostatic property cluster* (hereafter, HPC) view of natural kinds. I shall adapt this view, noting explicitly where I depart from Boyd. Boyd initially introduced this view as part of his defense of a naturalistic version of realism in ethics, but from the outset he clearly intended for it to apply to natural kinds in science and to species in particular. Precursors to the HPC view include Wittgenstein’s discussion of cluster concepts via the metaphor of family resemblance; Putnam’s (1962) introduction of a law cluster view of scientific concepts; and Hull’s (1965) argument that biologists who recognize higher taxa as cluster concepts should extend this view to species themselves. Boyd’s previously published discussions have been rela-

Table 7.1 Some properties of cat retinal ganglion cells

	Y Cells	X Cells	W cells
Receptive field center size	large, 0.5–2.5°	small, 10'–1°	large, 0.4–2.5°
Linearity of center-surround summation	nonlinear	linear	not tested
Periphery effect	present	usually absent	absent
Axonal velocity	fast, 30–40 m/sec	slow, 15–23 m/sec	very slow, 2–18 m/sec
Soma size, peripheral retina	large, > 22 μm	medium, 14–22 μm	small, < 15 μm
Proportion of population	< 10%	approximately 40%	approximately 50–55%
Retinal distribution	concentrate near area centralis, more numerous relatively in peripheral retina	concentrate at area centralis	concentrate at area centralis and in streak
Central projections	to laminae A, A ₁ , and C ₁₂ of LGN, to MIN and, via branching axon, to SC from the A-laminae of LGN to cortical areas 17 and 18, also by branching axon; and from MIN to areas 17, 18, 19	to laminae A, A ₁ , and C ₁₂ of LGN; thence to area 17; to midbrain (a minority), but probably not to SC	to SC, to C-laminae of LGN and thence visual cortex area 17 and/or 18, and 19
Nasotemporal division	nasal cells project contralaterally; most temporal cells ipsilaterally; strip of intermingling centered slightly temporal to area centralis	nasal cells project contralaterally, temporal cells project ipsilaterally; narrow strip of intermingling centered on area centralis	nasal cells project contralaterally; most temporal cells also project contralaterally; about 40% of temporal cells project ipsilaterally

Modified from Rowe and Stone (1977).

tively programmatic, and his current view of the implications of the HPC view for issues concerning species (see Boyd, chapter 6 in this volume) is somewhat different from the view I advocate here.

The basic claim of the HPC view is that natural kind terms are often defined by a cluster of properties, no one or particular n-tuple of which must be possessed by any individual to which the term applies, but some such n-tuple of which must be possessed by all such individuals. The properties mentioned in HPC definitions are *homeostatic* in that there are mechanisms that cause their systematic coinstantiation or clustering. Thus, an individual's possession of any one of these properties significantly increases the probability that this individual will also possess other properties that feature in the definition. This is a fact about the causal structure of the world: the instantiation of certain properties increases the chance that other particular properties will be coinstantiated because of underlying causal mechanisms and processes.

The view is a “cluster” view twice over: only a cluster of the defining properties of the kind need be present for an individual to fall under the kind, and such defining properties themselves tend to cluster together—that is, tend to be coinstantiated in the world. The first of these features of the HPC view of natural kinds allows for inherent variation among entities that belong to a given natural kind.

The second of these features distinguishes the HPC view as a *realistic* view of kinds from the Wittgensteinian view of concepts more generally to which it is indebted. On the HPC view, our natural kind concepts are regulated by information about how the world is structured, not simply by conventions we have established or language games we play. Before moving to the case of species, consider how the HPC view applies to our pair of neural kinds.

First, take the case of the individuation of neural crest cells. For a cell to be adrenergic is for it to have a certain cluster of properties that scientists have discovered; amongst other things, it is to originate in the posterior of the neural tube, to follow one of a given number of migratory paths, to function in the sympathetic nervous system, and to produce the neurotransmitter norepinephrine. Facts about the structure of the biological world—facts still being uncovered—explain why these properties tend to be (imperfectly) coinstantiated by certain kinds of cells. This clustering is the result of incompletely understood mechanisms that govern an embryo’s development and is absent, either partially or wholly, just when the normal function of those mechanisms is disrupted. No single one of these properties is, however, strictly necessary for a cell to be adrenergic. The presence of *all* of them, however, is sufficient for a cell to be adrenergic, at least in the environments in which development normally occurs.³ This feature of the HPC view marks one of the affinities between it and traditional realism, about which I say more later. On this view, adrenergic neural crest cells are a natural kind of cell, and individual cells are members of that natural kind in virtue of satisfying the homeostatic property cluster definition of that natural kind.

Second, take the case of the individuation of retinal ganglion cells. Consider in particular the physiological taxonomy of *Y*, *X*, and *W* cells. The tendency of the various physiological properties—such as the axonal velocity, soma size, and retinal distribution—to be coinstantiated by particular types of cells is no accident, but the result of underlying mechanisms governing neural development and neural functioning. Again, a determinate form of any one of these properties could be absent in a particular cell, yet the cell will still be a certain kind of cell—say, a *Y* cell—so no *one* of these properties is an essential property for being a member of that kind of retinal ganglion cell. Nevertheless, there is a general definition of what it is to be a *Y* cell, one based on the homeostatic cluster of properties that one finds instantiated in some cells and not in others. *Y* cells are a natural kind of cell with a sort of essence, albeit one different from the sort of essence characterized by traditional realism. Moreover, there is a kind of integrity to being a *Y* cell that invites a unificationist rather than a pluralistic view of it.

A more ambitious way to apply the HPC view to this example is worth noting. Although it is a substantive hypothesis that the morphological and physiological taxonomies of retinal ganglion cells are roughly coextensive, it is a hypothesis that is reasonably well confirmed (see Chalupa 1995, 40–42). The HPC view provides a natural way of integrating the two taxonomies in effect by adding together the two lists of properties in each cluster. This integration assumes, of course, that certain common mechanisms explain the presence of this new cluster of properties *qua* cluster, without which we would simply have a disjunction of two homeostatic clusters, not a new homeostatic cluster of properties.

I suggest that the HPC view applies to species taxa as follows. Particular species taxa are natural kinds defined by a homeostatic cluster or morphological, genetic, ecological, genealogical, and reproductive features. This cluster of features tend to be possessed by any organism that is a member of a given species, though no one of these properties is a traditionally defined essential property of that species, and no proper subset of them is a species essence. This clustering is caused by only partially understood mechanisms that regulate biological processes (such as inheritance, speciation, and morphological development) and the complex relations between them. More generally, the homeostatic clustering of these properties in individuals belonging to a single species is explained by facts about the structure of the biological world. For example, organisms in a given species share morphology in part because they share genetic structures, and they share these structures because of their common genealogy. This is not to suggest, however, that any one of these properties is more basic than all of the others or that there is some strict ontological hierarchy on which they can all be placed, for the dependency relations between these properties are complex and almost certainly multifarious.

Having severed the connection between the HPC view and traditional realism, let me now indicate an important affinity that the two views share. Although possession of individual properties or *n*-tuples of the relevant homeostatically clustered properties are not necessary for membership in the corresponding species kind, possession of all of them *is* sufficient for membership in that kind. If the homeostatic property cluster definition is sufficiently detailed, this circumstance will likely remain merely an idealization, uninstantiated in fact and approximated to a greater or lesser extent in particular cases. This in turn points to one way in which the sort of essentialism that forms a part of traditional realism is a limiting case of the sort of essentialism implicit in the HPC view of natural kinds.

The HPC view can also be applied to the species category, allowing a definition of what sorts of thing a species is that marks it off from other biological categories. First, the general nature of the cluster of properties—morphology, genetics, genealogy, and so on—will distinguish species from nonevolutionary natural kinds, such as cells (in physiology), predators (in ecology), and diseases (in epidemiology). Second, species will be distinguished

from other evolutionary ranks, such as genera above and varieties below, by the particular specifications of this general cluster of properties (cf. Ereshefsky, chapter 11, and Mishler, chapter 12 in this volume). For example, for species for which reproductive criteria are applicable, reproductive isolation will distinguish a species from the mere varieties within it (because the latter are not so isolated), and interbreeding across the population will distinguish it from the genus to which it belongs. In some cases, the distinction of species as a particular rank in the biological hierarchy will be difficult to draw, but I suggest that this is a virtue, not a liability, of the HPC view because varieties sometimes *are* very like species (e.g., in cases of so-called incipient species), and species sometimes *are* very like genera (e.g., in cases of geographically isolated populations that diverge only minimally and share a recent ancestor).

That the HPC view is a *realist* view should be clear: it claims that there are natural kinds in the world individuated by properties existing independent of us and that our schemes of categorization in science track these natural kinds. Here, there seems a clear endorsement of the priority assumption from traditional realism. In addition, the properties that feature in the cluster need not be observable. For example, neither the lineages of descent nor the pathways of projection from the retina to the lateral geniculate nucleus need themselves be observable to feature in the respective HPC definitions of species and retinal ganglion cells. Lingered doubts about the realist credentials of the view should be dispelled by noting that it has traditional realism as its limiting case, one in which all of the properties in the cluster are present in all instances falling under the concept; the HPC view is a loosening of traditional realism, not an abandonment of its realist core.

Consider now the HPC view of species more explicitly vis-à-vis essentialism and unificationism. On the HPC conception, species are natural kinds, not individuals, with essentialism in the style of traditional realism a limiting case rather than a definitive feature of this type of natural kind. And just as the HPC view of species is incompatible with a traditional form of essentialism, so too is it incompatible with a traditional form of the commonality assumption, according to which all members of a natural kind must share some set of intrinsic properties. There *is*, however, a sort of common basis for membership in any given species, which can be expressed as a finite disjunction of sets of properties (and relations), and we might thus view the HPC view of species as compatible with a version of the commonality thesis that allowed such disjunctions. Likewise, because some of the criteria that define the species category may have a different level of significance in different cases—in the extreme, they may be absent altogether—simple versions of the ordering assumption are incompatible with the HPC view of natural kinds. Yet the possibility of more complicated forms of the ordering assumption would seem compatible with the HPC view because there seems to be a clear place for a unified species category amongst other (unified!) biological taxa, according to the HPC view of species.

Note how the HPC view of natural kinds preserves another idea that is a part of traditional realism: all and only members of a natural kind satisfy the corresponding definition of that kind. Anything that is a species and only things that are species will satisfy the HPC definition for species; any individual that is a member of a particular species and only such individuals will satisfy the HPC definition for a particular species—likewise for neural crest cells and retinal ganglion cells (as well as their determinate forms).

But what does it mean “to satisfy” such a definition? Thus far, I have implied that “to satisfy” is to possess “enough” of the properties specified in the HPC definition. Here, we might suspect the vagueness this implies regarding (say) the delineation of the species category and membership in particular species taxa is the Achilles’ heel of the view. I want to offer two responses to this concern.

First, what counts as having “enough” of the relevant properties—as with what are the relevant properties in the first place—is an a posteriori matter determined in particular cases by the practitioners of the relevant science rather than by philosophers with a penchant for crisp universality. There need be no one answer to the question of what is “enough,” but whatever answers are given in particular cases will be responsive to the clusters that one finds in the world.

Second, even once there is general agreement about what counts as “enough,” there clearly will be cases of genuine indeterminacy with respect to both the species category and membership in particular species taxa. Yet this indeterminacy seems to me to reflect the continuities one finds in the complex biological world, whether one is investigating species, neurons, or other parts of the biological hierarchy. There will be genuine indeterminacy about the rank of given populations of organisms, and particular organisms may in some cases satisfy more than one HPC definition for particular species taxa. The former of these indeterminacies, however, is a function of the fact that under certain conditions and over time varieties *become* species, and the descendants of a given species become members of a particular genus; the latter reflects the process of speciation (and its indeterminacies) more directly.

THE INDIVIDUALITY THESIS

Insofar as the HPC view of natural kinds embraces a form of essentialism, it presents an alternative to the individuality thesis and a revival of ideas central to traditional realism. Whether it represents a better alternative to the individuality thesis turns both on broader issues in the philosophy of science and further reflection on the nature of species in particular. Here, I simply summarize what the argument thus far has shown on this issue and what some of the options are in the issue.

Ghiselin (1974, 1997) and Hull (1976, 1978) have given multiple and diverse arguments for the individuality thesis about species—one part of

their view negative (species are not natural kinds), another part positive (species are individuals). For example, it has been argued that the heterogeneity within biological populations implies that species are not natural kinds and that their status as *historical* entities within evolutionary theory supports a view of them as individuals. Insofar as the former types of argument presume a two-way conceptual connection between traditionally conceived essences and natural kinds, they carry no force against the view that species are HPC natural kinds. Thus, the view I have defended undermines negative arguments for the individuality thesis. But the HPC view of natural kinds also shows *both* types of arguments for the Ghiselin-Hull view in a new light because parity of reasoning should lead one to abandon thinking of neuronal populations as natural kinds and embrace a view of them as individuals. Of course, such parity considerations can always be undermined by the differences between how the term *species* is used within evolutionary biology and how (say) the term *retinal ganglion cell* is used within visual neuroscience. The HPC view, however, places the burden on those who think that there is something special about species talk that warrants a unique ontological view of species as individuals to show this uniqueness.

Alternatively, perhaps reflection on the neuroscientific cases should lead one to extend the individuality thesis beyond the case of species to other biological categories. Interestingly, at least some researchers in the relevant neuroscience may be amenable to this idea. For example, following Tyler (1975), Rowe and Stone (1977, 1980a, 1980b) advocate what they call a *parametric* or *polythetic* approach to the individuation of retinal ganglion cells, viewing these cells not as kinds with some type of essence, but as intrinsically heterogeneous *populations* of cells that have their own internal coherence and duration. (Indeed, Rowe and Stone explicitly take their cue from the modern species concept.) The problem with such a view, it seems to me, is that central to neural taxonomy is the idea of identifying categories of cells that at least different organisms in the same species instantiate, and these instances considered together do not form an individual. For example, your adrenergic cells and my adrenergic cells considered together are not spatially bounded, occupy different temporal segments, and do not form an integrated whole. Perhaps this points the way to how the positive arguments for the individuality thesis can be sharpened in light of the parity considerations introduced with respect to the negative part of the argument for the thesis.

PLURALISM

To remind you of what the pluralist holds about species, consider what Dupré (1993) says in articulating his version of pluralism:

There is no God-given, unique way to classify the innumerable and diverse products of the evolutionary process. There are many plausible and defensi-

ble ways of doing so, and the best way of doing so will depend on both the purposes of the classification and the peculiarities of the organisms in question. . . . Just as a particular tree might be an instance of a certain genus (say *Thuja*) and also a kind of timber (cedar) despite the fact that these kinds are only partially overlapping, so an organism might belong to both one kind defined by a genealogical taxonomy and another defined by an ecologically driven taxonomy. (p. 57)

In introducing pluralism as the denial of either or both of two assumptions central to traditional realism—the priority and ordering assumptions—I meant to suggest that there is some tension between pluralism and realism *punkt*. The metaphysical angst that many realists experience with pluralism concerns the extent to which one can make sense of the idea that there are incompatible but equally “natural” (i.e., real) ways in which a science can taxonomize the entities in its domain. There is at least the suspicion that, to use Dupré’s terms, pluralism is driven more by the “purposes of the classification” than by the “peculiarities of the organisms in question,” as Dupré’s own analogy suggests. In rejecting the priority assumption, such pluralism would move one from a realist view toward a nominalist view of species (see Wilson 1996; cf. Hull, chapter 2 in this volume).

Yet the most prominent forms of pluralism about species have all labeled themselves “realist,” from Dupré’s “promiscuous realism” to Kitcher’s “pluralistic realism.” Moreover, Boyd (chapter 6 in this volume) views at least Kitcher’s brand of pluralism as compatible with his own articulation of the HPC view of natural kinds—suggesting a form of realism that accepts the priority assumption, but rejects the ordering assumption. The idea that Boyd and Kitcher share is one Mishler and Donoghue express (cited earlier): the various species concepts that one can derive and thus the various orders within which one can locate species are merely a reflection of complexities within the biological world. This view has two problems—one with pluralistic realism itself, the other with viewing the HPC view of natural kinds as compatible with such pluralistic realism.

As pluralists say, one can arrive at different species concepts by emphasizing either morphological, reproductive, or genealogical criteria for the species category. Yet it is difficult to see how the choices between these sorts of alternatives could be made independently of particular research interests and epistemic proclivities, which calls into question the commitment to the priority assumption that, I claim, needs to be preserved from traditional realism in any successor version of realism. Perhaps pluralistic realists would themselves reject the priority assumption, although Boyd’s own emphasis on what he calls the “accommodation demands” imposed by the causal structure of the world on inductive and explanatory projects in the sciences suggest that he himself accepts some version of the assumption.

Boyd’s own view of the compatibility of the two views seems to me to fail to capitalize on the *integrationist* potential of the HPC view, one of its chief appeals. One of the striking features of the various definitions of the species

category is that the properties that play central roles in each of them are not independent types of properties, but are causally related to one another in various ways. These causal relationships and the mechanisms that generate and sustain them form the core of the HPC view of natural kinds. Because the properties specified in the HPC definition of a natural kind term are homeostatically related, there is a clear sense in which the HPC view is integrationist or unificationist regarding natural kinds. By contrast, consider the view of pluralists. Kitcher (1984) says that we can think of the species concept as being a union of overlapping species concepts (pp. 336–337; cf. Hull 1965), so it is unified in some sense, but without a further emphasis on something to play the metaphysical role that underlying homeostatic mechanisms play in the HPC view, the unity to the species concept remains allusive within Kitcher's view.

Consider how the differences in views manifest themselves in a concrete case—whether asexual clonelines form species. For the pluralist, the answer to this question depends on which species concept one invokes—in particular, whether one appeals to interbreeding criteria to define the species category. By contrast, on the HPC view, asexual clonelines *are* species because they share in the homeostatic cluster of properties that defines the species category, even though they don't have at least one of those (relational) properties, interbreeding.

Likewise, consider the issue of whether there is a qualitative difference between species and other (especially higher) taxa (see Ereshefsky, chapter 11 in this volume). Again, a natural view for a pluralist to adopt is that how one construes the relationship between species and other taxa depends on which species concept one invokes. For example, on Mayr's biological species concept, species have a reality to them provided by their gene flow and its boundaries, which higher taxa lack; alternatively, pheneticists view both species and higher taxa as nominal kinds because taxa rank is determined by a conventional level of overall phenetic similarity. By contrast, on the version of the HPC view of species I have defended, although the general difference between various taxa ranks will be apparent in their different HPC definitions, there will be cases where questions of the rank of particular taxa remain unresolved by the HPC view.

CONCLUSION

My chief aims here have been to clarify the commitments of a realist view of natural kinds and to suggest a way of modifying rather than abandoning traditional realism in light of the challenge of biological heterogeneity. Both the individuality thesis and species pluralism seem to me to be extreme reactions to the failure of traditional realism in the biological realm, but I have stopped short here of trying to make a full case for the middle-ground position I have advocated as an alternative to both of these views. That remains for another day.

Because the homeostatic property cluster view of natural kinds is in part inspired by the Wittgensteinian idea that instances falling under a common concept bear only a family resemblance to one another, it should be no surprise that it softens the contrast between natural kinds and other categories of things in the world. On the HPC view, however, two things are special about natural kinds. First, the mechanisms that maintain any given HPC are a part of the natural world, not simply our way of thinking about or intervening in the world. Second, unlike artificial or conventional kinds, natural kinds have HPC definitions that feature only properties that exist independent of us. Thus, the reason for the intermediate character of social, moral, and political categories between natural and artificial kinds is made obvious on the HPC view.

I have suggested that the concept of a natural kind needs some broadening within a realist view of science. Although I think of the resulting view as a form of essentialism, whether it is remains of less significance than the requisite broadening. But if we do think of the resulting view as a form of essentialism, then the concept of an essence need not be viewed as the concept of substance came to be viewed within modern science: as unnecessary metaphysical baggage to be jettisoned.

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NOTES

1. Later, I return to this appearance and the putative contrast between traditional realism and pluralism when I consider so-called pluralistic or promiscuous realism.
2. J. D. Trout's (1988) brief discussion of neural crest cells, including the distinction between adrenergic and cholinergic cells, stimulated my interest in this example; I also owe Barbara Finlay a note of thanks for helpful, early discussions of both this and the following example. Neither should be landed with the interpretation I give to the example.
3. Alternatively, one could make the normal developmental sequence part of the homeostatic property cluster definition itself. In either case, the sufficiency is not one that allows for a consideration of all logically or even nomologically possible cases.

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