William Whewell, Cluster Theorist of Kinds

Zina B. Ward
Florida State University
zina.b.ward@gmail.com

Forthcoming in *HOPOS: The Journal of the International Society for the History of Philosophy of Science*

Abstract: A dominant strand of philosophical thought holds that natural kinds are clusters of objects with shared properties. Cluster theories of natural kinds are often taken to be a late twentieth-century development, prompted by dissatisfaction with essentialism in philosophy of biology. I will argue here, however, that a cluster theory of kinds had actually been formulated by William Whewell (1794-1866) more than a century earlier. Cluster theories of kinds can be characterized in terms of three central commitments, all of which are present in Whewell's work on classification. Like contemporary cluster theorists, Whewell claims that kinds are united by similarity, that many kinds do not have essences, and that there are "gaps" between kinds. Moreover, Whewell advises taxonomists to look for consilience (roughly, convergence) between different classificatory schemes, a recommendation that reinforces the identification of natural classes with property clusters. Thus Whewell was not only an early cluster theorist, but one with important insights into what a cluster theory of kinds means for the practice of classification.

1. Introduction

The contemporary philosophical literature on natural kinds is dominated by cluster theories. The locus classicus of such theories is Richard Boyd's homeostatic property cluster (HPC) account, on which many natural kinds are associated with collections of properties that their members typically possess (Boyd 1989, 1991, 1999a). Causal mechanisms sustain the co-occurrence of these properties, but no individual property need be necessary or sufficient for kind membership. It is difficult to overstate the impact of Boyd's view on the philosophy of science. The HPC account is treated as the leading alternative to essentialism about natural kinds. Countless papers take the theory on board, using it to argue for other conclusions (e.g., Serpico 2018; Tsou 2021). And even those who reject the theory usually retain Boyd's central insight that at least some kinds are property clusters (Chakravartty 2007; Magnus 2012; Khalidi 2018).

Many see this turn toward cluster theories of natural kinds as a relatively recent philosophical development (Brzović 2018; Bird and Tobin 2022). It is widely known that Boyd's account was inspired by cluster theories of reference in twentieth-century philosophy of language (Searle 1958). What has not been appreciated is that the basic elements of a cluster theory of kinds had been independently articulated and defended in the nineteenth century by William Whewell (1794-1866). Ian Hacking (2007) credits Whewell, as well as John Stuart Mill, with "set[ting] the engine of natural kinds in motion" in philosophy (215). Here I'll argue that Whewell's work on scientific classification also represents, *pace* Hacking, the "rosy dawn" of cluster theories of kinds.

Whewell's views on classification have attracted recent scholarly attention (Snyder 2006; McOuat 2009; Wilkins 2013; Magnus 2015; Sandoz 2016; Quinn 2017, forthcoming). A few of these authors have hinted that he might be considered a cluster theorist of kinds. Gordon McOuat (2009), for instance, explains that on Whewell's view, natural kinds are "indefinable, yet significantly clustered" (220). McOuat notes a "kinship" between Whewell's account of kinds and Wittgenstein's notion of family resemblance, a connection also drawn by John S. Wilkins (2013). Wilkins' comparison is notable as he claims that "HPC kinds are causal versions of Wittgenstein's family resemblances" (235). Laura Snyder (2006) also reads Michael Ruse (1976) as claiming that Whewell takes natural kinds to be property clusters, although she dissents from this interpretation for reasons to be discussed below.

These suggested parallels between Whewell and cluster accounts of kinds are intriguing but cursory. This paper aims to make a more systematic case for interpreting Whewell as a nineteenth-century cluster theorist. First, in Section 2, I'll articulate three commitments that characterize cluster theories of natural kinds. Section 3 will introduce Whewell's general epistemological framework within which his view of kinds took shape. The following three sections will argue that Whewell embraces each of the core commitments of cluster theories: he holds that kinds are united by similarity (Section 4), that many kinds do not have essences (Section 5), and that there are gaps between kinds (Section 6). In Section 7, I'll bolster the conclusion that Whewell was a cluster theorist by highlighting the connection between clustering and his celebrated notion of consilience. Finally, Section 8 will suggest that this link is one that contemporary theorists should embrace. Recognizing consilience as a guide to property clustering helps bridge the gap between cluster theories of natural kinds and the practice of scientific classification.

2. Cluster Theories of Natural Kinds

Boyd's homeostatic property cluster account ushered in the contemporary enthusiasm for cluster theories of kinds (Boyd 1989, 1991, 1999a). Boyd argues that many natural kinds are what he calls "HPC kinds." Each HPC kind is associated with a collection of properties which its members usually (but need not always) possess. Boyd claims that the co-occurrence of these properties within individuals constitutes a sort of homeostasis. The presence of some of the properties might favor others, or there might be underlying homeostatic mechanisms that cause the properties to be instantiated in the same individuals. Either way, since the properties (merely) cluster together, the boundaries of natural kinds can be fuzzy. For Boyd, biological species are paradigmatic HPC kinds: a variety of genetic, developmental, and evolutionary mechanisms ensure that members of a species share numerous properties, even though there are no necessary and sufficient conditions for species membership (Boyd 1999a, 165; cf. Ereshefsky and Matthen 2005).

Boyd's HPC account belongs to a broader family of views that I've been calling cluster theories of natural kinds. These theories hold that natural kinds are (or are associated with) property clusters. They are often elaborated by appeal to a spatial metaphor (Broad 1920; Russell 1948; Dupré 1981): Picture an abstract space with many dimensions, each corresponding to a property that objects can possess.[1] Imagine that every object that exists is plotted in this space according to

[1] The word "object" should be read expansively. One might substitute "individual" or "entity" instead. There are things that are not reasonably called objects or entities – such as events or processes – whose place in cluster theories of natural kinds is not clear (cf. Boyd 1999a). For his part, Whewell agreed that

its properties. Cluster theorists believe that the result would be "clumpy": there would be regions of property space practically empty, and other regions with a high density of points, representing a cluster of similar objects. Natural kinds correspond to such clusters in property space.

The key ideas captured by this image can be expressed as three core commitments of cluster theories of natural kinds:

(i) *Similarity:* Individual members of a natural kind share many properties.
(ii) *Anti-Essentialism:* Many or most natural kinds do not possess essences: there are no necessary and sufficient conditions for membership in the kind.
(iii) *Separation:* The co-occurring properties that characterize natural kinds are clustered in the sense that there are "gaps" between kinds in property space.

For the cluster theorist, a crucial feature of natural kinds is that their members are similar to one another (Quine 1969; cf. Ereshefsky and Matthen 2005, Magnus 2011). This idea is captured by the first commitment, *Similarity*, which implies that a collection of objects cannot be a natural kind unless the objects share many properties. However, there need not be any property that all and only the members of a kind have in common. Cluster theories are opposed to essentialist theories, which hold that natural kinds are associated with necessary and sufficient membership conditions (Wilkerson 1988; Ellis 2001; Devitt 2008). *Anti-Essentialism* asserts that many or most kinds do not possess such essences. Cluster theories also require that the similarities within and between kinds exhibit a particular structure, as described by *Separation*. Natural kinds are distinct from one another, meaning that they are separated by gaps in property space. Of course, there might be scattered individuals that don't fall cleanly into one kind or another: the boundaries of a natural kind may not be sharp. But all *Separation* requires is an overall pattern of discrete (rather than continuous) variability between groups of objects that belong to different natural kinds.

Although there are important differences between various cluster theories of kinds, they are united in their acceptance of these core commitments.[2] Consider Boyd and the HPC account. Boyd's acceptance of *Similarity* can be seen in his claim that each HPC kind is associated with properties that are "contingently clustered in nature in the sense that they co-occur in an important number of cases" (Boyd 1999a, 143). He doubles down on *Similarity* when critics argue that biological species are united by genealogy rather than shared properties (e.g., Ereshefsky and Matthen 2005). He writes, "I do not, for better or worse, hold that HPC kinds are defined by reference to historical relations among the members, rather than by reference to their shared properties" (Boyd 1999b, 80). Second, Boyd asserts that HPC kinds cannot be defined in terms of necessary and sufficient conditions, indicating his acceptance of *Anti-Essentialism* (1999a, 141). He occasionally suggests that we recast the notion of an essence to include homeostatic property clusters, and thus sometimes appears sympathetic to essentialism (Boyd 1999a; see also Griffiths 1999). But if one assumes a traditional understanding of essences, he clearly belongs on the anti-

---

classification must be *of individuals*. For instance, he took pains to argue that there are mineralogical individuals so as to establish that natural history can be applied to mineralogy (Whewell 1858a, 2:145-9).

[2] A reviewer points out that there is some irony in characterizing cluster theories of kinds using three essential features, given those theories' opposition to essentialism. However, cluster theorists do not deny that there may be some kinds that have essences; *Separation* claims only that many or most kinds lack them. Moreover, although Boyd suggests that philosophical doctrines like empiricism and vitalism count as HPC kinds, I am more doubtful that cluster theories of kinds can be applied straightforwardly to philosophical views (Boyd 1999a, 156). For these reasons, I do not think it is inconsistent to give an "essentialist" characterization of a family of philosophical theories that hold that kinds in nature often lack essences.

essentialist side of the ledger. Finally, Boyd's work also includes an implicit commitment to *Separation*. If there is a "contingent clustering" of properties that characterizes kinds, there must also be contingent gaps: combinations of properties that do not regularly appear in nature.

Thinkers after Boyd have loosened his account in various ways, often while remaining committed to *Similarity, Anti-Essentialism*, and *Separation.* For instance, Anjan Chakravartty (2007) and Matthew Slater (2015) both drop Boyd's requirement that the properties associated with a natural kind be "held together" by a homeostatic mechanism or causal relationships among the properties. They are motivated to do so (in part) by putative counterexamples like quarks, which seem to be natural kinds but whose characteristic properties may not be sustained by an underlying causal mechanism. Slater proposes to replace Boyd's homeostatic mechanism condition with the more minimal requirement that the clustering of properties within a natural kind be "cliquishly stable." By this he means roughly that the instantiation of some of the properties in the cluster by an individual member of the kind makes it reliably more likely that other of the properties will be instantiated by that individual. Chakravartty's (2007) account distinguishes between "essence kinds," which have necessary and sufficient membership conditions, and "cluster kinds," which are characterized by "sociable" properties, that is, properties that "'like' each other's company" (2007, 170). Despite their disagreements with Boyd, both Chakravartty and Slater apparently continue to hold that shared properties are a key feature of natural kinds, that many kinds do not have essences, and that members of a kind cluster together. Both, then, are cluster theorists. A more detailed accounting of which contemporary accounts qualify as cluster theories of natural kinds is beyond the scope of this paper. Suffice it to say that many prominent theorists share this set of core commitments.

Cluster theories of kinds are usually taken to be a recent arrival on the philosophical scene. This view is supported by a common historical narrative that contends that essentialism dominated thinking about classification until the Darwinian revolution in biology exposed its empirical inadequacy (Hull 1965; Mayr 1968). The implicit shift away from essentialism was solidified when philosophers of biology rejected essentialist thinking outright in the mid-twentieth century, paving the way for Boyd to propose property clustering as a novel philosophical foundation for natural kinds. This "essentialism story" has recently been debunked by historians who point out that it ignores the diversity of views and active debates that characterized pre-Darwinian taxonomy (Winsor 2003, 2006; Levit and Meister 2006; McOuat 2009). (Wilkins [2009] even suggests that *no* pre-Darwinian taxonomists were essentialists about biological species.) But the claim that Boyd was the first cluster theorist of natural kinds has remained unchallenged. We'll now see that this too is a mistake. Not only did William Whewell (1794-1866), a pre-Darwinian thinker, reject essentialism, his account of classification betrays all three commitments of a cluster theory of kinds.

3. Classification and Whewell's Antithetical Epistemology

It is customary to introduce Whewell as a polymath. His academic interests and activities were astonishingly diverse, encompassing mineralogy, crystallography, political economy, architectural history, tidology (his own neologism), educational reform, natural theology, and moral philosophy, among other pursuits (Snyder 2011). Although his research on tides earned him a Royal Society Gold Medal, Whewell took his most important intellectual contributions to be his "metascientific" projects (Yeo 1993). His work as a historian and philosopher of science culminated in two ambitious, multi-volume works: *History of the Inductive Sciences* (1st ed. 1837) and *Philosophy of the Inductive Sciences, Founded Upon Their History* (1st ed. 1840). In the *History,* Whewell presents a historical survey of the sciences from ancient Greek astronomy and mechanics up through nineteenth-century chemistry, physiology, and geology. Whewell's historical work was partly in service of his philosophy: he thought one could "learn the best methods of discovering truth, by examining how truths, now universally recognized, have really been discovered" (Whewell 1858a, 1:3). Although it is difficult to summarize as wide-ranging a work as Whewell's *Philosophy*, Menachem Fisch (1991) argues that it has three primary goals: to formulate a theory of what an inductive science is, to propose methods for excellent science, and to identify marks of a true scientific hypothesis (17-8).

Whewell devotes several chapters of both the *History* and *Philosophy* to scientific classification. His account of natural kinds emerges from these discussions.[3] Throughout his work, Whewell stresses the importance of taxonomy and nomenclature, arguing that classification and description are the "first portion and indispensable foundation" of many, if not all, of the sciences (Whewell 1837, 2:268). One cannot hope to discover general laws, much less understand a phenomenon's causes, without describing and classifying the objects in the domain.[4] In the *Philosophy*, Whewell argues further that any sort of knowledge requires classification: "The *Kinds* of natural objects must differ, and we must think of things as of different Kinds, in order that we may know anything about natural objects" (Whewell 1860, 366). We cannot exercise our intellect on the natural world unless we divide objects into classes and give them names.

Whewell's views on kinds were shaped by his own scientific activities and by what he took to be exemplary science. Early in his career, Whewell was chair of Mineralogy at Cambridge, taking a strong interest in mineralogical taxonomy and making an important contribution to mathematical crystallography (Whewell 1825; see Deas 1959). His (1828) *Essay on Mineralogical Classification and Nomenclature* proposes a naming system for minerals and tries to reconcile two competing classificatory schemes (see Section 7). There Whewell also singles out botany as a field worthy of emulation (1828, xiv). He claims that "in Botany we have an example of a branch of knowledge in which systematic classification has been effected with great beauty and advantage" (Whewell 1858a, 2:108). In Whewell's estimation, the classification of organic bodies had been more successful than the classification of inorganic bodies (Whewell 1837, 3:187). He sought to improve the latter by studying the former.

The lynchpin of Whewell's epistemology and philosophy of science, including his theory of classification, is an idea he dubbed the "Fundamental Antithesis of Philosophy" (Whewell 1844). The Fundamental Antithesis states that all knowledge involves both an empirical, objective, *a posteriori* element, and an ideal, subjective, *a priori* element. Rejecting the Baconian empiricism

[3] In what follows I will generally cite the third edition of the *Philosophy*, which was divided in three parts: the *History of Scientific Ideas* (Whewell 1858a, 2 volumes), *Novum Organon Renovatum* (Whewell 1858b), and *On the Philosophy of Discovery* (Whewell 1860). Scholars usually claim that Whewell's philosophical views did not change much after the first edition of the *Philosophy* was published in 1840 (Fisch 1991, 141; Snyder 2006, 51). Whether or not that is true, I'll be discussing his mature theory of kinds, as presented primarily in later editions of the *Philosophy*. For insight into how Whewell's philosophical views on classification may have developed over time, see Fisch (1991), Sloan (2003), and Quinn (2017).

[4] See Quinn (2016, forthcoming) for interesting discussion of this idea in relation to Whewell's architectural writings. According to Quinn, Whewell's work on the history of German architecture was in part an attempt to found a scientific discipline of historical architecture. Whewell thought that historical architecture, like all historical sciences, involves classification as a foundational component. It requires getting clear on the category of "Gothic architecture" before seeking its historical causes, for instance.

that dominated England at the time, Whewell believed that the mind is not a passive recipient of sense data, but an active participant in knowledge production (Snyder 1997). He took himself to be paving a middle way between ultra-empiricism and the rationalism of German thinkers like Kant (Fisch 1985a; Snyder 2006). Whewell calls the empirical component of knowledge "sensation" or "impressions." Although we can have sensation without mental input, he claims, sensation itself has "no form," and so must be combined with "Ideas" to obtain knowledge (Whewell 1858a, 1:40). He argues, "we can have no knowledge, except we have both impressions on our senses from the world without, and thoughts from our minds within: … except we are passive to receive impressions, and active to compare, combine, and mould them" (1844, 172). To know anything, "Fundamental Ideas" must supply form to our sensations.

Whewell's Fundamental Ideas include Space, Time, Number, Cause, Force, and Substance, among others (Whewell 1858a, 1:82-3).[5] The Fundamental Ideas act through what Whewell calls "conceptions" (Whewell 1858b, 31). Conceptions are "special modifications of [Fundamental Ideas] which are exemplified in particular facts" (Whewell 1858, 31). The Idea of Space, for instance, gives rise to conceptions of particular shapes: square, circle, ellipse (Ruse 1976). To make progress in science, we must clarify and "unfold" the Ideas, generating conceptions that are suitable for the target of our investigation (Whewell 1858b, 30; 1858a, 1: 81). Conceptions play an important role in Whewell's theory of induction. A critical inductive step is the "colligation of facts," a process in which conceptions are used to "bind together the Facts" (Whewell 1858b, 29). During colligation, one brings together a number of facts by finding a conception that fits them. One of Whewell's central examples of colligation – leading to clashes with Mill (Snyder 1997) – was Kepler's discovery of the elliptical orbit of Mars. Kepler's breakthrough, Whewell suggests, consisted in imposing the "*conception* of an *ellipse*, which was supplied by his own mind" on his observations of the locations of Mars (Whewell 1860, 253). Here we see Whewell's Fundamental Antithesis in action: Kepler's (empirical) impressions were colligated with an (ideal) conception to yield new knowledge.

4. Whewell on (i) *Similarity*

Whewell's account of classification takes shape against the backdrop of this "antithetical epistemology" (Fisch 1991; Snyder 2006). His account, I'll now show, incorporates all three commitments of a cluster theory of natural kinds. An initial caveat: Whewell spoke of "kinds" and "natural classes" (both sometimes capitalized) but not "natural kinds." According to Hacking (1991), the term "natural kinds" was coined later by John Venn (1866) as a modification of Mill's phrase "Kinds in nature." Nevertheless, scholars have uniformly read Whewell as talking about what we would today call "natural kinds" (Hacking 1991, 2007; Snyder 2006; Magnus 2015;

[5] These Fundamental Ideas bear an obvious resemblance to Kant's categories. Whewell was quite familiar with Kant, but scholars debate the extent to which Whewell was influenced by him and the degree of similarity between their views (Fisch 1985a, 1991; Sloan 2003; Snyder 2006, 2022; Ducheyne 2014; Sandoz 2016). One important difference is that Whewell's Fundamental Ideas "function not as conditions of experience but as conditions for having knowledge" (Snyer 2006, 44). Another is that Whewell held that the Fundamental Ideas enable knowledge acquisition because they resemble the Ideas used by God to create the world: "How is it that man's Ideas, developed in his internal world, are found to coincide universally with the laws of the external world? …because these Ideas of the human mind are also Ideas of the Divine Mind according to which the universe is constituted" (Whewell 1860, 371).

Khalidi 2016). Whewell did not think that any arbitrary collection of objects forms a "natural class." Natural classes, unlike artificial ones, "already exist in nature" (Whewell 1858a, 2:265).

The breadth of Whewell's academic interests gave him a keen appreciation for the differences between scientific fields (Sandoz 2016). This diversity is reflected in his antithetical epistemology: Whewell claims that different branches of science are oriented around different Fundamental Ideas (Whewell 1858b, 42). There can be no colligation of facts, no inductive inference, without conceptions elaborated from Ideas; but which Ideas are serviceable depends on one's field of study. For instance, mechanics primarily relies on the Ideas of Space, Time, and Number; crystallography on Symmetry; and physiology on Irritability and Final Cause. Whewell groups together botany, zoology, and parts of mineralogy and crystallography under the heading of the "Classificatory Sciences." Their primary task, he claims, is to "divide bodies into kinds" (Whewell 1837, 3:187). The Fundamental Idea on which they depend is the Idea of Likeness or Resemblance (Whewell 1858a, 2:116).

Roughly speaking, the Idea of Likeness is the assumption that objects are similar to and different from one another, and that they can be sorted into classes in accordance with their similarities.[6] Without the Idea of Likeness, Whewell argues, classification would be impossible:

> If we had not the power of perceiving in the appearances around us, likeness and unlikeness, we could not consider objects as distributed into kinds at all. The impressions of sense would throng upon us, but being uncompared with each other, they would flow away like the waves of the sea, and each vanish from our contemplation when the sensation faded. That we do apprehend surrounding objects as belonging to permanent kinds, as being men and horses, oaks and roses, arises from our having the idea of likeness, and from our applying it habitually, and so far as such a classification requires. (Whewell 1858a, 2:98)

Here Whewell claims that the Idea of Likeness is constantly mediating our interactions with the world. But in the classificatory sciences, Likeness "should be applied in a more exact and rigourous manner than in its common and popular employment" (Whewell 1858a, 2:108).

The Idea of Likeness is indispensable to classificatory science because the aim of classification, according to Whewell, is to unite like objects with like: "all classifications are intended to bring together things resembling each other" (Whewell 1858a, 2:7). Indeed, "kinds, sorts, [and] classes" just are collections of individuals "associated in virtue of resemblances, and of permanently connected properties" (Whewell 1858a, 2:102). These claims make evident Whewell's endorsement of *Similarity,* the cluster theorist's first commitment, which states that members of a natural kind share many properties. Echoing taxonomists in France and elsewhere (Sloan 1972), Whewell also draws a distinction between artificial and natural systems of classification. He claims that a system is artificial if it is based on one or a few properties picked out in advance (Whewell 1858b, 174; 1858a, 2:123). On Whewell's view, the Linnaean system of botanical classification is artificial because of its rigid dependence on organs of fructification to

---

[6] I gloss the Idea of Likeness as a sort of assumption or expectation because of passages like the following, which occurs in a discussion of the Ideas requisite for botany and chemistry: "We assume, as a necessary basis of our knowledge, that things are of definite kinds; and the aim of chemistry, botany, and other sciences is, to find marks of these kinds; and along with these, to learn their definitely-distinguished properties" (1844, 177). Similarly, in a discussion of the Idea of Names, Whewell writes, "as the foundation of all [classificatory] labour, and as a necessary assumption during every part of its progress, there has been in men's minds the principle, that objects are so distinguishable by resemblances and differences, that they may be named" (1844, 177).

distinguish different classes of plants (as Linnaeus himself granted; Wilkins 2009, 74). To find natural classes, one must instead attend to the "*total* resemblances and differences" among the objects of study (1828, xix). Unlike artificial classes, natural classes share a "*mass of resemblances*, indicating a natural affinity" (Whewell 1858b, 174; my italics). Perhaps influenced by Mill (Magnus 2015), Whewell even suggests that there are *infinitely* many properties shared by members of a kind (Whewell 1858b*,* 290). Hence, on his view, the classificatory sciences seek to group together similar objects, and members of natural classes resemble one another in myriad ways.

There are a few passages in the *Philosophy* which, taken in isolation, might lead one to doubt Whewell's commitment to *Similarity.* He writes, for example, that "additional Ideas must be employed, besides those of mere likeness and unlikeness, in order to point out that Classification which has a real scientific value" (Whewell 1858a, 2:116). Likewise, he argues that botanist Michel Adanson mistakenly takes resemblance "to suffice for the general arrangement" of plants (Whewell 1858a, 2:129; see footnote 15). But such claims do not signal Whewell's retreat from the idea that members of a natural class resemble one another. Rather, they stem from a recognition that resemblance is "vague" and multi-faceted (Whewell 1858a, 2:127). We need other Fundamental Ideas to point us to *which* similarities are most important in each domain: "in minerals as in plants, the mere general notion of Likeness cannot lead us to a real arrangement: this notion requires to have precision and aim given to it by some other relation; -- by the relation of Chemical Composition in minerals, as by the relation of Organic Function in vegetables" (Whewell 1858a, 2:139). In other words, the similarity that matters most for mineralogical classification is similarity of composition; in botany, it is functional similarity. The Idea of Likeness is "unfolded" as science progresses by identifying the appropriate conception of likeness for each domain. *Similarity* remains central to Whewell's view of natural kinds, even though he claims Likeness must be supplemented with other Fundamental Ideas to yield determinate classes.[7]

5. Whewell on (ii) *Anti-Essentialism*

Some philosophical proponents of *Similarity* argue further that certain resemblances between members of a natural kind constitute the kind's essence: that for every natural kind there is a property or set of properties that are necessary and sufficient for kind membership (Ellis 2001; Devitt 2008). Whewell is not one of these thinkers. Scholars usually – and, I think, correctly – interpret Whewell as rejecting essentialism about natural kinds (Ruse 1976; McOuat 2009; Wilkins 2013; Quinn forthcoming).

The main line of evidence for Whewell's commitment to *Anti-Essentialism* is his resistance to defining natural classes (Whewell 1833). McOuat (2009) explains that Whewell's opposition to definitions was a rejection of reform efforts by philosophical radicals like Jeremy Bentham. Taking from Locke an admonition to "Define your words," Bentham and his allies held that establishing precise definitions of terms was key to both scientific and moral progress (McOuat 2009, 214; see

[7] How are we to determine which conception of likeness is most relevant to each branch of science? Whewell's answer comes from his "Fundamental Principle of Classification," which states that the ultimate purpose of classifying is to enable the formulation of true general assertions (Whewell 1858b, 220). The relevant notion of similarity for a given domain is the one that best facilitates the articulation of true generalizations about that domain. As he explains, "The object of a scientific Classification is to enable us to enunciate scientific truths: we must therefore classify according to those resemblances of objects (plants or any others) which bring to light such truths" (Whewell 1858a, 2:114).

also McOuat 1996). Conservative Whewell resisted this reform movement (Snyder 2006). In his work on classification, he argues that seeking definitions of kinds is "almost always, not only useless, but prejudicial" (Whewell 1858b, 231). According to Whewell, "in every department of Natural History the object of our study is *kinds* of things, not one of which kinds can be rigorously defined, yet all of them are sufficiently definite. In these cases we may indeed give a specific description of one of the kinds, and may call it a definition; but it is clear that such a definition does not contain the essence of the thing" (Whewell 1858b, 175). Here Whewell grants that one often sees what look like definitions in the classificatory sciences, but argues they do not specify a kind's essence. They are rather useful heuristics for the naturalist, who relinquishes them when necessary. So-called definitions are "never immortal," for "[i]f we find a case which manifestly belongs to our Natural Class, though violating our Definition, we do not shut out the case, but alter our definition" (Whewell 1858b*,* 231-2). If a scientist refuses to alter their definitions, clinging stubbornly to characterizations of classes adopted at the outset of inquiry, they will end up with artificial classes rather than natural ones.

Whewell justifies his opposition to essential definitions in several ways. First, he gives examples of definitions of natural classes that have obvious exceptions. There are certain rose species, for instance, that lack the characteristic properties of roses (Whewell 1858b*,* 175). Second, he argues that trying to define natural classes leads to a problem of regress. Once we define a tree as "a living thing without the power of voluntary motion," we find ourselves in need of definitions of "living thing" and "voluntary motion," and so on *ad infinitum* (Whewell 1858a, 2:99). Finally, even the most precise and sophisticated thinkers "would find it difficult or impossible to give good definitions even of a few of the general names which they use" (Whewell 1858a, 2:99-100). Since definitions of most natural classes are out of reach, it would be foolish to insist that classification needs them.

What should taxonomists use to characterize a natural class, if not a definition? Whewell suggests we appeal to a *Type*. When well-chosen by the natural historian, a Type is "an example which possesses in a marked degree all the leading characters of [its] class" (Whewell 1858b, 21; see also 1858a, 2:121-2). This proposal leads McOuat (2009) to label Whewell's account a "prototype" theory of natural kinds. Whewell is suggesting that we describe each natural class by reference to one of its prototypical members. To characterize a family of plants, for instance, we pick out one genus within the family that displays its typical characteristics. Whewell summarizes his position in a Baconian aphorism: "Natural Groups are best described, not by any Definition which marks their boundaries, but by a Type which marks their center" (Whewell 1858b*,* 21).

Whewell's notion of a type can be understood, following Farber (1976), as a "classification type-concept," on which a type is a "taxonomic model" used in classification and nomenclature. Farber explains that nineteenth-century naturalists interpreted classification type-concepts in different ways: some took types to be merely "convenient tool[s] for characterizing groups," while others thought that types were a "reflection of a real relationship in nature" (Farber 1976, 114-115). Whewell belongs in the former camp, for he indicates that naturalists have (some) discretion in selecting the Type of a natural class. He explains, "we cannot say of any one genus that it *must* be the Type of the family, or any one species that it *must* be the Type of the genus" (Whewell 1858a, 2:122). The naturalist should strive to choose a Type that is "connected by many affinities with most of the others of its group" (Whewell 1858a, 2:122). But often there are multiple reasonable options (see e.g., the discussion of roses in Whewell 1858b*,* 21).[8]

[8] Not only does a Type help to *characterize* a natural class (and identify its members; Winsor 2003), there are also suggestions in Whewell that the Type of a class has a name-fixing function. Whewell's view on

Whewell's hostility to definitions and endorsement of Types strongly suggest that he accepts *Anti-Essentialism.* Snyder (2005, 2006), however, has recently dissented from this common interpretation. She argues that Whewell thinks natural kinds do have essences, we just don't know what most of them are. On her reading, Whewell believes in "essential, underlying traits" that define each natural class and are responsible for its superficial properties (Snyder 2006, 159). His denigration of definitions is merely a warning about defining classes too early. Adopting definitions at the outset of an investigation is usually "prejudicial" because it prevents us from modifying our classes in light of new observations (Whewell 1858b, 231). But this doesn't mean natural classes can never be defined. Snyder argues that Whewell believes kinds have essences that are known by God. Sometimes, at the end of inquiry, we too may be in a position to know the essence of a kind. In other cases, the essence of a kind may remain permanently out of reach. Still, Snyder claims, despite this epistemological pessimism, Whewell remains committed to kind essences.

Some of the textual evidence Snyder offers for an essentialist reading of Whewell is equivocal. The passages she cites do indeed show that Whewell thinks the observable properties of a class are often explained by unobservable properties. But this is a far cry from essentialism: the unobservable properties that characterize a class may give rise to observable properties without constituting an essence. Snyder also claims that Whewell identifies the essences of different sorts of objects: in plants, for instance, "the essence is the 'general structure and organization' of the being, especially those organs most important for the preservation of life" (Snyder 2006, 159). But in the passage of the *History* she cites, there is no mention of essences or definitions. Whewell does think botanists should pay particular attention to structure and organization, but he does not say that they constitute the essences of plant kinds (Whewell 1837, 3:338).

The strongest evidence for Whewell's essentialist leanings comes from the following passage of the *Philosophy*:

> [I]n how few cases – if indeed in any one – can we know what is the essence of any Kind;– what is the real nature of the connexion between the character of the Kind and its Properties! Yet on this point we must suppose that the Divine Intellect, which is the foundation of the world, is perfectly clear. Every Kind of thing, every genus and species of object, appears to Him in its essential character, and its properties follow as necessary consequences. He sees the essences of things through all time and through all space; while we, slowly and painfully, by observation and experiment…make out a few of the properties of each Kind of thing. (Whewell 1860*,* 367-8)

Snyder takes Whewell to be claiming that God knows the essences of natural kinds, though they are often inaccessible to us. This passage is indeed initially difficult to square with the anti-essentialist tenor of the rest of Whewell's work on classification. But additional context casts it in a different light. In the chapter of the *Philosophy* in which the passage appears, Whewell is

---

the role of Types in nomenclature was likely influenced by the 1842 Strickland Code for zoological nomenclature and its "type method" (McOuat 1996, Quinn forthcoming). According to Whewell, "the mode in which words in common use acquire their meaning, approaches far more nearly to the *Method of Type* than to the method of definition" (Whewell 1858b, 176-7). Whewell seems to be endorsing something akin to the causal theory of reference thought to originate in the latter half of the twentieth century (Haber 2012). On Whewell's view, we ought to look to the world, rather than definite descriptions, to understand what terms signify: "The Book of Nature is its dictionary: it is there that the natural historian looks, to find the meaning of the words which he uses" (Whewell 1858b*,* 177). My thanks to Aleta Quinn for discussion on this point.

proceeding systematically through the most important Fundamental Ideas, arguing that each one is mirrored by a similar Idea in the mind of God. The paired Ideas are not identical, however, for Ideas are "immeasurably more luminous, penetrating and comprehensive in the Divine than in the human mind" (Whewell 1860*,* 367). Whewell devotes several pages to what he calls the "Idea of Kinds" and the "correlative" "Idea of Properties" (Whewell 1860, 367). Together these Ideas imply that the objects that exist belong to distinct kinds, and that kinds are individuated by property resemblances and differences. (On my reading, this is a relabeling of the Idea of Likeness. It is not uncommon for Whewell to refer to the same Idea using multiple names.) Whewell argues that humans are largely ignorant about the connections between kinds and properties: we know that "the Properties of Things depend upon their Kinds, and that the Kind of Things are determined by their Properties," but we do not fully understand why or how (Whewell 1860, 367). The purpose of the passage quoted above is to draw a contrast with God, who alone fully understands "the nature of the connexion of Kinds and Properties" (Whewell 1860*,* 367).

Given its place in this dialectic, we can read the above passage not as being about God's acquaintance with the necessary and sufficient properties that define every natural kind, but rather God's deeper understanding of the properties that members of a kind tend to share. While we may make out a few of those shared properties, God knows them all. And though we may come to understand some of the (apparently contingent) ways in which these properties are linked to one another, God understands all of the connections, which are for Him "necessary." For example, we have now discovered a few of the ways in which a mineral's micro-structural properties predict its macro-level properties. But while the human mind is "all but wholly dark" on such matters, the Divine Mind "must be fully perfectly clear" about how the countless properties of minerals are related to one another (Whewell 1860, 367). Talk of "essences" in the passage therefore shouldn't be taken as evidence of essentialism. Whewell is stressing the partiality of human understanding of kinds, not the existence of essential properties known only by God.

Snyder's interpretation of the passage renders it highly anomalous: Whewell's extensive writings contain repeated and adamant discussions of the impossibility of finding essential definitions for kinds, and very little about God's potential acquaintance with them. This lends credibility to the alternative interpretation proposed here. The most consistent reading of Whewell, which takes seriously his preference for Types over definitions, understands him as committed to *Anti-Essentialism.*[9]

6. Whewell on (iii) *Separation*

The final commitment of the cluster theorist is to the existence of gaps between the collections of individuals that comprise distinct natural kinds. There are at least two indications that Whewell endorses *Separation:* first, he proposes an "inductive method" for classification that

---

[9] Snyder's (2006) interpretation of Whewell as an essentialist may be rooted in her conflation of natural kind realism with essentialism. Throughout her book, she implicitly adopts a Lockean view on which natural kinds *just are* things with real essences (Snyder 2006, 159, 164). For her, then, a rejection of real essences is a denial of the existence of natural kinds. This assumption is evident in Snyder's argument about Mill: she claims that because Mill rejected Lockean essences, he didn't believe in natural kinds (Snyder 2006, 163-4). Since it is clear from Whewell's work that he *does* believe natural classes exist, Snyder is more or less forced to interpret him as an essentialist. There is far less pressure to find essentialism in Whewell once we discard the assumption that belief in essences is a prerequisite for belief in natural kinds.

presupposes it; and second, the spatial metaphors that he constructs suggest an image of natural kinds as clusters separated from one another in property space.[10]

In the *Philosophy,* Whewell articulates an inductive "Method of Gradation" to be used when "gather[ing] together the cases which resemble each other, and… separat[ing] those which are essentially distinct" – that is, when sorting individuals into kinds (Whewell 1858b*,* 224). The Method of Gradation involves taking the "intermediate stages of the properties in question, so as to ascertain by experiment whether, in the transition from one class to another, we have to leap over a manifest gap, or to follow a continuous road" (Whewell 1858b*,* 224). The Method seems to be intended for a taxonomist who is trying to determine if a collection of objects belongs to a single class or two distinct classes. Whewell is suggesting that the taxonomist line up the objects in accordance with one or more of their properties, then look for a discontinuity or "manifest gap" in the sequence. If there is a gap, the kinds "are separated by distinctions of opposites" rather than mere "differences in degree" (Whewell 1858b, 224). Whewell gives a number of historical examples of this method being deployed (Whewell 1858b*,* 224-8).[11] One involves Michael Faraday, who Whewell describes as showing that "Electrics" and "Conductors" are not distinct classes by demonstrating that there is a "gradation" between conductors and non-conductors. The Method of Gradation presupposes *Separation*, as it treats the presence of a "manifest gap" as a marker of distinct classes, and the absence of a gap as an indicator that objects belong to the same kind.[12]

Another clue that Whewell endorses *Separation* comes from his spatial metaphors. In a discussion of Types, Whewell explains that the Type of a natural class should be an instance that is "near the center of the crowd, and not one of the stragglers" (Whewell 1858a, 2:122; see also Whewell 1858b, 176). This metaphorical language is suggestive of a property space, a construct often invoked by cluster theorists (see Section 2). Whewell seems to be imagining individuals distributed in a space where greater proximity represents greater similarity. Each natural kind is associated with a "crowd" of individuals. These "crowds" are separated by relatively unpopulated regions where one finds only "stragglers." We find a similar image in Whewell's discussion of the relation between Type-species and their corresponding genera:

---

[10] Whewell's commitment to *Separation* distinguished him from other thinkers. Many earlier philosophers and natural historians believed that nature is characterized by continuous gradation along the Great Chain of Being (Wilkins 2009). Some held, for instance, that plants "resembl[e] one another in continuous series, rather than as lumpy groups separated by gaps" (Winsor 2003, 392).

[11] I doubt that all of Whewell's examples are applications of the same rule. Some seem to involve inferring the existence of a particular causal process from the observation of all its intermediate products. If such examples are to be taken seriously, the Method of Gradation includes more than what I've suggested here.

[12] Aleta Quinn (personal correspondence) shared with me an unpublished draft chapter of Whewell's *Philosophy* that deals with natural affinity (c. 1835). Though not fully legible, it appears to argue that "homogenous[?] analogy," which "exists between objects of the same kind," can be demonstrated by exhibiting a continuous sequence in a body part of different species. For instance, Whewell claims that the bones in the forelimbs of animals "are absolutely the same; or at least can be traced from one form to another with no violation of continuity." (Whewell's ideas about homology were almost certainly shaped by interactions with and feedback from Richard Owen [Sloan 2003]). Such an argument from continuity of form to sameness of kind would seem to be another application of the (as yet unnamed) Method of Gradation in Whewell's early work. I am grateful to Aleta for alerting me to this unpublished material and sharing her transcription.

> All the species which have a greater affinity with [the] Type-species than with any others, form the genus, and are ranged about it, deviating from it in various directions and different degrees. Thus a genus may consist of several species, which approach very near the type, and of which the claim to a place with it is obvious; while there may be other species which straggle further from this central knot, and which are yet clearly more connected with it than any other. And even if there should be some species of which the place is dubious, and which appear to be equally bound by two generic types, it is easily seen that this would not destroy the reality of the generic groups, any more than the scattered trees of the intervening plain prevent our speaking intelligibly of the distinct forests of two separate hills. (Whewell 1858a, 2:122)

There is much to unpack in this rich passage. Types are again characterized spatially: species that belong to a genus are "ranged about" the Type-species of the genus. Particular species are closer to or farther from the Type-species, depending on their similarity to it. Whewell also hints that one can determine the genus that a species belongs to by finding the closest Type-species. This too suggests that kind membership is a matter of finding the nearest property cluster.

The end of the passage contains a reply to an anticipated objection from a skeptic about the reality of genera. The skeptic points out that there are species that lie equidistant (so to speak) from two Type-species, making their genus membership uncertain. Because genera do not have sharp boundaries, the skeptic suggests, they are not real. Whewell agrees that genera have vague boundaries but resists the skeptic's conclusion. He offers an argument by analogy, pointing out that we can clearly distinguish the distinct forests of two separate hills even if there are a few trees scattered on the plain between the hills. This reply belies a commitment to *Separation*. The reason the forests are "distinct" is that they are each associated with a high density of trees, and the density declines as one goes from hill to plain. Whewell applies the same reasoning to biological taxonomy. Kinds aren't threatened by edge cases: their existence only requires that the members of each kind cluster together, leaving a relative gap between them.[13]

7. Consilience and Clustering

We've now seen that Whewell shares with contemporary cluster theorists a commitment to *Similarity, Anti-Essentialism,* and *Separation*. His account of classification implies that natural kinds, which typically defy essential definition, are clusters of similar individuals. He is therefore an early cluster theorist of kinds. There is also a significant connection between Whewell's account of natural kinds and his well-known notion of consilience. Understanding this relationship not only bolsters the conclusion that Whewell is a cluster theorist, but also sheds light on the practical implications of his theory of kinds.

Whewell proposes consilience as one of the best indicators of truth in a scientific hypothesis (Laudan 1971; Ruse 1976, 1979; Fisch 1985b, 1991; Harper 1989; Snyder 2005, 2006,

[13] Whewell's recognition that natural classes have fuzzy boundaries is another area of overlap with contemporary cluster theories. A core tenet of Boyd's view is that there are cases of "extensional indeterminacy" where "no rational considerations dictate" whether an individual belongs to a particular kind or not (Boyd 1999a, 144). Whewell likewise claims that the "outskirts" of distinct genera might approach one another, "and may even be intermingled, so that some species may doubtfully adhere to one group or another" (Whewell 1858b, 176). But this grey area doesn't undermine the kinds' existence: "there may be very important differences between two groups of objects, though we are unable to tell where the one group ends and where the other begins" (Whewell 1858b, 176).

2022). As he explains, "[t]he Consilience of Inductions takes place when an Induction, obtained from one class of facts, coincides with an Induction, obtained from another different class" (Whewell 1858b, 70-1). A theory is consilient when it is able to explain not just the facts it was formulated to account for, but facts of other kinds as well. For Whewell, the consilience of inductions is confirmatory: "the evidence in favour of our induction is of a much higher and more forcible character when it enables us to explain and determine cases of a *kind different* from those which were contemplated in the formation of our hypothesis... No accident could give rise to such an extraordinary coincidence" (Whewell 1858b, 87-8). Whewell's favorite example of the consilience of inductions is Newton's discovery that an inverse-square attractive force accounts for a variety of astronomical and physical phenomena. Just as Newton's law of universal gravitation was confirmed by this unexpected unification of facts, any scientific hypothesis is confirmed when it allows "facts altogether different" to "jum[p] together" (Whewell 1858b, 88).

Whewell applies the concept of consilience not just to scientific hypotheses, but also to scientific classification (Quinn 2017). Two taxonomic schemes are consilient when they converge on the same classes. To explain the consilience of classifications, Whewell cites botanist Augustin Pyramus de Candolle, who argued that the same major groupings emerge if one looks at either plants' nutritive organs or reproductive organs. According to Candolle, taxonomies based on the two great functions of plants – growth and reproduction – are "necessarily the same" (Whewell 1858a, 2:163). Just as Whewell takes consilience of inductions to confirm the hypothesis from which the inductions derive, he sees consilience of classifications as marker of naturalness, declaring: "the Maxim by which all Systems professing to be natural must be tested is this: -- that the *arrangement obtained from one set of characters coincides with the arrangement obtained from another set*" (Whewell 1858a, 2:163). A system of natural classes can be approached from different theoretical perspectives, oriented toward different characters. Whewell intends this "test" to be thoroughly practical. A taxonomist ought to ensure "that our classes being collected according to one mark, are confirmed by many marks not originally stated in our scheme" (Whewell 1858b, 174).[14]

Whewell developed these ideas in his early studies of mineralogy. In 1825 he traveled to Germany to learn about the two leading schools of mineralogical classification (Whewell and Douglas 1881), one based on the "physical or external characters" of minerals, and the other on minerals' chemical properties (Whewell 1828, iii). Rather than picking sides, Whewell ultimately argued that what matters most is convergence between the two approaches:

> [W]hatever may be thought of the respective merits of these two modes of classification, this will probably be allowed; -- that either of them would receive a remarkable confirmation if it conducted us to the other: -- That if the classes selected in consequence of their external properties, were found to have each some peculiarity or common analogy of chemical constitution; -- or if the divisions made by the chemists were found to consist of minerals with striking external resemblances; -- we should acquire a sort of criterion that we were approaching to a system which was both chemically and mineralogically true. (Whewell 1828, iii)

In other words, natural classes of minerals can be found through independent examination of both their external properties and their chemical constitution. Whewell claims that, as a matter of fact,

[14] The remainder of this passage reads: "…and are thus found to be grouped together, not by a single resemblance but by a mass of resemblances, indicating a natural affinity." For more on Whewell's understanding of natural affinity and its relation to consilience, see Quinn (2017, forthcoming).

there is consilience between the two schemes, and hence that scientists have identified some natural classes of minerals.[15]

Whewell's remarks about consilience in classification reinforce the conclusion that he is a cluster theorist of natural kinds. Discovering consilience across different taxonomic schemes suggests that those schemes pick out groups of objects that cluster together. Consider two proposed taxonomies of fish, one based on jaw bone structure and the other on gill morphology. The taxonomies are consilient if the groups in each system are the same, i.e., if the individuals that cluster together when one looks at jaw structure also cluster when one examines gill morphology. We can see the resulting classes as property clusters, since the individuals that comprise them are united by multiple independent characteristics.

This argument can be illustrated with a familiar spatial metaphor. Consider two different property spaces. The axes of the first, m-dimensional space represent various features of a fish's jaw, such as the number of jaw sets, their positioning, linkage mechanisms, degree of protrusion, and so on. The axes of the second, n-dimensional space represent various properties of fish gills, including surface area, number of gill openings, and presence or absence of a bony cover. Imagine that scientists investigating jaw morphology find groups of fish that cluster together in the first property space, while scientists investigating gills find groups of fish that cluster together in the second. (Whewell's comments about the method of gradation support this picture of local classificatory practice.) Consider what would happen if the first, m-dimensional space were combined with the second, n-dimensional space to create an $m+n$-dimensional space which included properties related to both jaw structure and gill morphology. If the taxonomic schemes are consilient, the clusters found in the initial property spaces will be preserved in the combined property space. A cluster of individuals in the jaw-based property space will remain clustered together in the combined space if they also cluster along the gill-related dimensions. If the taxonomic schemes are not consilient – that is, if gill-based groupings of fish are different from jaw-based groupings – then one will not find clusters in the combined property space, since individuals similar to one another along the jaw-related dimensions will find themselves far apart along gill-related dimensions.

This suggests that consilience and property clustering go hand in hand. On Whewell's view, natural systems of classification are discoverable through independent consideration of different significant properties of the objects under study. Natural classes thus correspond to clusters of individuals in a high-dimensional space whose axes represent the properties that ground alternative classificatory approaches. Since Whewell recommends consilience as a marker of natural classes, and seeking consilience can lead one to property clusters, we have yet more evidence that Whewell is a cluster theorist of natural kinds.

8. Classification: Theory and Practice

[15] For Whewell, consilience involves convergence across *principled* systems of classification. This is what distinguishes consilience from Adanson's "method of general comparison" (Whewell 1837, 3:333-5; 1858a, 2:128-30). Adanson proposed constructing a large number of "artificial systems" based on single characters, and taking as natural those classes which reappear in a large number of systems. Echoing the criticisms of Candolle, Whewell argues that classification cannot start from the infinite resemblances between objects. Rather, the taxonomist must focus on "significant" resemblances that enable one to formulate true scientific assertions in the domain under investigation (see footnote 7). We want consilience across well-motivated taxonomies, not consilience across as many artificial systems as one can dream up (Quinn 2017).

Central aspects of Whewell's philosophy of science were given a "less than appreciative" reception by many twentieth-century commentators (Fisch 1991, 4; e.g., Laudan 1971, Buchdahl 1991). Lately, though, scholarly opinion has warmed to Whewell, bringing renewed attention to his work (e.g., Ruse 1991; Yeo 1993; Snyder 1997, 2006; Ducheyne 2014). The argument defended here contributes to this revival by showing the richness of Whewell's views of classification (see also Quinn 2017). Whewell may have been the earliest cluster theorist of natural kinds: the first to integrate *Similarity, Anti-Essentialism,* and *Separation* in a theory of classification. This is yet another strike against the "essentialism story" that takes all pre-Darwinian thinkers to be proponents of an unscientific essentialism about the biological world (Winsor 2006). Whewell opposed evolutionism both before and after the publication of Darwin's *Origin* (Ruse 1975; Snyder 2006). Yet he not only rejected essentialism, he pioneered a (now leading) alternative theory of natural kinds.

Why has Whewell been overlooked in narratives about the development of cluster theories of kinds? It is only recently that Whewell's views on classification have been brought into the contemporary conversation about natural kinds at all (Hacking 1991, 2007; Khalidi 2016). This is probably due in part to the fact that most recent work on natural kinds has roots in the twentieth-century literature on the semantics of natural kind terms, most associated with Putnam and Kripke. As P.D. Magnus (2014) explains, this literature in philosophy of language had very little contact with the nineteenth-century tradition of natural kinds, to which Whewell and Mill were the primary contributors. According to Magnus, then, "the presently active tradition of natural kinds is less than half a century old" (2014, 0). Neglect of Whewell's cluster theory must be understood in light of this discontinuity in philosophical thinking about natural kinds.

Still, there is much to be gained from properly locating Whewell in the tradition of cluster theories of kinds. Philosophical work on natural kinds can seem somewhat remote from the practice of scientific classification. Philosophers are interested in questions about the nature and status of essences, whether kinds reflect human interests, and how kinds support induction. But it is often unclear what answers to those questions imply for how scientists ought to classify objects in their domain of study. A philosophical theory might tell us what natural kinds are but not how to find them. Even philosophers who hold that our theories of natural kinds should be responsive to scientific practice often treat the interaction as unidirectional: science can teach us about natural kinds, but a theory of natural kinds carries few prescriptions for scientists.

Whewell, however, aimed to provide methodological guidance for the classificatory sciences. As a result, his work contains important insights about what a cluster theory of kinds means for taxonomic practice. His "method of gradation," which is grounded in the cluster theorist's commitment to *Separation,* offers a way of testing for the presence of distinct kinds within a population. Indeed, this method is arguably implicit in the contemporary use of cluster analysis techniques to discover scientific kinds (Hennig et al. 2015).

Whewell's most significant methodological contribution to classification is his notion of consilience. On the assumption that natural kinds are property clusters, Whewell points out that scientists looking for natural kinds ought to seek out categories that are discoverable from different theoretical perspectives. That is, they ought to look for classes of objects that recur when one considers multiple, independent systems of important properties. Using consilience as a guide to classification can lead one to collections of objects that cluster together in property space. Contemporary cluster theorists, I suggest, would do well to take up Whewell's emphasis on consilience. Seeking consilient classes is a reasonable and non-obvious heuristic for picking out collections of objects that qualify as natural kinds on a property cluster account. Hence, understanding Whewell as a cluster theorist helps bridge the gap between the theory and practice of natural kinds.

References

Bird, Alexander, and Emma Tobin. 2022. “Natural Kinds.” In *The Stanford Encyclopedia of Philosophy*, ed. Edward N. Zalta, Spring 2022. Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/entries/natural-kinds/ .

Boyd, Richard. 1989. “What Realism Implies and What It Does Not.” *Dialectica* 43 (1–2): 5–29.

———. 1991. “Realism, Anti-Foundationalism and the Enthusiasm for Natural Kinds.” *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition* 61 (1/2): 127–48.

———. 1999a. “Homeostasis, Species, and Higher Taxa.” In *Species: New Interdisciplinary Essays*, ed. R. A. Wilson, 141–85. Cambridge, MA: MIT Press.

———. 1999b. “Kinds, Complexity and Multiple Realization: Comments on Millikan’s ‘Historical Kinds and the Special Sciences.’” *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition* 95 (1/2): 67–98.

Broad, C. D. 1920. “The Relation between Induction and Probability (Part II).” *Mind* 29 (113): 11–45.

Brzović, Zdenka. 2018. “Natural Kinds.” In *Internet Encyclopedia of Philosophy*, ed. James Fieser, Robert Bishop, and Brad Dowden. https://iep.utm.edu/nat-kind/ .

Buchdahl, Gerd. 1991. “Deductivist Versus Inductivist Approaches in the Philosophy of Science as Illustrated by Some Controversies Between Mill and Whewell.” In *William Whewell: A Composite Portrait*, ed. Menachem Fisch and Simon Schaffer, 311–44. Oxford: Oxford University Press.

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

Deas, Herbert D. 1959. “Crystallography and Crystallographers in England in the Early Nineteenth Century: A Preliminary Survey.” *Centaurus* 6 (2): 129–48.

Devitt, Michael. 2008. “Resurrecting Biological Essentialism.” *Philosophy of Science* 75 (3): 344–82.

Ducheyne, Steffen. 2014. “Whewell’s Philosophy of Science.” In *The Oxford Handbook of British Philosophy in the Nineteenth Century*, ed. W.J. Mander, 71–88. Oxford: Oxford University Press.

Dupré, John. 1981. “Natural Kinds and Biological Taxa.” *The Philosophical Review* 90 (1): 66–90.

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

Ereshefsky, Marc, and Mohan Matthen. 2005. “Taxonomy, Polymorphism, and History: An Introduction to Population Structure Theory.” *Philosophy of Science* 72 (1): 1–21.

Farber, Paul Lawrence. 1976. “The Type-Concept in Zoology during the First Half of the Nineteenth Century.” *Journal of the History of Biology* 9 (1): 93–119.

Fisch, Menachem. 1985a. “Necessary and Contingent Truth in William Whewell’s Antithetical Theory of Knowledge.” *Studies in History and Philosophy of Science Part A* 16 (4): 275–314.

———. 1985b. “Whewell’s Consilience of Inductions--An Evaluation.” *Philosophy of Science* 52 (2): 239–55.

———. 1991. *William Whewell, Philosopher of Science*. New York: Oxford University Press.

Griffiths, Paul E. 1999. “Squaring the Circle: Natural Kinds with Historical Essences.” In *Species: New Interdisciplinary Essays*, ed. Robert A. Wilson, 209–28. MIT Press.

Haber, Matthew H. 2012. “How to Misidentify a Type Specimen.” *Biology and Philosophy* 27 (6): 767–84.

Hacking, Ian. 1991. “A Tradition of Natural Kinds.” *Philosophical Studies: An International Journal for Philosophy in the Analytic Tradition* 61 (1/2): 109–26.

———. 2007. “Natural Kinds: Rosy Dawn, Scholastic Twilight: Ian Hacking.” *Royal Institute of Philosophy Supplement* 61: 203–39.

Harper, William. 1989. “Consilience and Natural Kind Reasoning.” In *An Intimate Relation: Studies in the History and Philosophy of Science Presented to Robert E. Butts on His 60th Birthday*, ed. James Robert Brown and Jürgen Mittelstrass, 115–52. Boston Studies in the Philosophy of Science. Dordrecht: Springer Netherlands.

Hennig, Christian, Marina Meila, Fionn Murtagh, and Roberto Rocci, eds. 2015. *Handbook of Cluster Analysis*. CRC Press.

Hull, David L. 1965. “The Effect of Essentialism on Taxonomy—Two Thousand Years of Stasis (i).” *The British Journal for the Philosophy of Science* 15 (60): 314–26.

Khalidi, Muhammad Ali. 2016. “Natural Kinds.” In *The Oxford Handbook of Philosophy of Science*, ed. Paul Humphreys, Anjan Chakravartty, Margaret Morrison, and Andrea Woody, 397–416. Oxford University Press.
———. 2018. “Natural Kinds as Nodes in Causal Networks.” *Synthese* 195 (4): 1379–96.
Laudan, Larry. 1971. “William Whewell on the Consilience of Inductions.” *The Monist* 55 (3): 368–91.
Levit, Georgy S., and Kay Meister. 2006. “The History of Essentialism vs. Ernst Mayr’s ‘Essentialism Story’: A Case Study of German Idealistic Morphology.” *Theory in Biosciences* 124 (3): 281–307.
Magnus, P. D. 2011. “Drakes, Seadevils, and Similarity Fetishism.” *Biology and Philosophy* 26 (6): 857–70.
———. 2012. *Scientific Enquiry and Natural Kinds: From Planets to Mallards*. Palgrave-Macmillan.
———. 2014. “No Grist for Mill on Natural Kinds.” *Journal for the History of Analytical Philosophy* 2 (4).
———. 2015. “John Stuart Mill on Taxonomy and Natural Kinds.” *HOPOS: The Journal of the International Society for the History of Philosophy of Science* 5 (2): 269–80.
Mayr, Ernst. 1968. “Theory of Biological Classification.” *Nature* 220 (5167): 545–48.
McOuat, Gordon. 1996. “Species, Rules and Meaning: The Politics of Language and the Ends of Definitions in 19th Century Natural History.” *Studies in History and Philosophy of Science Part A* 27 (4): 473–519.
———. 2009. “The Origins of ‘Natural Kinds’: Keeping ‘Essentialism’ at Bay in the Age of Reform.” *Intellectual History Review* 19 (2): 211–30.
Quine, W. V. 1969. “Natural Kinds.” In *Ontological Relativity & Other Essays*, 114–38. New York, NY: Columbia University Press.
Quinn, Aleta. 2016. “William Whewell’s Philosophy of Architecture and the Historicization of Biology.” *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 59 (October): 11–19.
———. 2017. “Whewell on Classification and Consilience.” *Studies in History and Philosophy of Science Part C: Studies in History and Philosophy of Biological and Biomedical Sciences* 1 (64): 65–74.
———. Forthcoming. “Whewell and Scientific Classification.” In *William Whewell: Victorian Polymath*, ed. Lukas M. Verbugt. University of Pittsburgh Press.
Ruse, Michael. 1976. “The Scientific Methodology of William Whewell.” *Centaurus* 20 (3): 227–57.
———. 1979. “Falsifiability, Consilience, and Systematics.” *Systematic Zoology* 28 (4): 530–36.
———. 1991. “William Whewell: Omniscientist.” In *William Whewell: A Composite Portrait*, ed. Menachem Fisch and Simon Schaffer, 87–116. Oxford, New York: Oxford University Press.
Russell, Bertrand. 1948. *Human Knowledge, Its Scope and Limits*. Simon and Schuster.
Sandoz, Raphaël. 2016. “Whewell on the Classification of the Sciences.” *Studies in History and Philosophy of Science* 60 (December): 48–54.
Searle, John R. 1958. “Russell’s Objections to Frege’s Theory of Sense and Reference.” *Analysis* 18 (6): 137–43.
Serpico, Davide. 2018. “What Kind of Kind Is Intelligence?” *Philosophical Psychology* 31 (2): 232–52.
Slater, Matthew H. 2015. “Natural Kindness.” *The British Journal for the Philosophy of Science* 66 (2): 375–411.
Sloan, Phillip R. 2003. “Whewell’s Philosophy of Discovery and the Archetype of the Vertebrate Skeleton: The Role of German Philosophy of Science in Richard Owen’s Biology.” *Annals of Science* 60 (1): 39–61.
Snyder, Laura J. 1997. “The Mill-Whewell Debate: Much Ado about Induction.” *Perspectives on Science* 5 (2): 159–98.
———. 2005. “Consilience, Confirmation, and Realism.” In *Scientific Evidence: Philosophical Theories & Applications*, ed. P. Achinstein, 129–49. The Johns Hopkins University Press.
———. 2006. *Reforming Philosophy: A Victorian Debate on Science and Society*. Chicago, IL: University of Chicago Press.
———. 2011. *The Philosophical Breakfast Club: Four Remarkable Friends Who Transformed Science and Changed the World*. New York: Broadway Books.
———. 2022. “William Whewell.” In *The Stanford Encyclopedia of Philosophy*, ed. Edward N. Zalta, Summer 2022. Metaphysics Research Lab, Stanford University. https://plato.stanford.edu/archives/sum2022/entries/whewell/
Tsou, Jonathan Y. 2021. *Philosophy of Psychiatry*. Cambridge University Press.
Venn, John. 1866. *The Logic Of Chance*. London: Macmillan and Company.

Whewell, William. 1825. “IV. A General Method of Calculating the Angles Made by Any Planes of Crystals, and the Laws According to Which They Are Formed.” *Philosophical Transactions of the Royal Society of London* 115 (January): 87–130.

———. 1828. *An Essay on Mineralogical Classification and Nomenclature*. Cambridge: J. Smith.

———. 1833. “On the Use of Definitions.” *The Philological Museum* 2: 263–72.

———. 1837. *History of the Inductive Sciences*. 3 vols. London: John W. Parker, West Strand.

———. 1844. “On the Fundamental Antithesis of Philosophy.” *Transactions of the Cambridge Philosophical Society* 8: 170–81.

———. 1858a. *History of Scientific Ideas*. 2 vols. London: J.W. Parker and Son.

———. 1858b. *Novum Organon Renovatum*. London: J.W. Parker and Son.

———. 1860. *On the Philosophy of Discovery*. London: J.W. Parker and Son.

Whewell, William, and Stair Douglas. 1881. *The Life and Selections from the Correspondence of William Whewell*. London: C.K. Paul & Company.

Wilkerson, T. E. 1988. “Natural Kinds.” *Philosophy* 63 (243): 29–42.

Wilkins, John S. 2009. *Species: A History of the Idea*. Berkeley: University of California Press.

———. 2013. “Biological Essentialism and the Tidal Change of Natural Kinds.” *Science & Education* 22 (2): 221–40.

Winsor, Mary P. 2003. “Non-Essentialist Methods in Pre-Darwinian Taxonomy.” *Biology and Philosophy* 18 (3): 387–400.

———. 2006. “The Creation of the Essentialism Story: An Exercise in Metahistory.” *History and Philosophy of the Life Sciences* 28 (2): 149–74.

Yeo, Richard R. 1991. “William Whewell’s Philosophy of Knowledge and Its Reception.” In *William Whewell: A Composite Portrait*, ed. Menachem Fisch and Simon Schaffer, 175–99. Oxford, New York: Oxford University Press.

———. 1993. *Defining Science: William Whewell, Natural Knowledge and Public Debate in Early Victorian Britain*. Cambridge: Cambridge University Press.