Essentialism in Biology

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1 Introduction

When we teach students about evolution, we often set up narratives that are, to put it mildly, triumphalist. This does not aid either the reception of evolution nor understanding the historical contexts in which these ideas of science were developed, and it can set up a false dichotomy between older ideas often embedded in religion and culture and modern science. In this chapter, I shall attempt to bring some clarity to an often-abused term – "essentialism" – in the context of scientific thinking and in particular of biology. It is a term that has real rhetorical power. To be accused of essentialism is to be, variously, an adherent of an outmoded and dangerous metaphysics, to be antiscientific, anti-Darwinian, anti-women, racist, nationalist, anti-LGBT, and very probably some kind of political regressive. Like many other terms of that kind, it is almost entirely defined by its opponents, and has little generic meaning beyond expressing the disapprobation of those opponents, and relegating those who are said to hold the ideas to the outer darkness.

In recent years the term "essentialism" has been much employed by biologists and philosophers of biology, and to a lesser extent psychologists and historians of science. The general claim of what I shall call *scientific essentialism* is that natural kinds must have modally necessary shared properties that nothing else does. A variety of this is *biological [or taxic] essentialism*, in which it is thought, wrongly as I argue, that pre-evolutionary and anti-evolutionary scientists held an essentialistic metaphysics in which evolution was prohibited by sharply divided taxic kinds between which there were "bridgeless gaps". There may be scientific essential kinds in some sciences; I do

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not think that biology (and other sciences that are special or historical, like geology or psychology) has ever really appealed to them for taxic kinds. When essences have been employed by biologists it has been in a non-modal, non-"Aristotelian" manner. I scare quote "Aristotelian" because the kind of taxic essentialism being attacked was not Aristotle's, and it was never really scientific essentialism.

The understanding of essentialist claims and counterclaims goes a long way to uncovering the tensions and issues in modern biology and the philosophy of biology, and at the same time uncovers how we have generated some of the framing narratives of our time. Teaching the history and philosophy of essentialism would be of great use to students coming to a nuanced and useful understanding of science, of biology, of evolution, and of philosophy.

2 Essentialism and Evolution

2.1 The Origins of Essentialism

There are many narratives told about evolution. One of the most widely told is the Essentialism Story, replayed in textbook, popular storytelling and philosophy alike (Hull 1965a; Sober 1980, 1994; Wilson 1999; Okasha 2002; Walsh 2006). It goes like this: Before Darwin, biologists were constrained by essentialist thinking, and were committed to species being natural kinds composed of essential characters shared by every member of the species. This meant that either a species had to evolve in a discontinuous fashion (*saltatively*) where the parents of the first member of the new species were members of the ancestral species, or that evolution was logically impossible. In the narrative, Darwin changed all this by adopting a kind of nominalism,[1] in which every member of a species, and every species, was a unique object, and no species had members that shared characters that all members exhibited and which no other species did. In the place of the traditional metaphysics of essentialism, Darwin developed a view in which species were *populations* (Mayr 1982, 1988, 1991; Hull 1973; Sober 1980). Michael Ghiselin and David Hull developed an individualistic view of species, in which species themselves were Darwinian individuals, particulars not classes (Ghiselin 1974; Hull 1976). The Individuality Thesis consisted of three not entirely connected claims: one, that kinds in biology were not universals but historical objects; two, that as individuals they were causally cohesive and acted as systems (usually populations in respect to species); and three, that they presented themselves to observation with unique sets of observable properties. Metaphysically, however, it is the claim that species are historical individuals, like "The United States of America" or "the blues", that was most influential. A historical individual is something or group that has a beginning, and end,

[1] Nominalism in metaphysics is the view that only individual things exist, and no universal kinds. See below.

and is spatially located (Zalta 1988). This is the new metaphysics of evolution. Anything else is "outmoded metaphysics" (as a review of a colleagues' paper called it). If you aren't with the new evolutionary metaphysics, you aren't modern.

Only, it isn't historically the case. There is little evidence that *anyone* was what I call a "biological [or taxic] essentialist" (Wilkins 2009b, 2010). It is true that writers often talked about the essences of life, of organs, and so forth, but they never accepted that species had to have what we now call *jointly necessary and severally sufficient conditions*, or that members of a species or any other taxon would bear such essential properties. The alarm was first sounded by Paul Farber (1976), and more recently historian of systematics Polly Winsor made the same argument (Winsor 2003, 2006a, b), as have others (Amundson 2005; Richards 2010). So, when did the story arise? Winsor thinks it was based on the ideas of Arthur J. Cain, taken up and disseminated by Mayr, Hull and thence many philosophers and biologists. Hull was influenced directly and personally by Popper, whose graduate seminar he had taken in the early 1960s, resulting in the famous paper "The Effect of Essentialism on Taxonomy – Two Thousand Years of Stasis" which Popper took it on himself to submit without Hull's knowledge (Hull 1965a: personal communication). Popper had defined and criticized "methodological essentialism" in his book, *The Open Society and Its Enemies* (Popper 1945), in the first volume on Plato as the founder of ideas that led to the then-threatening views we call fascism:

> I use the name *methodological essentialism* to characterise the view, held by Plato and many of his followers, that it is the task of pure knowledge or science to discover and to describe the true nature of things, i.e. their hidden reality or essence. It was Plato's peculiar belief that the essence of sensible things can be found in their primogenitors or Forms. But many of the later methodological essentialists, for instance, Aristotle, did not altogether follow him in this, although they all agreed with him in determining the task of pure knowledge as the discovery of the hidden nature or Form or essence of things. All these methodological essentialists also agreed with Plato in maintaining that these essences may be discovered and discerned with the help of intellectual intuition; that every essence has a name proper to it, the name after which the sensible things are called; and that it may be described in words. And a description of the essence of a thing they all called a definition. According to methodological essentialism, there can be three ways of knowing a thing: 'I mean that we can know its unchanging reality or essence; and that we can know the definition of the essence; and that we can know its name. Accordingly, two questions may be formulated about any real thing […]: A person may give the name and ask for the definition; or he may give the definition and ask for the name.' (p. 25f)

What Popper is critiquing here is sometimes called *rationalism*: that we can know the natures of things through reflection and reasoning, doing science-by-definition (SBD). He contrasts it to

> *methodological nominalism* [which] aims at describing how a thing behaves, and especially, whether there are any regularities in its behaviour. (p. 26)

Popper's view was widely known and influenced many scientists and philosopher of science, especially when his *Logik des Forschung* was translated as *Logic of Scientific Discovery* (Popper 1959), although one thing it lacked was a theory of discovery. Hull's paper set the tone, and clearly established the notion that Aristotle was the author of essentialist thinking, whereas Popper and before him Dewey

(1997/orig. 1908) had suggested it was Plato, with which G. G. Simpson, the palaeontologist and one of the major authors of the Modern Synthesis agreed. Hull gave a longer historical summary in his *Science as a Process* (1988), and Ernst Mayr, in his widely read *The Growth of Biological Thought* (1982), constantly interpreted, sometimes aggressively selecting sources, the history of biology in terms of essentialism. Clearly one of the influences was Popper, via Hull, through to Mayr (who cited Popper's definition on page 864). But Mayr himself gave only a general, and non-philosophical, account of Aristotelian essentialism:

> … a limited number of fixed and unchanging forms, *eide* (as Plato called them) or *essences* as they were called by the Thomists in the Middle Ages. (p. 38)

Essentia preceded Thomas by a comfortable margin; at the very least his teacher Albertus Magnus used the term frequently, and the term is used, seemingly in the usual sense, in Quintilian's *Institutio Oratoria* Book 2, 14.2 (c100CE). But the issue here is where *modern* definitions of essentialism come from. Oddly the *term* "essentialism" has no great philosophical history itself. Apart from its use in education (essentialism is the claim there are essential things that must be taught, what we now call the canon), it was used shortly after Popper in a philosophical sense in a paper on aesthetics (Gallie 1948). These are the two earliest versions I can locate in English. A Google Ngram for "essentialism" places the rise of the term in the late 1930s, far too late for it to have been a label used to describe anything pre-Darwinian. Similar patterns occur for variants and different capitalizations.[2] Although Google Ngrams are a somewhat unreliable source of frequency of uses, this pattern is repeated in German and French, where it often applies to existentialist philosophical discussions.[3] The term first gets used – apart from a small spike around 1900 – beginning in 1939. Some of this is in the logic literature, where it gets discussed in questions of modality (Parsons 1969; Wiggins 1974; Hooker 1976), until it becomes more widely used in philosophical literature, and it really picks up after Mayr's book in 1982.

But the source of the standard definition, and the one that ties it to Aristotle, seems to be one of the most widely read and cited philosophy papers of the century: Quine's "Two Dogmas of Empiricism" (Quine 1951; reprinted in Quine 1953a). Quine is attacking a particular theory of meaning:

> The Aristotelian notion of essence was the forerunner, no doubt, of the modern notion of intension or meaning. For Aristotle it was essential in men to be rational, accidental to be two-legged. But there is an important difference between this attitude and the doctrine of meaning. From the latter point of view it may indeed be conceded (if only for the sake of argument) that rationality is involved in the meaning of the word 'man' while two-leggedness is not; but two-leggedness may at the same time be viewed as involved in the meaning of 'biped' while rationality is not. Thus from the point of view of the doctrine of meaning it makes no sense to say of the actual individual, who is at once a man and a biped, that his rationality is essential and his two-leggedness accidental or vice versa. Things had

[2] http://books.google.com/ngrams/

[3] In the mid-nineteenth century, it is used in a philosophical context and also a medical context in German, on occasion, but not in our sense.

> essences, for Aristotle, but only linguistic forms have meanings. Meaning is what essence becomes when it is divorced from the object of reference and wedded to the word.

A commentator (White 1972) noted that it is unremarkable that Quine did not cite any text of Aristotle in support of this interpretation, since it is only tenuously connected to anything Aristotle wrote. Quine later gave a more technical definition (Quine 1953b):

> … Aristotelian essentialism […] is the doctrine that some of the attributes of a thing (quite independently of the language in which the thing is referred to, if at all) may be essential to the thing and others accidental. E.g., a man, or talking animal, or featherless biped (for they are all the same *things*), is essentially rational and accidentally two-legged and talkative, not merely qua man but qua itself. (p. 173f)

This introduces modal necessity (the "necessary" part of the *necessary and sufficient conditions* definition). What is interesting is that this seems to be the very first use of "Aristotelian essentialism", and while that's just a phrase, not much else marries scientific essentialism with Aristotle. It looks like one of the major preoccupations of modern philosophy of science is no older than the early 1950s. A Google Ngram for the phrase "Aristotelian essentialism" and cognate terms shows that the phrase did not exist in English until the early 1950s. It is clear that Aristotle was not seen to be a *scientific* essentialist before Quine's essay, even had Quine thought that he was (which he didn't). I suspect that this interpretation was inadvertent, and Quine's status as a philosopher led others to think that this *en passant* comment was historically and generally correct, when in fact scientific essentialism was not the kind of essentialism Aristotle actually held (Charles 2002; Matthews 1990). He thought essences were, as Quine noted, about words, not objects: "I want to claim here that Aristotle's grasp of modal notions, and of the use of modal operators, is such that he could not clearly express the Quinian distinction between essential and non-essential attributes of a sensible particular". (White, p. 60; White's argument is subtle, and has to do with the role sensible particulars play in Aristotle's metaphysics and epistemology, that is not relevant here.)

In conclusion, the notion of a scientific Aristotelian essentialism is a mistake based on a casual reading of various philosophers, including (as I detail in my 2009b) Dewey, logic texts, and Popper, but the particular widespread error of ascribing it to Aristotle appears to be based on Quine's passing comment.

2.2 Darwinism and the Essentialist Story

The hardening of the idea of pre-Darwinian essentialism was due to Hull's essay. In it, Hull appeals to Popper's usage, and a discussion by Michael Scriven (1959) about the distinction between "normic" and "analytic" criteria, the former being something like a typical example of a kind, and the latter a defined set of characteristics of a kind. But what is most interesting is that Popper's attack in the *Open Society* (1945), and Scriven's here, are discussing what we might call the assumption that we can define terms in an essentialistic or analytic fashion, and *thereby*

know something. Popper's attack is centered on the idea, long held in philosophy, that one can gain knowledge by definition: I call this "science-by-definition" (SBD). Aristotle in his *logical* works did practice a form of SBD, and Plato clearly did, although the famous "carve nature at its joints" comment (*Phaedrus* 265d–266a) applied to *justice* and not any "natural" kind in the modern sense. But the knowledge Aristotle thought he gained from analytic characters, as Scriven might put it, was of a different kind to the knowledge gained by empirical observation and experiment, which is what he typically applies in the natural history works we might call science. When Hull equated logical analytic criteria with criteria in taxonomy, he changed the argument substantially, for it is unclear whether any naturalist ever proceeded by definitional analysis.[4] For instance, Linnaeus, whose system has been deprecated and described in this way (Enç 1975; Ereshefsky 1999, 2000), did not. His was an empirical classification based upon types, and it served a largely diagnostic role. Linnaeus himself knew it was a conventional system, and largely artificial, and he certainly did not intend it to be in some fashion fixist or essentialistic. Unfortunately, the diagnostic criteria in the Linnaean scheme were called the "essential characters" in the English translation (*character essentialis*), which has misled many modern commentators. They would better be called "diagnostic characters". Linnaeus' thoughts on the matter are clear enough:

> If the essential characters of all genera had been discovered, the recognition of plants would turn out to be very easy, and many would undervalue the natural characters, to their own loss. But they must understand that, without regard for the natural character, no one will turn out to be a sound botanist; for when new genera are discovered, the botanist will always be in doubt if [he] neglects the natural character. Anyone who thinks that he understands botany from the essential character and disregards the natural one is therefore deceiving and deceived; for the essential character cannot fail to be deceptive in quite a number of cases. The natural character is the foundation of the genera of plants, and no one has ever made a proper judgement about a genus without its help; and so it is and always will be the absolute foundation of the understanding of plants. (*Philosophia botanica* 1751, quoted in Winsor 2006b, p. 5)

The "natural character" here is something like the key causal properties as identified by a skilled and trained botanist. Linnaeus referred to the "unique idea" (*unica idea*) that was, in effect, a set of characters that distinguished genera.[5] For example, he used the fructative apparatus (calyx, corolla, stamen, pistil, pericarp, seed, and receptacle) on four analytic dimensions as the potential natural character of genera (Atran 1990, p. 174). This is not an essentialism of the constitutive *or* the definitional kind, but merely a diagnostic essentialism. Even more interesting is that whether or not Linnaeus was a diagnostic essentialist in the sense that he defined the taxa analytically, which I doubt, the practice thereafter was to treat these taxonomic definitions as identifying a *type* taxon, around which classifications were arranged.

[4] A possible exception is Louis Agassiz, but I think his practice and his theoretical argument in Agassiz (1859) are not necessarily all that deeply connected. He was an excellent observer (Winsor 1979). What scientists say they are doing, and what they actually do, are often distinct.

[5] I am indebted to Larissa Vasiliyeva for bringing this to my attention, through an advance copy of her forthcoming paper in Botanica Pacifica with Steven Stephenson (2012).

The "type species" of a genus was the "most typical" form of it, and as Whewell noted of this approach

> These lessons are of the highest value with regard to all employments [*sic*] of the human mind; for 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 1840, vol 2, pp. 517–519)

And

> So long as a plant, in its most essential parts, is more like a rose than anything else, it is a rose. (p. 520)

As Whewell notes, the method of classifying by type is more common and a better account of taxonomies in biology. Winsor (2003) calls this the *method of exemplars*; either term will serve. Nevertheless, on this misunderstanding of Linnaean taxonomy a whole story was erected, and Linnaeus became, along with Aristotle and to a lesser extent Plato, the whipping boy of bad taxonomy and systematics (see Hull 1988, chapter 3 "Up from Aristotle").

In fact, the primary use of the essentialism story has been to attack opposing systematic techniques and philosophies. Ernst Mayr used it to attack cladism as being "typological", which he wrongly treated as synonymous with "essentialism". Pheneticists attacked cladistics in a similar fashion. Process cladists attacked pattern cladists as being "creationists" and "typologists" because they failed to include process based, or historical, classifications in their phylogenetic trees.[6] And non-neo-Darwinians were often attacked in the same fashion, particularly those who applied, following D'Arcy Thompson (1917), formal analyses to development and evolution. The use of the very term "form" became an identifier for essentialistic issues. Much of this is too recent to be easily neutrally discussed (cf. Winsor 2006a; Levit and Meister 2006; Love 2009).

2.3 Transformation and Variation

The irony, then, appears to be that if scientific essentialism, especially in biology, has ever been promoted, it looks to be a very modern invention, and not something that has preceded Darwinian thinking at all. I suspect that it arose in reaction to

[6]It is widely accepted that there are three kinds of classification philosophies in modern biology. One is called "phenetics", and it relies on mathematically measuring similarities of arbitrarily chosen traits. It was replaced in most instances by "cladistics", which draws treelike diagrams to represent relations based on shared or unique homologies. Process cladists think that these treelike diagrams (cladograms) represent the history of the evolution of the taxa, while pattern cladists think they are merely statements of relationship that might have been evolved in any number of historical pathways. The third view is misleadingly called "evolutionary systematics" (misleading because none of the other views are unevolutionary). It holds that classification is both genealogical (tracing treelike pathways in evolution) and "grade-based", in which groups are put together on the basis of evolutionary novelties like flight or skeletal structures. These novelties represent grades of organization or evolution. For that reason it is sometimes called "gradism".

Darwinian, and more particularly Mendelian genetic versions of Darwinian, thinking, together with ruminations concerning the philosophy of language and in particular of the reference of kind terms in the 1950s and on. Darwin is not the latest metaphysical view of biology at all. This is why biological essentialism has become popular of late: it is a somewhat revisionary response to Darwin himself.

Ernst Mayr, whose work is so influential on the popular narrative, argued that evolutionary thinking shifted from the transformational, in which entire species changed into new species as Lamarck thought, to the variational, in which parts of species (varieties or populations) changed to form new species but leaving the rest of the ancestral species unchanged (Mayr 1991, 1992). This has been taken up by others (Kronfeldner 2007; Shtulman 2006; Shtulman and Schulz 2008).

Why did Mayr propose this, among many, distinctions? It is an extension of his prior use of the terms "population thinking" and "essentialism". Populational accounts of species imply that they vary. Transformational accounts such as Lamarck's (or the neo-Lamarckians still active when Mayr was a student in Berlin) tended to have an instantaneous essentialism; a species was whatever the essential traits were at a moment. As a champion of the so-called "allopatric", or geographical isolation, view of species formation, Mayr naturally preferred to stress the role variation played in species formation, and therefore in the individual natures of species and of the evolutionary process (Wilkins 2007), and so the contrasting views tended to become one big error in his mind (Chung 2003). Thus, transformational views of evolution, typology, and essentialism are all examples of a bad metaphysics misleading science before (and even after) Darwin arrived to set things straight.

3 What Is Essentialism?

3.1 The Meaning of "Essentialism"

The word "essentialism", like its root word "essence", does not refer to a single notion or view, but a group of them, which are not all closely related but which form a family of ideas that resemble each other somewhat (Stone 2004). *Essence* itself has been long held to be contentious. A well known and widely-used dictionary of philosophy at the turn of the twentieth century defined it the traditional way:

> Essence [Lat. *essentia*, from *esse*, to be]: Ger. *Wesen*; Fr. *essence*; Ital. *essenza*. The constant and necessary nature of a thing as contrasted with its accidents. […] Aristotle uses the word for (1) the form, (2) the matter or substratum, (3) the concrete being, the individual. […] But the scholastics defined the word more precisely in contrast with substance: essence is the nature of the individual thing, substance is the indeterminate substratum, which, united to the form, makes up the individual thing. Descartes follows the scholastic usage, but since his time the word essence has usually had the same meaning as substance. Kant defines essence as determined by an idea; hence it may be false to reality, while the nature of a thing is actually experienced and cannot be false. (Baldwin 1901, Vol. I)

The traditional logical definition appealed to the properties that marked out a class of things from other things (*differentia)*:

> Whatever term can be affirmed of several things must express either their *whole essence*, which is called the *Species*; or a *part* of their essence (*viz*. either the material part, which is called the *Genus*, or the *formal* and *distinguishing part*, which is called *Differentia*, or in common discourse, *characteristic*) or something *joined to the essence*; whether *necessarily* (*i.e.* to the *whole* species, or, in other words, *universally*, to every individual of it), which is called a *Property*; or *contingently* (*i.e.* to some individuals only of the species), which is an *Accident*. (Whately 1875)

However, the idea had been depreciated somewhat by the loose and often inchoate uses by idealists and those in the Hegelian tradition, leading one nineteenth century philosopher to write somewhat more succinctly than the dictionary that succeeded him:

> Essence, (*essentia*, from *esse*, to be,) "the very being of anything, whereby it is what it is." Locke. It is an ancient scholastic word, which cannot be really defined, and should be banished from use. (Jevons 1870, p. 335)

The quote from Locke comes from the *Essay Concerning Human Understanding*, III.3.15 (Locke 1997 [1690]). Locke, of course, propounded a nominalistic view, in which essences were known only as the meanings of words, and any real essences (physical natures) were forever hidden from our apprehension. Curiously he did not deny that there *were* real essences. Because the term is used in so many ways, it pays us to try to distinguish these different senses, which is ironic, since one of the original and core doctrines of essentialism is that terms have clear meanings. However, I have reconstructed these different senses rather than drawing them directly from the clear usage of the various technical communities that employ the word. Any actual use is likely to apply more than one of these senses, even when those senses in some way conflict with the claims being made about essence. One must not presume that the same word means the same thing even when the same author is using it in the same work. Often, indeed almost universally, people elide from one meaning to another unaware they have even done so, and this has caused no end of confusion in the literature. Susan Gelman and Lawrence Hirschfeld put it this way:

> When we co-taught a graduate seminar in 1996 on essentialism, and read sources from ancient Greek philosophers to postmodern feminist theorists, we were overwhelmed by the scope, richness, and variety in arguments about essentialism. We read authors who treated essences as a property of the real world, others who treated essences as an inevitable product of the human mind, and still others who treated essences as a historical construction imposed on people for political ends. (Gelman and Hirschfeld 1999, p. 404)

Table 1 presents the varieties of essentialism in the modern (post-1940) literature.

A view can be scientifically essentialist without thereby committing the advocate to psychological or human essentialism. It may be that there is a covariance between these views, but I think that it is usually one way: if one is justifying some human essentialistic view, like a racial realism, one often will appeal to taxic, scientific or even metaphysical essentialisms, but it does not thereby mean that these other forms imply a social essentialism.

Table 1 Varieties of essentialism as presented in the modern (post-1940) psychological and philosophical literature

Type of essentialism	Nature, examples, and references
Psychological [folk]	Imputing to objects an internal persistent nature on the basis of superficial appearances (Medin and Ortony 1989; Medin et al. 2000; Gelman 2003). For example, children think of animate objects as having some internal essence that moves them
Human [historical and social]	Imputing to sociocultural groups a shared persistent set of properties of each member of the group. Examples, gender (Heyes 2000), nations (White 1965), ethnicities (Gil-White 2001), races (Sesardic 2010) and medicine (Jensen 1984; Pickering in press)
Logical [semantic, linguistic]	Imputing to terms an invariant and unique meaning. Examples: The Aristotelian/scholastic tradition, Cicero. Criticized influentially by Popper (Popper 1957, Vol 1: Plato, chapter 3). Example: strict definitions of general terms like "life" or "human"
Metaphysical [Aristotelian essentialism, universalism, Platonism]	The claim that there are universals that are facts about the world (Aaron 1952; Quine 1951, 1953b). Examples: colors, numbers, shapes. The opposite of a universal is a *particular*, such as this color, that shape, or the number of people in this room
Scientific [natural kind]	The claim that scientific laws refer to objects that have invariant objects and properties (Ellis 2001, 2002). For example, "mass", or "charge" in physics; innate or species traits in biology
Biological [taxic]	The claim that all members of taxonomic objects in biology (species and higher, subspecies and lower) have invariant properties (Devitt 2008, 2010; Hull 1965a, 1984; Rieppel 2010; Sober 1980; Walsh 2006; Wilkins 2010, 2013). Examples: Linnaean "essential characters" that define a species or genus; the genome of a species

3.2 *Kinds of Essences*

There are basically three general forms of essentialism available for each type: *constitutive*, *diagnostic* and *definitional*. *Constitutive* essentialism is the view that some class of objects are what they are because they all possess invariant properties. *Diagnostic* essentialism is the view that classes of objects are recognizable because all members share some salient properties. *Definitional* essentialism is the view that kinds have severally necessary and jointly sufficient defining properties. Although Hull listed roughly these three tenets as "essentialistic tenets of typology",[7] these are not all the same, or even necessarily related, ideas, and it is not the case that these views must travel together as Hull insisted. However, it is hard to keep them apart. Even those who study one kind of essentialism, such as the psychological

[7] "The three essentialistic tenets of typology are (1) the ontological assertion that Forms exist, (2) the methodological assertion that the task of taxonomy as a science is to discern the essences of species, and (3) the logical assertion concerning definition" (Hull 1965b, p. 317).

Table 2 A taxonomy of essentialisms as found in the literature

	Constitutive	Diagnostic	Definitional
Physical	X	X	X
Biological	X	X	?
Psychological	X	X	?
Human	X	X	?
Logical	—	X	X
Metaphysical	X	—	X

Dashes indicate the inapplicability of that kind of essentialism to that category or domain, and queries indicate uncertainty as to whether that kind of essentialism has ever actually been imputed to that domain

kind, will elide from one sense to another. For example Susan Gelman and Lawrence Hirschfeld write

> … essentialism […] has a long history of links to other domains [than folkbiology] and indeed much of the evidence for essentialism comes from outside the domain of folkbiology. People appear to attribute hidden essences to social categories such as race, gender and personality […] Racial, gender and personality "essences" may be analogical extensions from a folk biological notion […], but race, gender and personality are not themselves biological categories. Similarly, claims of essentialism in language extend to words such as proper names […] Given these controversies, the present chapter examines the evidence for essentialism and addresses whether essentialism is plausibly a core component of folkbiology; whether it is an untutored belief, universal, and/or biologically specific. (Gelman and Hirschfeld 1999, p. 403f)

Gelman and Hirschfeld have a different taxonomy of essentialisms than the one I present here. They distinguish between the sortal (definitional essentialism), the causal (constitutive essentialism) and the ideal (metaphysical essentialism), and identify four kinds of each essentialism. For our purposes, dividing representational (semantic or psychosocial) essentialism into three disparate types is not helpful. Instead I prefer the following taxonomy, and the kinds of essentialism asserted in the literature are marked with an "X" (Table 2).

It is not clear that the philosophical essentialism of Kripke (1980) and Putnam (1975), who are primarily concerned with philosophical questions about the metaphysical implications of the reference of *terms* (as indeed Aristotle and many other philosophers throughout history were), has anything whatsoever to do with the notions of "essence" employed in folkbiology or race theory.[8] However, a surprising number of discussions of biological essentialism appeal to the structure of water (H_2O versus XYZ, which is Putnam's example, derived from Mill's discussion in the *Logic*[9]) or of the elements, like Gold, rather than biological examples of

[8] Contra Hull (1976, p.179n. 4).

[9] Putnam had argued in his 1975 that the meaning of kind terms did not depend on reference to the constituents of instances of that kind, by a "Twin Earth" thought experiment, in which everything was the same as on our Earth except that "water" denoted a substance XYZ not H_2O. The point was that such general meanings of terms were established by a set of macrolevel properties, not the microlevel ones. Mill's discussion (III.vi.1) of the nature of water is the ancestor of modern theories of emergence, which are only tangential to our topic.

essential kinds, and when philosophers do discuss biological examples, they often use vernacular terms like "swan" (which one? There are 6–7 species of swans, some of which carry black coloration) or "tiger" (which has nine extant or extinct subspecies, each with distinct colorations), basing their arguments upon superficial characters like pelt or plumage.

Sometimes, however, the logical and semantic sense is directly applied to kinds other than these, such as the definition given by Jensen of medical essentialism:

> … terms referring to entities have to be defined by specifying a conjunction of characteristics, each of which are necessary, and which together are sufficient for the use of the term. (Jensen 1984, p. 63)

The appeal to this definition of biological essentialism is common among the biologists themselves, and particular among those who discuss taxonomy and systematics. For example, herpetologist and systematist Kevin de Queiroz cites Karl Popper explicitly, appealing to the notions of *methodological essentialism* and *methodological nominalism* Popper introduced (de Queiroz 1992, 1994).

4 Historical Considerations

4.1 Aristotelian Essentialism

The term *essence* was not actually used by Aristotle, but by the late classical and medieval followers, or so they thought, of Aristotle. It is a Latin word, and Aristotle expressed himself in Greek, and the words (not word) he used – *to ti ên einai* and variations – mean, in a literal translation "what it is to be [that thing]". In this sense it is relatively harmless – even the most nominalistic of thinkers believes there are properties, causes or components that makes something what it is, but Aristotle appeared to make more of this than a simple passing phrase. He introduced the notion of an "accident" (*sumbebêkos*), a property that a thing has which, if changed, would not make it something else. For example, a white bird remains a bird if it changes into another color, so whiteness is not "essential" to being a bird. Those properties that a thing has that if changed *would* make it not a bird, like feathers and a beak, are "essential".

A famous and apocryphal story in Diogenes Laërtius' *Lives and Opinions of Eminent Philosophers* tells of the cynic Diogenes of Sinope challenging Plato's definition of the essential characters of Man as a "featherless biped" by bringing a plucked chicken to his next talk, whereupon Plato redefined Man as a featherless biped with broad nails (Book VI.20). Aristotle, whether he knew this story or not, took steps to avoid this ad hocery in two ways: first by excluding *privative* definitions – in terms of what something is *not*, the *diairesis* of the Academy and Plato[10];

[10] According to the Platonist view, classification had to proceed by dichotomous, or binary, division, hence "diairesis" or "splitting into two". They achieved this by defining things as being some property, or not being it. Aristotle, on the other hand, allowed for groups to be subdivided into many subsets, all of which had to have their own positive definienda (see Wilkins 2009b).

and second by seeking the truly essential necessary properties.[11] Based on his "three souls" account in *De Anima*, where living things essentially have three motive forces – nutrition and growth (life), sensory capacities and motion (animal), and reason – Aristotle was able to define humans as the living animal that reasons. Everything else was accidental. Aristotle's use of essentialism is ironic in some ways. In his discussions of the *what-it-is-to-be*, the examples he used were of *predicates*, which is to say, *terms*. So far as I can tell, he did not develop a *taxic* essentialism, although of course he did divide organisms into functional kinds, like animals that live in water, or fly, or have limbs (cf. Atran 1990; Nelson and Platnick 1981).

The neo-Platonists, and in particular Porphyry, conflated Plato's *diairesis* and Aristotle's logical division and developed what came, much later, to be known as the *Arbor Porphyriana*, or Porphyry's Tree. On this logical structure, one began with Aristotle's *Summum Genus* (most general kind), Being, and divided it into subordinate genera (species of the higher genus), such as Corporeal Being, and its negations (e.g., Incorporeal Being), and then subdivided *those* into subordinate genera, and so forth until one attained a species which had under it, or within it, only individuals. Each lower branch was quite literally more specific, and had *propria* (non-accidental properties) that differentiated them out of the higher genus. Combined with the Aristotelian scale of nature implicit in the *De Anima* and elsewhere, this led to the production of the *scala naturae* or great chain of being. However, the great chain, most popular from the sixteenth century, was not itself essentialistic either, as the scala (Latin for "ladder") was gradualistic. There were no sharp discontinuities in most of the post-medieval versions of either the Tree or the Chain, except at the attainment of reason (Man) and of divinity (God).

4.2 Scholastic Essentialism

One sense of "Aristotelian" that might be in play here is some version of medieval scholasticism. It is well known that Aristotle was "rediscovered" in the twelfth century following Michael Scot's and Willem van Moerbeke's translations of his works from Arabic, and that during the twelfth and thirteenth centuries a revitalization of science and philosophy was inspired by these works, culminating in Thomas Aquinas' theology. The term "essentia" was in use by these authors, especially Aquinas and Albertus Magnus, at this time. However, the mere use of the terms subsequently is not sufficient to make some author an essentialist, since the ubiquity of Thomas' ideas among philosophers and scientists meant the terminology was shared by nominalists (those who think only particular things exist, and that general terms are simply verbal conventions) and universalists (those who think that general properties are real facts about the world, and not merely about words, or *nomina*)

[11] E.g., Metaphysics 1022a22, Categories X, Posterior Analytics, I.4; on necessary properties see Metaphysics Z.4, Topics 102a3, Posterior Analytics, 73a34-5 cf. Cohen (2009).

alike. A nominalist who thinks only particulars exist might still talk about essences in order to deny their reality beyond the words.

Moreover, much of the modern focus is on the use of these ideas by modern thinkers, especially the neo-scholastics who developed from Pope Leo XIII's encyclical letter "Aeterni Patris" in 1879, which recommended Thomas as the philosopher of the Church. Initially this did not result in objections to evolution based upon static or essentialistic doctrines, but instead Catholic thinkers almost universally, from Mivart on, objected to the lack of teleology in Darwin's theory (Artigas et al. 2006; Paul 1979; on Darwin and teleology see Lennox and Kampourakis, this volume). In the early twentieth century, in reaction to Modernism, neo-scholasticism morphed into the neo-Thomism of Etiénne Gilson and Jacques Maritain (Gilson 1964, 1984; Maritain 1955), and around the turn of the century claims that logical essentialism prohibited Darwinian evolution began to surface, following objections raised around the turn of the century (Clarke 1895; Wasmann 1910). It is probably not coincidental that modern special creationism arose in the period just following this development.[12]

5 Philosophical Considerations

5.1 Classes, Types and Family Resemblances

In considering the philosophical arguments over biological essentialism, several distinctions must be made for clarity. One is the distinction between *type* and *essence*. Typologies are roughly phenomenological groupings, that is collections of phenomena based on similarity metrics that are held to be salient. Essential classes, on the other hand are very often held to require *intensional properties*. Intension is the notion of the meaning or definition of a kind term or general term, and is contrasted to *extension*, or the physical spatial extent of the class (consider "being Australian" and "being born in Australia"; people born in Australia can be accused of not being Australian). The use of terms like *class*, *set*, *kind* (especially *natural kind*, see below) and *taxon*, are often thought, at least by philosophers of biology, to entail that they and all their members have an intensional property set. Members of types, on the other hand, can have only some of the property set used to define or identify them.

The rise of the essentialism story coincided with an increasing interest in Wittgenstein at the end of the 1950s, and discussions of the notion of a *family*

[12]Contrary to the received opinion, special creationism as an alternative to evolutionary science is a fairly modern development. First proposed by George Macready Price, a Seventh Day Adventist, in the first two decades of the twentieth century, special "scientific" creationism was introduced onto the wider stage of American discourse in the 1960s. The period Price was writing was one of great turmoil in evolutionary opinion (Numbers 2006).

resemblance predicate. One particular paper was cited by Hull (1965b): Douglas Gasking's on "Clusters" (Gasking 1960). Gasking noted there was a distinction between sets and classes[13] which Hull took up, and he discussed how groups might be formed using a clustering notion similar to and based upon Wittgenstein's famous "predicate" (1968, §§66–67), in which "we see a complicated network of similarities overlapping and criss-crossing: sometimes overall similarities, sometimes similarities of detail." Again, in Wittgenstein's discussion, this is about *terms* (Campbell 1965), although some have applied it to the predicate *species* (Pigliucci 2003; Pigliucci and Kaplan 2006). Hull's discussion of essentialism considers the case where the taxa in question have a set of necessary and sufficient defining properties, a conjunction like a ∧b ∧c ∧d, versus the case in which the taxon must only have most of these properties, forming an extended disjunct: (a ∧b ∧c) ∨(a ∧c ∧d) ∨… for all combinations that obtain. At the time Hull wrote, the so-called "numerical taxonomy" (which later came to be called "phenetics" as discussed above) of Sokal and Sneath (1963) was heavily discussed amongst systematists, and Hull effectively argued that their view was the philosophically mandated view (although he later switched to a cladistic account of systematics). Hull's view was initially derived from Beckner's earlier work (1959) in which Wittgenstein's family resemblance predicate was first applied to biological taxa. Beckner distinguished an *E-definition* (effective definition) from a *W-definition* (well-defined definition) in biology, and considered a cluster definition to be E-defined. About the same time, Douglas Gasking defined a *chain group* as one in which the relationship is one of reflexive similarity and noted that:

> Likewise a field naturalist who has learnt, by long experience, to recognise on sight members of a diversified 'polytypic species' does not normally think of the species as a group of forms serially related to a certain focal form. He thinks of it as a chain-cluster of forms which is not essentially defined in terms of any particular one of them. (p. 13)

Note the final sentence: on Gasking's account, the field naturalist does *not* think that a polytypic species must be essentialistically defined. Contrary to Hull's

[13] Gasking (p5f) made the following comment about biological species:

"For our next example consider the symmetrical and non-transitive relation crossable with, defined as follows: Two local populations of plants or animals are said to be 'crossable' if they interbreed freely in nature, or would do so but for geographical or ecological barriers. 2 (It is a matter of biological fact that this relation is non-transitive. There do occur in nature series of populations where A is crossable with B, B with C, and C with D, but where A is not crossable with D.) On the basis of this non-transitive relation we can define the transitive relation serially crossable with. In terms of this, taking a local population as focus, we can define the chain-group as all those populations that are serially crossable with this population. In so doing we define a 'biological species' 3 – for between any two populations belonging to the same biological species there holds the chain-group relation serially crossable with."

Gasking's distinction showed Hull that simply grouping things, in this case living things, into sets did not imply all the logical relations that usually are drawn from talking about classes, such as transitivity. Given Gasking's previous comment that sets do not become (p.1) but are timeless, he clearly thinks that to be a species is a time-indexed relation; one shares the property of being the same species at a particular time *t*. This obviously raises a problem for species evolution, even if he permits them to be clusters.

three tenets (the ontological, methodological, and definitional commitments of essentialism), neither the metaphysical claim that Forms really exist nor the view that species must be defined essentialistically is true of the naturalist, either before or after Darwin (or Darwin himself). Only the claim that there must be some persistent causal process which makes a species a species is correct, and this is typological rather than essentialism. Gasking himself refers to this as a *concomitant of* relations (p. 14). Essentialism was a dead issue before it was defined and then attacked in biology.

However, in the second sense, which I have called the *constitutive* sense, of biological essentialism, not only are all biologists before *and* after Darwin (including Darwin himself) essentialists, but it is also the mission statement of taxonomy and systematics, developmental and evolutionary biology, genetics and ecology, to discover what these constitutive properties are. Something must cause species to be species, either individually and severally, or universally. No matter what causes all species to evolve, or if every species has its own cause, that is the constitutive "essence" of that species that taxonomists seek to explore and determine. Diagnostic and definitional essentialisms are about words and identification; constitutive essentialism is about what happens in the mind-independent world.

5.2 Natural Kinds[14]

Several "essentialist" accounts have been proposed in recent times for biological taxa. Two specific proposals of note are Richard Boyd's *homeostatic property cluster account* (HPC; Boyd 1999) and Paul Griffith's *historical essence account* (Griffiths 1999), and recently a more general account by Michael Devitt, *intrinsic biological essentialism* (IBE, Devitt 2008, 2010). Boyd's account is that some kinds have a shared causal mechanism that causes members of the kind to cluster about a stable point, which he calls homeostatic properties. Like Hull and Ghiselin's Individuals, these homeostatic property cluster kinds do not play a role in laws of nature, but the causal mechanisms are instead an outcome of such laws. Griffiths has argued that biological taxa share a *historical* property, that of having a common origin. This is clearly an extrinsic or relational property, as Griffiths observes. Devitt's IBE is a full-blown "Aristotelian" essentialism: taxa have some *intrinsic* shared properties such as developmental mechanisms or genetic mechanisms (to exclude Griffiths-style extrinsic properties). Where Griffiths' essentialism is relational, depending on how the species and all its members relate to a past event, and so to an ancestral species, Devitt's is internal to the species and its members; such as the developmental and genetic properties of the organisms that constitute it.

How do these new essentialisms affect the older claims made, such as the Individuality Thesis, that taxa are historical objects? This has to do with the

[14] Part of this section was previously published as section 7 of Wilkins (2013).

employment of the notion of a natural kind in modern philosophy of science. The term "natural kind" in the essentialism debate in the philosophy of biology can mean "a category of natural objects", or "a class defined by some physical properties" or "intrinsic property set", and so on. There is not a lot of agreement on what the term implies outside the philosophy of biology either, and this is not the place to cover the issue (see Bird 2009; Bird and Tobin 2009; Anderson 1994; Ben Yami 2001; Boyd 1991; Cordry 2004; Dupré 2002; Hacking 1990; Kathrin 2008; LaPorte 2004; Peterson 1999; Quine 1969; Riggs 1996; Sankey 1997; Sterelny 1983; Wilkerson 1988; Witmer and Sarnecki 1998). Griffiths and Boyd-style biological kinds are not in the philosophical sense "natural kinds", but as Boyd notes, if *they* aren't natural kinds then there's something wrong with the notion of a natural kind in philosophy, and I think this is right.

To resolve this, we may distinguish between three kinds of kinds: *type-kinds*, of the sort that Whewell propounded and which is, I think, the most common notion employed in natural history; *definitional class-kinds*, such as is correctly ascribed to the logical tradition deriving from Aristotle; and *property-based class-kinds*, in which every member of the kind must have the same unique set of properties. I have argued that Mill introduced these property-based kinds of kinds from chemistry and mineralogy (Wilkins 2013). Type-kinds are exemplars, types that one uses as a central or "typical" hook on which to hang a group.

There are several criteria held to be necessary for a natural kind in science: the kind must be an *actual* kind, it must be *natural* (that is, not arbitrary or artificial), it must be *required by the scientific discipline* covering the domain under investigation, and the kinds must participate in *laws* of that domain, or at least generalizations within it. Moreover, natural kinds are typically supposed to license inductive inferences across the domain. Taxa are supposed, under the essentialism story, to do all these things, but cannot, which is why the notion of taxa as kinds has to be abandoned in favor of the Individuality Thesis. Under this story, it is clear that individualism is supposed to be a kind of relative nominalism; the view that for this class of objects, at any rate, only particulars exist. The claim made by Ghiselin and Hull was that species are not class-kinds. To be sure, they also thought that before scientific evolutionary theory the received view was that species were class-kinds, which I reject, but that doesn't affect their argument that species are in fact particulars – spatiotemporally restricted contiguous objects that are unique in evolutionary history. Whether or not anyone thought species were class-kinds at all, the argument that they are not does not depend upon eliminating the view that species have definitional or property criteria. It depends upon the positive argument that species that evolve have beginnings and endings.

Unfortunately, later versions of the Individuality Thesis committed it also to the view that species were functionally coherent individuals, relying on a version of the "biological" species concept. Ghiselin attached several conditions: "individual" means, in addition to the metaphysical sense of "particular" or "instance", that the thing is integrated into a functional whole, like a pistol, and that it is observationally discriminable (Ghiselin 1997). However, a species can be a metaphysical particular without being functionally integrated. To illustrate this, consider a particular of

loose objects like a bag of jellybeans. Being a bag of things, it is a metaphysical particular (nothing else in time or space is that bag, which is what makes a particular a particular). But the bag of jellybeans need not function as an integrated whole the way a watch would. The watch is both a particular and a functional system. Likewise a species might be a functionally integrated population through interbreeding or cooperation, but another species might not (if asexual, for example, or if populations were in permanent isolation). In both cases, however, on the Individuality Thesis, these are metaphysical particulars. Another formulation is to say that to some degree, individual organisms within a species are, as Templeton put it, demographically replaceable (Templeton 1989; Wilkins 2007, 2010). Since functional integration usually requires *differentiation* of parts rather than homogeneity, a species need not be an integrated individual. In other words, species can be individuals and yet form kinds, because to a first approximation individual organisms are indiscernibly different, at least ecologically. The indiscernibility of members is a key characteristic of a kind. At any rate, species-as-metaphysical-particulars, and as historical objects, remains untouched by the distinction between type-kinds, class-kinds, and clade-kinds.

Essentialisms of a non-taxonomic but explanatory kind have been offered, a recent example being Dennis Walsh's "adaptive essentialism" approach (Walsh 2006). Here, and in Devitt's intrinsic biological essentialism, the emphasis is on the developmental "natures" of the organisms. This is a rather benign form of essentialism – that there are underlying causal processes – including but not restricted to genes, parental investment, ecological niches, constructed niches, social inheritance and the like, that make a typical member of the species, well, typical – is not at issue. What it cannot be is a Millian class kindship, which is what Devitt's version requires. This sense of *essence* need merely be a type-kind: the essence of the species is just the developmentally typical lifecycle (which is in fact a tautology, as the species would not be a species if it lacked at least one typical developmental lifecycle, however that might play out as reaction norms in different environments).[15] Consequently, Boyd's homeostatic property cluster (HPC) account doesn't provide a malignant essence either. A HPC is a kind maintained by causal mechanisms, that cause properties to cluster together, but which are not jointly necessary. HPC kinds are causal versions of Wittgenstein's family resemblances. However, one might say that HPCs, being causally maintained, can only apply to populations that are in constant (enough) causal contact, which supports the "metapopulational" account of Kevin de Queiroz (2007); higher taxa above the metapopulation level cannot be maintained by HPC kinds. If a particular species does not comprise a metapopulation, then it cannot be a HPC kind, and clades that are not in causal contact (say, because they are isolated temporally or biogeographically) cannot be HPC kinds either.

[15] Some have proposed "cryptic species" or "pseudospecies" for taxa that lack their own distinguishing properties. I think that if they truly lacked all unique properties, they would not even be distinct species; even if we do not know the causes of differentiation, the organisms certainly do, in the sense that they react physically when the right properties exist and not otherwise.

Finally, in Paul Griffiths' historical essence account, species and other taxa have essences in virtue of a shared genealogy, which is consistent with, for example, the genealogical concordance view of species of Avise and Ball (1990). This "essence" is not really an intrinsic essence, but one of genealogical relations between individuals and populations distributed over time. As such it is quite consistent with Whewellian type-kinds in a cladistic manner, because it is identified by conserved developmental homologies, and these need not be conserved in a logical essence, with all and only those properties that class all and only members of the taxon. Instead the developmental mechanisms that conserve these relations, like those of the HPC, are a notional type around which the variations accrue over time.

So biological kinds are best thought of as exemplary types, rather than the arid classes of "Aristotelian essentialism", and as Whewell and Jevons (1878) and many other nineteenth century authors thought before Mill, types and kinds in natural history are classified, and exist, as clusters around exemplars. There never were nor is there any need for there to be biological essences in that sense.

6 Educational Considerations

What does all this mean in terms of teaching biology? One of the most important is that both disciplines are historical themselves, and rely heavily on sociological and cultural context if we are to make sense of them. Biologists do not work in some isolated cultural vacuum, and their ideas about not only what they are studying, but how they view their competitors and predecessors is often based on a kind of triumphalism in which there are the Good Guys who got us to the state of blessed enlightenment we now enjoy (if, for example, you happen to accept the right speciation theory or taxonomic methodology) and those who are the Bad Guys, who don't think what We think and so are retarding progress and knowledge with pre-modern metaphysics and epistemologies. One doesn't have to read far to find these comments made; Hull's (1965) paper and Mayr's *Growth of Biological Thought* (1982) are two classic examples. Science is a human activity, and students need to understand that even the best authorities fall prey to the temptation to be Whiggists trumpeting the modern and denigrating alternative views. Since the arrival of a new theory or result doesn't render past researchers stupid or blind, why should we paint them as fools? Neither the history of a scientific discipline nor the history of a concept will necessarily move from foolish old to clever new science. History is not like development of an organism; there are no predetermined sequences (Wilkins 2009a), and to think that there is we might call the *developmentalist fallacy* in history.[16] Science does not recapitulate cognitive ontogeny, nor do students need to learn science by

[16]Not unrelated to the identically named problem in social history (Dussel 1993), in which the linear idea of history always moves from simple or immature to complex or mature. An example of a developmentalist fallacy can be found in Piagetian "genetic epistemology", which is often take to represent a historical process in individual development.

recapitulating the historical development of the science itself. In teaching the history of science, we are providing context and guarding against simple-minded triumphalism, but a historical narrative is not necessarily a curriculum.

Another educational point to make is the problem of *polysemy*, the fact that even technical words can have multiple loosely connected meanings. That this is more than a point about semantics is clear from the ways in which various inferences are made by appealing to first one, then another disconnected sense of "essentialism". The confusion of logical essentialism with biological essentialism, and both with psychological essentialism is a case in point. Many discussions of race and cognition would be improved by clearly distinguishing these distinct meanings. We would be less inclined to posit racial classifications if we could disentangle ourselves from the idea that race implies property-based class-kinds. Likewise we would be less inclined to think of essentialism as mandated by psychological dispositions if we could clearly separate the idea there is a persistent underlying cause for things being differentiated from diagnostic or definitional essentialism.

Finally, we might attend to some logical fallacies, and in particular, the fallacies of composition and division. The aggregate or average properties of the members of a group do not give the properties of the group, and vice versa. A species like *Homo sapiens* can be two legged and rational without every member of the group being two legged or rational. There can be diagnostic properties for any taxonomic group that doesn't commit us to thinking they are only real groups if every member has them. As obvious as this point is, it is often overlooked by scientists, and even occasionally by philosophers.

It is time to abandon the notion of essentialism and call each kind of conception its own name – psychological essentialism, for example, might better be called "inherentism", philosophical logical essentialism, "definitionalism", and scientific essentialism "elementalism" or some such. That will stop many of the ambiguities and their consequent errors; along with the developmentalist fallacy and the tendency to vilify those whose views do not match some modern consensus, which are often reached by political rather than empirical or theoretical means. Science progresses because there are alternatives, and many alternative views thought long dead can revive and even motivate fruitful research. Considering the influence of now-peripheral and deviant views on science, like neo-Platonism and alchemy on early modern science, formalism in biology, the revival of preformationism in modern genetics, and so on, to denigrate something just because it is old is to commit a terrible and costly mistake. Of course science progresses, and many empirical ideas and avenues are forever closed to us, but philosophical ideas in science deserve to be treated with respect, for one never knows when one will arise and help us out of a hole we have fallen in.

References

Aaron, R.I. 1952. *The theory of universals*. Cambridge: Cambridge University Press.

Agassiz, Louis. 1859. *An essay on classification*. London: Longman, Brown, Green, Longmans and Roberts and Trubner.

Amundson, Ron. 2005. *The changing rule of the embryo in evolutionary biology: Structure and synthesis*, Cambridge studies in philosophy and biology. New York: Cambridge University Press.

Anderson, Erik. 1994. Kant, natural kind terms, and scientific essentialism. *History of Philosophy Quarterly* 11(4): 355–373.

Artigas, Mariano, Thomas F. Glick, and Rafael A. Martínez. 2006. *Negotiating Darwin: The Vatican confronts evolution, 1877–1902*, Medicine, science, and religion in historical context. Baltimore: Johns Hopkins University Press.

Atran, Scott. 1990. *The cognitive foundations of natural history*. New York: Cambridge University Press.

Avise, J.C., and R.M. Ball Jr. 1990. Principles of genealogical concordance in species concepts and biological taxonomy. In *Oxford surveys in evolutionary biology*, ed. D. Futuyma and J. Atonovics, 45–67. Oxford: Oxford University Press.

Baldwin, James Mark (ed.). 1901. *Dictionary of philosophy and psychology including many of the principal conceptions of ethics, logic, aesthetics, philosophy of religion, mental pathology, anthropology, biology, neurology, physiology, economics, political and social philosophy, philology, physical science, and education and giving a terminology in English, French, German, and Italian*. 3 vols. New York/London: Macmillan.

Beckner, Morton. 1959. *The biological way of thought*. New York: Columbia University Press.

Ben Yami, Hanoch. 2001. The semantics of kind terms. *Philosophical Studies* 102(2): 155–184.

Bird, Alexander. 2009. In *Routledge companion to metaphysics*, ed. R.L. Poidevin, P. Simons, A. McGonigal, and R. Cameron, 497–506. Abingdon: Routledge.

Bird, Alexander, and Emma Tobin. 2009. Natural kinds. In *The Stanford encyclopedia of philosophy,* ed. E.N. Zalta. http://plato.stanford.edu/archives/spr2009/entries/natural-kinds/

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

Boyd, Richard. 1999. Homeostasis, species, and higher taxa. In *Species, new interdisciplinary essays*, ed. R. Wilson, 141–186. Cambridge, MA: Bradford/MIT Press.

Campbell, Keith. 1965. Family resemblance predicates. *American Philosophical Quarterly* 2(3): 238–244.

Charles, David. 2002. *Aristotle on meaning and essence*. Oxford: Oxford University Press.

Chung, Carl. 2003. On the origin of the typological/population distinction in Ernst Mayr's changing views of species, 1942–1959. *Studies in History and Philosophy of Biological and Biomedical Sciences* 34: 277–296.

Clarke, Richard F. 1895. *Logic*, Manuals of catholic philosophy, 3rd ed. London: Longmans, Green.

Cohen, S. Marc. 2009. Aristotle's metaphysics. In *The Stanford encyclopedia of philosophy*, ed. E.N. Zalta. http://plato.stanford.edu/archives/spr2009/entries/aristotle-metaphysics/

Cordry, Ben S. 2004. Necessity and rigidly designating kind terms. *Philosophical Studies* 119(3): 243–264.

de Queiroz, Kevin. 1992. Phylogenetic definitions and taxonomic philosophy. *Biology and Philosophy* 7(3): 295–313.

de Queiroz, Kevin. 1994. Replacement of an essentialistic perspective on taxonomic definitions as exemplified by the definition of "Mammalia". *Systematic Biology* 43(4): 497–510.

de Queiroz, Kevin. 2007. Species concepts and species delimitation. *Systematic Biology* 56(6): 879–886.

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

Devitt, Michael. 2010. Species have (partly) intrinsic essences. *Philosophy of Science* 77(5): 648–661.

Dewey, John. 1997. *The influence of Darwin on philosophy and other essays, great books in philosophy*. Amherst: Prometheus Books.

Dupré, John. 2002. Is 'Natural Kind' a natural kind term? *The Monist* 85(1): 29–49.

Dussel, Enrique. 1993. Eurocentrism and modernity (Introduction to the Frankfurt lectures). *Boundary* 220(3): 65–76.

Ellis, Brian David. 2001. *Scientific essentialism*, Cambridge studies in philosophy. Cambridge: Cambridge University Press.
Ellis, Brian David. 2002. *The philosophy of nature: A guide to the new essentialism*. Chesham: Acumen.
Enç, Berent. 1975. Necessary properties and Linnaean essentialism. *Canadian Journal of Philosophy* 5(1): 83–102.
Ereshefsky, Marc. 1999. Species and the Linnean hierarchy. In *Species, new interdisciplinary essays*, ed. R.A. Wilson, 285–305. Cambridge, MA: Bradford/MIT Press.
Ereshefsky, Marc. 2000. *The poverty of Linnaean hierarchy: A philosophical study of biological taxonomy*. Cambridge/New York: Cambridge University Press.
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.
Gallie, W.B. 1948. IV. The function of philosophical æsthetics. *Mind* LVII (227): 302–321.
Gasking, Douglas. 1960. Clusters. *Australasian Review of Psychology* 38: 13–18.
Gelman, Susan A. 2003. *The essential child: Origins of essentialism in everyday thought*, Oxford series in cognitive development. Oxford/New York: Oxford University Press.
Gelman, Susan A., and Lawrence A. Hirschfeld. 1999. How biological is essentialism? In *Folkbiology*, ed. D.L. Medin and S. Atran, 403–446. Cambridge, MA: MIT Press.
Ghiselin, Michael T. 1974. A radical solution to the species problem. *Systematic Zoology* 23: 536–544.
Ghiselin, Michael T. 1997. *Metaphysics and the origin of species*. Albany: State University of New York Press.
Gilson, Etienne. 1964. *The spirit of Thomism*. New York: Harper & Row.
Gilson, Etienne. 1984. *From Aristotle to Darwin and back again: A journey in final causality, species, and evolution*. Trans. J. Lyon. Notre Dame: University of Notre Dame Press.
Gil-White, Francisco. 2001. Are ethnic groups biological "species" to the human brain? Essentialism in our cognition of some social categories. *Current Anthropology: A World Journal of the Human Sciences* 42(4): 515–554.
Griffiths, Paul E. 1999. Squaring the circle: Natural kinds with historical essences. In *Species, new interdisciplinary essays*, ed. R.A. Wilson, 209–228. Cambridge, MA: Bradford/MIT Press.
Hacking, Ian. 1990. Natural kinds. In *Perspectives on quine*, ed. R.B. Barrett and R.F. Gibson. Cambridge: Blackwell.
Heyes, Cressida J. 2000. *Line drawings: Defining women through feminist practice*. Ithaca: Cornell University Press.
Hooker, John. 1976. Brody on essentialism. *Philosophical Studies* 29(4): 263.
Hull, David L. 1965a. The effect of essentialism on taxonomy: Two thousand years of stasis. *The British Journal for the Philosophy of Science* 15: 314–326, 316:311–318.
Hull, David L. 1973. A populational approach to scientific change. *Science* 182: 1121–1124.
Hull, David L. 1976. Are species really individuals? *Systematic Zoology* 25: 174–191.
Hull, David L. 1984. Can Kripke alone save essentialism? A reply to Kitts. *Systematic Zoology* 33: 110–112.
Hull, David L. 1988. *Science as a process: An evolutionary account of the social and conceptual development of science*. Chicago: University of Chicago Press.
Jensen, U.J. 1984. A critique of essentialism in medicine. In *Health, disease and causal explanations in medicine*, ed. L. Nordenfelt and B.I.B. Lindahl, 63–73. Dordrecht: D. Reidel Publishing.
Jevons, William Stanley. 1870. *Elementary lessons in logic: Deductive and inductive: With copious questions and examples, and a vocabulary of logical terms*, Macmillan's school class books. London: Macmillan.
Jevons, William Stanley. 1878. *The principles of science: A treatise on logic and scientific method*, 2nd ed. London: Macmillan. Original edition, 1873.
Kathrin, Koslicki. 2008. Natural kinds and natural kind terms. *Philosophy Compass* 3(4): 789–802.
Kripke, Saul A. 1980. *Naming and necessity*. Cambridge, MA: Harvard University Press.

Kronfeldner, Maria. 2007. Is cultural evolution Lamarckian? *Biology and Philosophy* 22(4): 493–512.
LaPorte, Joseph. 2004. *Natural kinds and conceptual change*. Cambridge: Cambridge University Press.
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: 281–307.
Locke, John. 1997 [1690]. An essay concerning human understanding. In *Penguin classics, classics series, penguin philosophy*, ed. R.S. Woolhouse. London: Penguin.
Love, Alan. 2009. Typology reconfigured: From the metaphysics of essentialism to the epistemology of representation. *Acta Biotheoretica* 57(1): 51–75.
Maritain, Jacques. 1955. *Bergsonian philosophy and Thomism*. New York: Philosophical Library.
Matthews, Gareth B. 1990. Aristotelian essentialism. *Philosophy and Phenomenological Research* 50: 251–262.
Mayr, Ernst. 1982. *The growth of biological thought: Diversity, evolution, and inheritance*. Cambridge, MA: The Belknap Press of Harvard University Press.
Mayr, Ernst. 1988. *Toward a new philosophy of biology: Observations of an evolutionist*. Cambridge, MA: The Belknap Press of Harvard University Press.
Mayr, Ernst. 1991. *One long argument: Charles Darwin and the genesis of modern evolutionary thought*. Cambridge, MA: Harvard University Press.
Mayr, Ernst. 1992. Speciational evolution or punctuated equilibria. In *The dynamics of evolution*, ed. A. Somit and S. Peterson, 21–48. New York: Cornell University Press.
Medin, Douglas L., and Andrew Ortony. 1989. Psychological essentialism. In *Similarity and analogical reasoning*, ed. S. Vosniadou and A. Ortony. New York: Cambridge University Press.
Medin, Douglas L., Elizabeth B. Lynch, and Karen O. Solomon. 2000. Are there kinds of concepts? *Annual Review of Psychology* 51(1): 121–147.
Nelson, Gareth J., and Norman I. Platnick. 1981. *Systematics and biogeography: Cladistics and vicariance*. New York: Columbia University Press.
Numbers, Ronald L. 2006. *The creationists: From scientific creationism to intelligent design*. Expanded ed. Cambridge, MA/London: Harvard University Press.
Okasha, Samir. 2002. Darwinian metaphysics: Species and the question of essentialism. *Synthese: An International Journal for Epistemology Methodology and Philosophy of Science* 131(2): 191–213.
Parsons, Terence. 1969. Essentialism and quantified modal logic. *Philosophical Review* 78(1): 35–52.
Paul, Harry W. 1979. *The edge of contingency: French Catholic reaction to scientific change from Darwin to Duhem*. Gainesville: University Presses of Florida/A University of Florida Book.
Peterson, Philip L. 1999. The meanings of natural kind terms. *Philosophia* 27: 137–176.
Pickering, Neil. in press. Extending disorder: Essentialism, family resemblance and secondary sense. *Medicine, Health Care and Philosophy*.
Pigliucci, Massimo. 2003. Species as family resemblance concepts: The (dis-)solution of the species problem? *Bioessays* 25(6): 596–602.
Pigliucci, Massimo, and Jonathon Kaplan. 2006. *Making sense of evolution: The conceptual foundations of evolutionary biology*. Chicago/London: University of Chicago Press.
Popper, Karl R. 1945. *The open society and its enemies*. 2 vols. London: G. Routledge & Sons.
Popper, Karl R. 1957. *The open society and its enemies*, 3rd ed. London: Routledge and Kegan Paul.
Popper, Karl R. 1959. *The logic of scientific discovery*. Trans. K. Popper, J. Freed and L. Freed. London: Hutchinson.
Putnam, Hilary. 1975. *Mind, language, and reality*, His philosophical papers, vol. 2. Cambridge/New York: Cambridge University Press.
Quine, Willard Van Orman. 1951. Two dogmas of empiricism. *Philosophical Review* 60: 20–43.
Quine, Willard Van Orman. 1953a. *From a logical point of view: 9 logico-philosophical essays*. Cambridge, MA: Harvard University Press.

Quine, Willard Van Orman. 1953b. Three grades of modal involvement. In *Actes du XIème Congrès International de Philosophie* XIV: Volume complémentaire et communications du Colloque de Logique, 65–81, Republished in 1966. The ways of paradox, and other essays. New York: Random, 158–176.
Quine, Willard Van Orman. 1969. Natural kinds. In *Essays in honour of Carl G. Hempel: A tribute on the occasion of his sixty-fifth birthday*, ed. N. Rescher, 5–27. Dordrecht: Springer.
Richards, Richard A. 2010. *The species problem: A philosophical analysis*, Cambridge studies in philosophy and biology. Cambridge: Cambridge University Press.
Rieppel, Olivier. 2010. New essentialism in biology. *Philosophy of Science* 77(5): 662–673.
Riggs, Peter J. 1996. *Natural kinds, laws of nature and scientific methodology*, Australasian studies in history and philosophy of science, vol. 12. Dordrecht/Boston: Kluwer Academic.
Sankey, Howard. 1997. Induction and natural kinds. *Principia* 1(2): 239–254.
Scriven, Michael. 1959. The logic of criteria. *The Journal of Philosophy* 56(22): 857–868.
Sesardic, Neven. 2010. Race: A social destruction of a biological concept. *Biology and Philosophy* 25(2): 143–162.
Shtulman, Andrew. 2006. Qualitative differences between naïve and scientific theories of evolution. *Cognitive Psychology* 52(2): 170–194.
Shtulman, Andrew, and Laura Schulz. 2008. The relation between essentialist beliefs and evolutionary reasoning. *Cognitive Science: A Multidisciplinary Journal* 32(6): 1049–1062.
Sober, Elliott. 1980. Evolution, population thinking, and essentialism. *Philosophy of Science* 47: 350–383.
Sober, Elliott. 1994. *From a biological point of view: Essays in evolutionary philosophy*, Cambridge studies in philosophy and biology. Cambridge/New York: Cambridge University Press.
Sokal, Robert R., and P.H.A. Sneath. 1963. *Principles of numerical taxonomy*, A series of books in biology. San Francisco: W. H. Freeman.
Sterelny, Kim. 1983. Natural kind terms. *Pacific Philosophical Quarterly* 64: 110–125.
Stone, Alison. 2004. Essentialism and anti-essentialism in feminist philosophy. *Journal of Moral Philosophy* 1(2): 135–153.
Templeton, Alan R. 1989. The meaning of species and speciation: A genetic perspective. In *Speciation and its consequences*, ed. D. Otte and J. Endler, 3–27. Sunderland: Sinauer.
Thompson, D'Arcy Wentworth. 1917. *On growth and form*. Cambridge: Cambridge University Press.
Vasilyeva, Larissa N., and Steven L. Stephenson. 2012. The hierarchy and combinatorial space of characters in evolutionary systematics. *Botanica Pacifica. A Journal of Plant Science and Conservation* 1(1): 21–30.
Walsh, Denis. 2006. Evolutionary essentialism. *The British Journal for the Philosophy of Science* 57(2): 425–448.
Wasmann, Erich. 1910. *Modern biology and the theory of evolution*. Trans. A.M. Buchanan. 3rd ed. London: Kegan Paul, Trench, Trübner (Original edition, 1906).
Whately, Richard. 1875. *Elements of logic*. Ninth (octavo) ed. London: Longmans, Green & Co (Original edition, 1826).
Whewell, W. 1840. *The philosophy of the inductive sciences: Founded upon their history*. vol. 2. London: John W. Parker.
White, Morton Gabriel. 1965. *Foundations of historical knowledge*. New York: Harper & Row.
White, Nicholas P. 1972. Origins of Aristotle's essentialism. *The Review of Metaphysics* 26(1): 57–85.
Wiggins, David. 1974. Essentialism, continuity, and identity. *Synthese* 28(3–4): 321.
Wilkerson, T.E. 1988. Natural kinds. *Philosophy* 63: 29–42.
Wilkins, John S. 2007. The concept and causes of microbial species. *Studies in History and Philosophy of the Life Sciences* 28(3): 389–408.
Wilkins, John S. 2009a. Darwin. In *A companion to the philosophy of history and historiography*, ed. A. Tucker, 405–415. Chichester: Wiley-Blackwell.
Wilkins, John S. 2009b. *Species: A history of the idea*, Species and systematics. Berkeley: University of California Press.

Wilkins, John S. 2010. What is a species? Essences and generation. *Theory in Biosciences* 129: 141–148.
Wilkins, John S. 2013. Biological essentialism and the tidal change of natural kinds. *Science & Education* 22(2): 221–240.
Wilson, Robert A. 1999. Realism, essence, and kind: Resuscitating species essentialism? In *Species, new interdisciplinary essays*, ed. R.A. Wilson, 187–208. Cambridge, MA: Bradford/ MIT Press.
Winsor, Mary Pickard. 1979. Louis Agassiz and the species question. *Studies in History of Biology* 3: 89–117.
Winsor, Mary Pickard. 2003. Non-essentialist methods in pre-Darwinian taxonomy. *Biology and Philosophy* 18: 387–400.
Winsor, Mary Pickard. 2006a. The creation of the essentialism story: An exercise in metahistory. *History and Philosophy of the Life Sciences* 28: 149–174.
Winsor, Mary Pickard. 2006b. Linnaeus' biology was not essentialist. *Annals of the Missouri Botanical Garden* 93(1): 2–7.
Witmer, D.Gene, and John Sarnecki. 1998. Is natural kindness a natural kind? *Philosophical Studies* 90(3): 245–264.
Wittgenstein, Ludwig. 1968. *Philosophical investigations*. Trans. G.E.M. Anscombe. Repr. of [3rd ed.] English text, with index. ed. Oxford: Basil Blackwell.
Zalta, Edward N. 1988. *Abstract objects: An introduction to axiomatic metaphysics*. Dordrecht: Reidel.