An Ontology of Weak Entity Realism for HPC Kinds

This paper defends an ontology of weak entity realism for homeostatic property cluster (HPC) theories of natural kinds, adapted from Bird's (2018) taxonomy of such theories. Weak entity realism about HPC kinds accepts the existence of natural kinds. Weak entity realism denies two theses: that (1) HPC kinds have mind-independent essences, and that (2) HPC kinds reduce to entities, such as complex universals, posited only by metaphysical theories. Strong entity realism accepts (1) and (2), whereas moderate entity realism accepts only (1). Given its commitment to (2), strong entity realism is more theoretically complex than weak entity realism, with little explanatory payoff. Given their commitment to (1), moderate and strong entity realisms cannot explain how the identity conditions of HPC kinds are to be straightforwardly knowable. I argue that weak entity realism avoids such epistemic difficulties. I further rebut two plausible criticisms of weak entity realism, namely that weak entity realism cannot account for quantification over kinds, and that weak entity realism cannot provide identity conditions for HPC kinds which are both scientifically useful and objective. Given the theoretical costs of strong and moderate entity realism, and weak entity realism's adequate response to its most plausible challenges, weak entity realism about HPCs is to be preferred, especially for biological and chemical kinds.

1. A Taxonomy of Views about Natural Kinds

There are a variety of positions available concerning the nature and existence of natural kinds. The main axis along which the contemporary debate turns is that of realism versus anti-realism (Hacking 1991; Hawley and Bird 2011; Franklin-Hall 2015; Bird 2018). Several distinct questions, however, may easily be conflated under the realist/anti-realist distinction. The question of *whether* kinds exist can be conflated with the question of *how* kinds are individuated, and with the question of *what* kinds are.

In light of such questions, several taxonomies have recently been proposed to distinguish realism and anti-realism about natural kinds. Such taxonomies aim to spell out how the philosophical commitments of realists about kinds differ from those of anti-realists. The goal is to have a consistent and informative test for what counts as a realist versus an anti-realist *view* about natural kinds. Bird's (2018) taxonomy, building on Hawley and Bird (2011),

focuses on the questions of whether natural kinds exist, and if so, what sort of entity kinds are. Franklin-Hall's (2015) taxonomy focuses instead on whether kinds are individuated by a mind-independent principle, or whether kinds "carve at the joints"[1]. This paper focuses mainly on the issues raised by Bird's (2018) taxonomy.

Bird (2018, 1397) seeks to measure the strength of realism about kinds—from anti-realism, to weak realism, and up to strong realism—by what he calls increasing degrees of "metaphysical commitment." Anti-realism denies both that kinds exist and that there are *natural* divisions or similarity relations between entities. Weak realism accepts that there are natural divisions or similarity relations between entities, but denies that kinds are entities with essences. Strong realism affirms that kinds are entities with essences (Bird 2018, 1397). Bird (2018) and Hawley and Bird (2011) further propose that kinds are reducible to complex universals, such that kinds have essences *qua* universals. It would not only be individual kind members, *qua* particulars, that have essences.

Now in asking such questions of realism about natural kinds, it helps to have a particular conception of what kinds are. Much contemporary work on kinds—including both Bird (2018) and Franklin-Hall (2015) –takes as a starting point Boyd's (1991; 1999; 2000; 2010) theory of natural kinds as homeostatic property clusters (HPCs). Indeed, Bird (2018, 1421) maintains that although the natural kinds are HPCs, HPCs themselves are *also* complex universals with essences. HPCs are statistical clusters of properties (such as particular genotypes and phenotypes and evolutionary lineages for species) which result from natural causal mechanisms and support scientific generalizations. The HPC account arose through a recognized failure to state necessary and sufficient conditions for kind membership, at least for biological kinds like species. There is no set of nontrivial intrinsic properties such that every member of a species

[1] Such joint-carving is traditionally cashed out through natural similarity relations for kind members, such that entities which have certain natural similarity relations to each other belong to the same kind K (as in Lewis 1986a, 1986b; Sider 2009, 2012).

instantiates all the properties in that set but no non-member of the species does (see Wetzel 2009; Bird 2007, 2018; Boyd 1999). So a member of a species cannot just be what instantiates all the properties in the master species-set. On the HPC account, then, property clusters need not be wholly instantiated in all kind-members.

Accordingly, I limit my focus here to property cluster theories of kinds. I won't consider, for example, nominalist views, according to which species are just mereological individuals. I am asking how best to conceive of realism and anti-realism concerning HPC kinds, and I will be arguing later against Bird's (2018) strong realist views. The extent to which my arguments are applicable, say, to nominalist conceptions of kinds, is a question that I do not consider.

The questions on which Bird (2018) focuses—whether kinds exist and what kinds are—I refer to as questions of *entity* realism[2] about natural kinds. Before defining and arguing for what I call "weak entity realism" about natural kinds, I need to explain entity realism further. The taxonomy of entity realism I adopt is slightly different from Bird's (2018).

Indeed, there is an important distinction which I think Bird's (2018) taxonomy does not adequately accommodate. Namely, the question of whether kinds have essences is distinct from the question of what kinds are. Even if kinds have essences, that does not tell us *what* type of entity natural kinds are. Bird (2018, 1415) is of course aware of this, which is why he raises the question of whether kinds are metaphysically fundamental or are instead reducible to some other type of entity, such as complex universals. But what he does *not* consider is that kinds might have essences without having any deeper ontological status, such as being complex universals. In particular, kinds (or at least biological kinds) might *only* be homeostatic property

[2] In using "entity realism," I am not concerned with the issues about the existence of unobservable entities with which Hacking (1983) was concerned in using the same term. Whether electrons or photons exist is not my question, though insofar as my article presumes the existence of what our best theories quantify over, it would be natural for me to say that they do (Hacking 1983, Miller 2016).

clusters, and there might be nothing more to say about kinds' metaphysical status. But HPC kinds might still have essences insofar as, for any given HPC kind K, certain natural mechanisms or causally privileged properties $P_1 \ldots P_n$—including perhaps extrinsic properties such as common lineage—could uniquely define K. $P_1 \ldots P_n$ could thus plausibly be the essence of K. The acceptance of essences and rejection of complex universals might well be consonant with certain scientific realist conceptions of HPCs, which would seek maximum objectivity while eschewing too much metaphysical theory (Devitt 2008; Craver 2009; Wilson, Barker and Brigandt 2007).

To distinguish between the question of whether kinds have essences and the question of what kinds are, I want to introduce the notion of a "metaphysical entity." Say that an entity x is a *metaphysical* entity iff: either x is metaphysically primitive and irreducible, or the correct identity criteria for x reduce x to a type of entity quantified over *only* by a distinctively metaphysical theory (Bird 2018; Hofweber 2012). I take complex universals to be a paradigm example of "metaphysical entities." For my purposes, a "distinctively" metaphysical theory fulfills two criteria. (1) It posits at least some entities which are not regularly quantified over in the empirical research of the natural sciences; and (2) if the entities in (1) do any explanatory work at all vis-à-vis empirical hypotheses, such work could instead be done by a more modest ontology less dependent on entities not discussed in the scientific literature. Complex universals seem to feature only in such distinctively metaphysical theories.[3] So, in answer to what kinds are, if Bird (2018; Hawley and Bird 2011) accepts that kinds are complex universals, then he is committed to kinds being metaphysical entities.

[3] Such criteria are intended to avoid substantive metaphysical disputes about what counts as a metaphysical entity. (2) in particular adds an important caveat. If it could be shown that complex universals do the kind of explanatory work ruled out by (2), then complex universals would not count as metaphysical entities as I define them. But Bird (2018) does not clearly show this.

On the other hand, to say that there are certain statistical patterns of properties (per Boyd (1991, 1999)) which define biological species is not to make a claim beyond the facts that are regularly reported in biological research. Such a claim is not likely to strike the practicing scientist as metaphysical at all. So the question of whether kinds are metaphysical entities allows us to consider *how much* metaphysical theory it is necessary to bring to the question of what kinds are.

Now the answers to what kinds are, and especially whether kinds have mind-independent essences, may differ depending on the type of kind being considered—namely, whether the kind is chemical, physical or biological (Magnus 2014). Indeed, the case against kinds' having essences is strongest for biological kinds like species and weakest for basic physical particles like electrons. The difference is that intrinsic properties of basic physical particles tend to cluster in "perfectly precise" ways, such that these properties are co-instantiated in all kind members (Hawley and Bird 2011, 217). (E.g. the electron's properties of having a charge of $-1.60217662 \times 10^{-19}$ coulombs and having a mass of $9.10938356 \times 10^{-31}$ kilograms cluster together in all instances). This is not the case for biological or even chemical kinds (see section 4).

Let τ then stand for a type of natural kind, either chemical, physical or biological.[4] (One could also introduce much finer-grained distinctions between types of kinds, so long as such distinctions are well-motivated). One can then adopt the following taxonomy of entity realism:

(E1) τ-kinds exist.

(E2): τ-kinds are entities with mind-independent essences.

[4] For my (coarse-grained) purposes, let's say that biological kinds are studied and classified primarily by the biological sciences (e.g. species, genes, stem cells, neurophysiological states), chemical kinds are primarily studied and classified by chemistry (e.g. small-molecule chemical compounds and elements), and physical kinds are studied and classified primarily by basic particle physics (electrons, protons, neutrons, quarks, and other subatomic particles).

(E3): τ-kinds are metaphysical entities.

	Entity Anti-Realism **(EAR)**	Weak Entity Realism **(WER)**	Moderate Entity Realism **(MER)**	Strong Entity Realism **(SER)**
E1	No	Yes	Yes	Yes
E2	No	No	Yes	Yes
E3	No	No	No	Yes

One might, for example, be a weak entity realist about biological kinds and a moderate entity realist about physical kinds. One might instead be either a weak or a strong entity realist about all types of kinds. Bird (2018) is inclined towards the latter position, whereas I try to make the case that the former position has much to recommend it.[5]

Note that the conception of essence at issue in E2 stipulates that essences be mind or agent-independent features of the world. That is, different evaluative attitudes, explanatory purposes or theories would not alter the essences of kinds. Mind-independence is a typical requirement for essence in contemporary metaphysics (Paul 2004, 170; Gorman 2005, 276), whether one accepts a modal conception of essence or Fine's (1994, 1995) view, adopted by Bird (2018), according to which essences are primitive and non-modal "definitions" of objects.

[5] It is logically possible to affirm E1 and E3 while denying E2. But it would be dialectically odd to do so, for several reasons. First, if one accepts that kinds are metaphysical entities, one is already accepting a role for metaphysical theory in the definition of kinds. An acceptance of kinds as metaphysical entities is likely a more expansive commitment to the importance of metaphysics in kind definition than is acceptance of kinds' having essences. Second, paradigm cases of metaphysical entities, such as complex universals, are entities which plausibly do have essences (Bird 2018). In any case, I cannot think of a well-motivated view which would accept that kinds are metaphysical entities while denying that kinds have essences. And so trying to accommodate such a position in a taxonomy of entity realism would add further complexity with little obvious payoff.

Nevertheless, one might object that *mere* existence seems too weak to set the standard for any sort of realism, even *weak entity* realism. Bird (2018) presses a similar point in suggesting that kinds without essences would not be "genuine" entities. But it is not trivial to say that kinds exist, even if there is no perfectly objective way to define kinds or give their essences. Indeed, even those of a scientific realist bent may question the existence of kinds, especially biological kinds. Quine, for one, suggests that kinds defined in terms of *qualitative* properties would be absent from a mature scientific theory (see Bird 2018, 1401; Quine 1969). If that's right, then biological kinds (to say nothing of psychological ones!) likely do not exist.

The entity realist taxonomy I defend, however, implies that biological kinds have as much right to exist as physical kinds, even *if* the latter have mind-independent essences and the former do not (see sections 2-3). That's because kinds are at least as important for inferring causal structure, if not more so, in the biological as in the physical sciences (see section 5). Indeed, facts about evolution would be no less dependent on the *existence* of species if species lacked mind-independent essences. In other words, while essence might imply existence, WER holds that the reverse is not true. Existence does *not* require essence. (Or so I argue in section 2). By considering the mere existence of kinds to be a form of realism, we can further emphasize how existence comes apart from essence.

One might object, however, not so much to WER as a thesis, but to the very idea of a taxonomy of entity realism. Perhaps Franklin-Hall's (2015) simple focus on whether kinds have mind-independent individuation conditions is sufficient to capture all we could reasonably want from a distinction between realism and anti-realism about natural kinds. I take such a mind-independent principle of individuation as committing to perfectly objective, mind-independent facts about which property clusters count as natural kinds. Consider the following taxonomy (see Franklin-Hall 2015):

Taxonomic Realism (TR): There is a fully mind-independent fact about whether a given property cluster counts as a natural kind.

	Taxonomic Anti-Realism	Taxonomic Realism
TR	No	Yes

Perhaps taxonomic realists must be strong or moderate entity realists, and taxonomic anti-realists must be weak entity realists or entity anti-realists. A taxonomy of entity realism would then be unnecessarily complicated, as it would add further distinctions that matter little in practice for distinguishing realists about kinds from anti-realists about kinds.

Nevertheless, entity realism raises different questions than taxonomic realism about the metaphysical status of kinds. Even if taxonomic realist philosophers were, in practice, coextensive with strong (or perhaps both moderate and strong) entity realists, these views would not necessarily go together. And it isn't clear why the questions raised by entity realism are any less philosophically important or interesting than those raised by taxonomic realism.

In any case, taxonomic realist views do come apart (though not entirely) from entity realist views.[6] There is reasonable motivation for being both a strong or moderate entity realist and a taxonomic anti-realist. One might, for example, hold that kinds are complex universals,

[6] While SER and MER may be *compatible* with taxonomic anti-realism (TAR), WER *requires* taxonomic anti-realism. WER is not compatible with taxonomic realism *tout court*. But unlike the various forms of entity realism, taxonomic anti-realism/realism might be reconstrued as a *gradable* distinction. WER (as opposed to EAR) would then fit most naturally with a moderate or weaker form of TAR. The idea would be that there is *enough* robust clustering of properties to explain why kinds are useful and even necessary for robust inferences and generalizations. Thus kinds exist, on the Quinean criterion of ontological commitment (see section 2). But we would still not have full taxonomic realism, because: (1) there would be some acceptable variance in scientific goals and standards, even for sciences concerned with making the most rigorous and wide-ranging investigations of the world, and (2) properties would not cluster with perfect precision and simplicity, excepting (perhaps) physical kinds (Franklin-Hall 2015).

but one might still hold that "conventions or human interests [play] a role in determining which of the complex universals count as natural kinds" (Hawley and Bird 2011, 217).

Indeed, even if the natural kinds have mind-independent essences, that does not tell us how to determine which property clusters count as the natural kinds. Consider, for example, whether certain clusters of psychological and neurophysiological properties count as natural kinds (rather than *mere* groups of correlated properties), or whether certain groupings of early hominids count as natural kinds or merely convenient classifications. (Questions about which property clusters count as natural kinds are in turn distinct from questions about how to distinguish kinds at different taxonomic levels—species from subspecies, organs from tissues, emotions from moods, etc. (Devitt 2008, 357)). One might be tempted to say that every property cluster with an essence counts as a natural kind. That, however, is an additional theoretical commitment. If we accept that there are essences for biological kinds, for example, then given the profusion of plausible candidates for such essences—structural similarities and mechanisms and common lineages—trying to individuate kinds through such essences *alone* would likely lead to an overabundance of kinds (see Craver 2009; Wilson, Barker and Brigandt 2007). It could thus be consistent with SER and MER to hold that it is not sufficient for a property cluster to have an essence in order to be a natural kind. Perhaps, rather, that cluster must *also* support a wide range of scientific generalizations and inductive inferences.

The point is that taxonomic realism and entity realism raise distinct but not unrelated issues. Thus Franklin-Hall's (2015) notion of taxonomic realism/anti-realism, while commendably simple, would *not* capture everything that one could wish for in considering questions of realism and anti-realism about kinds. And even if one agrees with Franklin-Hall's (2015) defense of taxonomic anti-realism, one would need additional arguments to establish WER over SER, given how entity realism comes apart from taxonomic realism.

One might still think that EAR, WER, MER, and SER are insufficient to divide up all the ontological space for views on kinds. I don't disagree. That is why I have distinguished entity realism from Franklin-Hall's (2015) taxonomic anti-realism. Indeed, there are multiple ways to talk about realism in relation to kinds. If realness is defined in terms of objective criteria for individuating kinds, then one has *taxonomic* realism. If realness concerns whether kinds exist and what their nature is, then one has *entity* realism. And if realness is defined in terms of fundamentality, then biological and chemical kinds might not be "real" even if they had essences!

In any case, this paper's aim is to make WER more attractive as a general ontology of natural kinds. Sections 2 and 3 rebut challenges to WER in general, as opposed to weak realism about particular types of kinds. Section 3 argues that WER provides plausible identity conditions for HPC kinds, and that SER adds unnecessarily complex theoretical commitments. Section 4 argues that both SER and MER (as articulated by Bird (2018)) do not adequately explain how we can know the identity conditions of kinds, due to their commitment to kinds' having mind-independent essences (E2). Given specific arguments for weak realism about biological and chemical kinds, weak realism about such kinds becomes even more plausible. Section 5 further argues that WER does not face a serious problem with objectivity, as MER and SER might allege. Admittedly, MER remains most plausible for basic physical kinds, and I offer no detailed arguments against moderate realism about such kinds. Nevertheless, the epistemic challenges raised in section 4 are framed in terms which would apply to all natural kinds, as is my argument in section 5 that WER can provide sufficiently objective identity conditions for kinds.

2. WER and Quantifying over Kinds

Now strong entity realists might claim that they are in a better position than weak realists to explain quantification over kinds (see Bird 2018, 1410, 1421). If that's so, then there would be a good reason to prefer SER over WER. Indeed, a general argument against anti-

realist accounts of kinds is that such accounts do not allow for quantification over kinds (Bird 2018; Wetzel 2009; Hawley and Bird 2011). If kinds do not exist, how can we explain the fact that we regularly quantify over kinds, especially in scientific discourse? Yet WER does not deny that kinds exist, and so might not seem to face this objection. If entities are merely what our best theories quantify over (values of bound variables), it may be unclear why denying E2 and E3 (as WER does) should pose a problem for quantifying over kinds.

Indeed, the simplest argument used to defend the existence of kinds entails nothing about kinds' having essences or being metaphysical entities. That argument is what Bird (2018, 1405) calls the "syntactic argument." We use singular terms to refer to kinds. There is a syntactic structure here of ΦK, where Φ is a predicate and K is a singular kind term. Moreover, it doesn't seem as if there is a uniform syntactic reduction of such singular term references to kinds, as Bird (2018, 1405) and Wolf (2002) point out. For many of the predications that we make of kinds do not apply to all of a kind's members, which rules out universally quantified conditionals. (That is, not every use of a kind term is *distributively* referential (Wolf 2002, 82)).

As Bird (2018, 1405) admits, we can't conclude anything about the *nature* of natural kinds from our use of singular terms to refer to kinds. Our mere reference to kinds can't distinguish natural kinds from non-natural kinds. Nor can our mere reference to kinds distinguish kinds qua metaphysical entities (per E3) from kinds qua non-metaphysical entities, or tell us whether kinds are individuated by a mind-independent principle (as in *taxonomic* realism).

Why might one think, then, that concerns about ontological commitment motivate a strong or moderate realist account of HPC kinds? There are at least two significant sources of concern for the weak realist. Firstly, one might doubt, as does Bird (2018, 1414), that *mere* property clusters—property clusters which don't have essences and don't reduce to metaphysical entities—are the sort of thing over which our best theories would be well-

motivated in quantifying. Secondly, it may be unclear that WER can offer plausible and objective identity conditions for property clusters. The first problem I address primarily in this section; the second I address primarily in the following section.

Now Bird (2018, 1408) motivates his appeal to essence in part by relying on the argument that essence implies existence, and that kinds must exist because they have essences. Bird's project is to commit to the existence of HPCs *qua* metaphysical entities such as complex universals. The natural kinds are still HPCs, but for Bird (2018, 1420) the HPCs are *also* complex universals. As metaphysical entities, there would be little doubt that kinds would have mind-independent essences.

I am puzzled, however, by why one would want to argue that kinds have essences in order to show that kinds exist. On standard Quinean theories of ontological commitment, it should be sufficient for committing to the existence of kinds that our best theories of natural science quantify over kinds (Quine 1948, 1961; Wetzel 2009). Our best scientific theories quantify over kinds. So we should accept the existence of kinds, so long at least as we can specify kinds' identity conditions. (Presumably our best mature scientific theories would specify these conditions).

Indeed, certain property clusters support scientific generalization much better than others. These generalization-supporting property clusters are plausibly what the *natural* kinds reduce to. Because of such property clustering, natural kinds greatly simplify our inferential practices. One may need to make only a few inferences to identify x as being of a natural kind K. But x's being a K then licenses many further inferences about the properties that x would have in virtue of being a K (Bird 2018, 1403; Boyd 1999). ("Non-natural" kinds, such as the group of everything that is colored white or positively charged, would not allow for such reliable inferences and generalizations (Bird 2018, 1401; Boyd 1999; Mill 1843)).

Perhaps there is some uncertainty about whether our best theories of natural science quantify over kinds. But given the usefulness of kinds for inference, I am not sure why we should be uncertain that our best theories do quantify over kinds. And in any case, property clusters are features of the world. It is in virtue of facts about the world that certain property clusters support scientific generalizations. And so I am not sure why it should be illegitimate to quantify over HPC kinds even if those kinds do not have essences and are not complex universals.

The more serious problem for the weak realist is that, in mature scientific and metaphysical theories, one should try not to quantify over things for which one cannot offer identity conditions. The weak realist, however, denies both that kinds have essences (E2), and that kinds are metaphysical entities (E3). SER and MER can then call into question whether WER has the resources to offer identity and existence conditions for natural kinds. The weak realist must explain how to offer such identity conditions if kinds are neither complex universals, nor metaphysically fundamental or irreducible entities, nor entities with mind-independent essences. Otherwise, the weak realist has no principled way to defend her commitment to the existence of kinds.

Perhaps, indeed, drawing on essences is the best way to provide the identity conditions for kinds. If kinds have essences, then we would have the resources to offer objective identity and existence conditions for kinds. All we would need to do would be to identify the essence of a given kind. And if kinds are complex universals (per E3), then kinds should have essences (E2), at least on Fine's non-modal (1994, 1995) sense of "essence" as a primitive, unanalyzable "definition" of an entity (Bird 2018). Even if HPC kinds are not complex universals, it is plausible that HPC kinds could have essences *without* being metaphysical entities. Indeed, one way of providing identity conditions for HPC kinds is to argue that such kinds are property clusters *defined* by their underlying mechanisms, or at least by some causally privileged properties which account for why many properties in a given cluster are frequently or typically co-

instantiated (see Wilson, Barker and Brigandt 2007). Such underlying mechanisms then might count as the essences of HPC kinds. Why then should one resist such an approach?

There are two good reasons for such resistance. Firstly, one can offer plausible weak realist identity conditions for HPC kinds. And secondly, as I argue in the rest of the paper, such weak realist identity conditions are simpler and less epistemically problematic than strong or moderate realist identity conditions. Indeed, if we can provide clear and scientifically respectable identity conditions for kinds without committing to kinds' having essences or being metaphysical entities, then E2 and E3 must be motivated on a different basis. And I argue that it isn't clear what that basis would be.

3. Weak Entity Realist Identity Conditions for HPC kinds

In this section, I want to explain how one can offer weak realist identity conditions for HPC kinds without admitting that kinds are either complex universals or that kinds have mind-independent essences. Such identity conditions, I argue, offer a significant advantage in theoretical simplicity over strong realist accounts. Likewise, my main concern is not to argue *for* the existence of kinds simpliciter, but rather to show how the weak realist can accept the existence of kinds *while* denying that kinds have essences or are metaphysical entities. In defending weak realism I already assume that kinds exist. WER thus does *not* differ from MER and SER by denying the existence of kinds. Only *entity anti-realism* denies the existence of kinds, in the taxonomy given in section 1. Entity anti-realism holds that there is no defensible reduction of natural kinds to something, e.g. property clusters, which would provide consistent identity conditions for natural kinds. I do hold that there is such a reduction.

For example, certain genetic and morphological properties are highly likely to cluster together in individuals of the same species. Such properties causally interact with each other, and are sustained in their clustering pattern through certain homeostatic or natural causal

mechanisms. The point is just to be able to identify kinds with property clusters, and then to state the identity conditions of clusters. But that need not mean that there are necessary and sufficient conditions for kind membership, as Boyd (1999) emphasizes.

So we can identify kinds as property clusters:

> **Kind-HPC Reduction (KCR):** For any natural kind K_α, there is a property cluster C_α such that $K_\alpha \equiv C_\alpha$.

And then we can state the identity conditions of property clusters as such:

> **Property Cluster Identity Conditions (PCI)**: For any property clusters C_A and C_B, $C_A \equiv C_B$ iff: Both C_B and C_A distribute, according to the same statistical pattern (within some range of tolerance),[7] the same properties $P_1 \ldots P_n$, where $P_1 \ldots P_n$ are elements of a set S_P. The properties in S_P are determinates of the elements of a set S_D of determinable properties.

Consistent with weak realist denial of E2, we can add:

> **Weak Kind Realism (WKR):** The determinable properties in S_D are selected by scientific practices, and vary depending on type of kind. Thus S_D would include different properties for chemical kinds than for biological or physical kinds. Scientists are not drawing on the *essences* of property clusters in selecting the properties in S_D, but rather ought to include in S_D those properties which best facilitate reliable generalizations and

[7] A property cluster C might remain the same property cluster even given certain changes to C's distribution of properties, provided that changes to C's property distribution fall within a certain range of tolerance. The range of tolerance here would be fixed by scientific practice, consistent with my denial that the individuation of kinds is fully mind-independent. So I do not claim that species cannot evolve to some extent without becoming new species.

serve a wide range of research goals for a given type of kind (chemical, biological, or physical). (See section 5).

Very generally, an S_D set ought to include those determinable properties that best support the generalizations that scientists want to make. For example, determinable properties of interest to biology include <DNA sequence> or <protein sequence>. Determinates in the S_P set for biology would then include particular DNA or protein sequences. Determinables are selected, consistent with WKR, to serve a wide range of research goals. DNA sequences, for example, facilitate successful generalizations and inductive inferences across basic molecular biology, translational and even clinical medicine, evolutionary biology, etc. Such properties thus best serve the research goals of the biological sciences.

Now WKR does not preclude interdisciplinary standards for kind definition. Presumably there are general standards of robustness and reproducibility which apply to causal explanations. Only those properties which facilitate generalizations that meet these standards would merit inclusion in an S_D set. And only those disciplines which study such properties and make such generalizations ought to play a role in kind definition (see section 5).

I see no reason why one could not quantify over the property clusters identified in PCI as easily as one could quantify over complex universals. Consistent with theoretical simplicity, we can thus avoid taking any position on the nature of mereological connections between simple universals. We need not, for example, either deny or affirm the uniqueness of composition. Hawley and Bird (2011, 210), by contrast, deny uniqueness to advance their theory of kinds as complex universals, and thus take another controversial metaphysical stand. Likewise, the weak realist account does not take any position on whether one needs to commit to properties as universals, or whether trope theory or another nominalistic approach is possible. Accordingly, the weak realist account is consistent with more parsimonious

ontologies which, at the least, exclude complex universals, and perhaps even do away with universals altogether.

PCI and WKR are thus intended as weak realist alternatives to E2 and E3. But even if one is not a strong realist about kinds, one might still object that PCI and WKR weaken the property cluster account of kinds too much. PCI and WKR seem to place few objective constraints on individuating property clusters into kinds. The latter is a question of which property clusters count as natural kinds. It's implausible that all clusters of properties frequently co-instantiated together would count as natural kinds, since many such clusters may be explanatorily uninteresting or may not yield scientifically important generalizations.

There are several options for constraints on individuating property clusters into kinds: counterfactual stability, relation to causal mechanisms, and support for scientific generalizations (Slater 2014, 201; Craver 2009; Wilson, Barker and Brigandt 2007). But my account does not *rule out* such constraints—quite the opposite. Indeed, I think it is a virtue that PCI and WKR stay largely neutral on such individuation. So long as one denies E2 and E3, one need not commit to a particular way of individuating kinds in order to accept PCI and WKR. Multiple principles of individuation should thus be consistent with such weak realist identity conditions.

In any case, an epistemic advantage of the weak realist HPC account, and particularly of the conjunction of PCI and WKR, is that it recognizes issues of scientific practice. The identity conditions of property clusters could be straightforwardly knowable, in contrast to SER and MER (see section 4). Indeed, scientists would have a role in selecting which properties ought to count in property clusters' identity conditions. Scientists would thus know which properties to include in the identity conditions for kinds, because scientists would know *what to look for*—namely the determinates of the determinable properties which scientists themselves select as best suited to fulfill the inferential demands of research practices.

And in explaining the differences between types of kinds (physical, biological, chemical, and maybe psychological), the weak realist again has an advantage over the strong realist in theoretical simplicity. The weak realist about kinds can tell a story about how the properties which support generalizations about species cluster together less tightly than the properties which count for the identity conditions of physical kinds. The realist can tell the same story. At least, strong realists can do so if, like Bird (2018), they accept a property cluster account of kinds.

But the realist also has to tell *another* story, on the level of metaphysical entities. Hawley and Bird (2011, 213) suggest, for example, that there may be multiple complex universals $U_1 \ldots U_n$ for a single species S, such that it would be *indeterminate* which member of $\{U_1 \ldots U_n\}$ is identical to S. In this way, a view of kinds as complex universals need not be inconsistent with an inability to define species through necessary and sufficient conditions. Of course, such a view could threaten a commitment to taxonomic realism. (And taxonomic realism would seem to sit better with Bird (2018)'s project). Perhaps it could still be a mind-independent fact which complex universals are included in $\{U_1 \ldots U_n\}$. But the larger point is that SER does not seem to do much explanatory work, in accounting for the differences between biological and physical kinds, that cannot also be done by the weak entity realist account. (E.g. properties of electrons, such as having a charge of $1.60217662 \times 10^{-19}$ coulombs and having a mass of $9.10938356 \times 10^{-31}$ kilograms, cluster together in all instances. Biological properties are more irregularly distributed across their instances). So it is not clear how an account of kinds is well-motivated in using complex universals to distinguish types of kinds, at least if, like Bird (2018), one *also* accepts that biological, physical and chemical kinds can all be conceived as property clusters.

Moreover, even if the strong entity realist seeks to reduce HPC kinds to something other than complex universals, some deeper metaphysical story needs to be told if strong realism is

to be true. And it isn't clear what explanatory work would be done by such a story. The clearest motivation for telling this deeper metaphysical story, and committing to SER, is to establish that kinds have essences. But as I've pointed out, it is possible to be a moderate entity realist who accepts that kinds have essences but denies that kinds are metaphysical entities. The prime example of such a moderate entity realist would be someone who holds that HPC kinds are uniquely defined by their underlying mechanisms, and that such mechanisms constitute the essences of such kinds (Craver 2009). Those inclined towards scientific realism may accept MER without seeing any point in going deeper into the ontological status of HPC kinds. And so it isn't clear why such a moderate entity realist should care about the strong entity realist's more elaborate story.

The strong entity realist might still object that the property clusters defined in PCI have no *mereological* unity. Such property clusters, are, after all, just statistical distributions of properties which are highly likely to be instantiated together. Such properties, however, can be conceived as having causal powers, either by virtue of the properties' natures or by the nomic relations in which they stand. We can likewise include in clusters certain "extrinsic" properties, such as common evolutionary lineage, which account for why certain properties tend to cluster together (as noted by Bird 2018, 1421). There might also be higher-order properties which specify the causal mechanisms by which properties in clusters relate to each other, and these higher-order properties can themselves be included in clusters. Indeed, it seems to me that the search for a mereological connection between properties, beyond the merely causal, is unnecessary from the standpoint of scientists' explanatory purposes. And it is the goal of the weak entity realist account, as an extension of Boyd's (1999; 2000) original account, to hew as close as possible to scientific practice.

4. Epistemic Disadvantages of MER and SER

The arguments in the preceding section target SER, but make only part of the case against MER. Recall that MER accepts that natural kinds have essences but denies that kinds are metaphysical entities (E3) (see section 1). Indeed, I have maintained that WER allows for quantification over kinds and for kind identity conditions which are straightforwardly knowable, since such identity conditions can depend to a certain extent on scientists' own epistemic aims and theoretical goals. Thus there is at least an alternative to MER. But why prefer WER over MER? And isn't MER at least more plausible for basic physical kinds?

In this section, I argue that MER and SER cannot explain adequately explain how we come to know the mind-independent essences of kinds (E2). Given such epistemic costs, and the existence of a plausible alternative in weak realism, moderate realism becomes correspondingly less attractive. This is especially the case for biological and chemical kinds, for which scientific practice already calls into question the existence of mind-independent essences, as I explain below (Wilson, Barker and Brigandt 2007; Tahko 2015).

Indeed, whether one conceives of essence modally or non-modally, essence is generally understood not to depend (ontologically) on mind-dependent criteria such as theories or epistemic aims. Essences, at least in the contemporary literature, are simply a matter of the way the world is (Paul 2004, 170; Gorman 2005, 276). This is unambiguously the case for Fine's (1994, 1995) nonmodal conception of essence, which Bird (2018) uses. On the Finean conception, a thing's essence "defines" it (at least heuristically), insofar as essence just gives the basic nature and identity of a thing.

So the challenge is: how is one to be able to know which properties are essential to an HPC kind (whether or not one accepts a further reduction of property clusters to complex universals)? On the nonmodal notion of essence, essence does *not* reduce to necessity—necessity rather reduces to essence (Fine 1994, 1995; Correia 2012). There can thus be many

necessary truths about an object which are not essential truths about that object.[8] So identifying the essence of a kind K could not just involve figuring out which properties of Ks are especially counterfactually robust. One would have to make an (untestable) supposition about which of these counterfactually robust properties make up the essence of K. And what could be evidence for such a supposition? One might have some sort of truth-conducive intuition about which properties constitute the essence of K. But accepting the possibility of such truth-conducive intuitions about essence would be an additional theoretical complication. Scientists would likely be wary of any epistemic dependence on intuitions which can't be empirically tested. Moreover, there is an alternative—the weak realist account of kinds (section 3)—which does not require such controversial commitments. In any case, it might be that some as-yet undiscovered properties are essential to a given kind. It's hard to see how one's intuitions could reliably indicate the existence of such undiscovered properties.

Why, however, would one need to know the essences of property clusters? If HPC kinds have essences in Fine's (1994) sense, then the essences of the kinds would indicate the kinds' nature or identity. If scientists did not adopt identity conditions for kinds mirroring the properties which constitute the nature of the kinds, then it's hard to see how scientists could be getting it right. Without being able to know the essences of property clusters, however, it's not clear how scientists could know whether they were getting kind identity conditions right. And yet there isn't any obvious way for scientists to acquire such knowledge, at least not without relying on unconfirmable intuitions. The weak entity realist, by contrast, need not commit to the concept of invariant, fully mind-independent essences for HPC kinds, and so is not subject to such epistemic problems.

[8] It is necessary that 1+1=2 if I exist, but it is certainly not essential *to me* that 1+1=2 if I exist. The fact that 1+1=2 has nothing to do with me, whereas any x's essential properties must reveal something non-trivial *about what x is*. See Fine 1994.

Now the moderate or strong entity realist might claim that I am being uncharitable. Indeed, there is an important distinction, raised by Bird (2007), between knowing a thing's complete essence and knowing certain essential facts about a thing. The defender of essences for kinds could say that it would be unreasonable to deny that we can know certain essential facts about things, or even to deny that we can know whether certain facts about things are indeed essential. It may well be essential to atomic elements that each element has a certain atomic mass. Moreover, perhaps we do not need to offer complete identity conditions for kinds in order to be justified in committing to the existence of kinds. After all, as Bird (2007, 300) points out, we had discovered many chemical elements before we came up with the periodic table.

But the question is not whether we should, at least as a hypothesis, believe in the existence of things for which we cannot offer complete identity conditions. I think it would be unreasonable to deny that *sometimes* we should. The question is instead whether, in our suitably *mature* scientific theories, we can indeed know the identity conditions of the kinds to which we commit. The problem with attributing essences to HPC kinds is that isn't clear, even in what we might reasonably consider a mature science, such as chemistry or molecular biology, that we could ever come to know the essences of such kinds. And I take this to be introducing an unacceptable epistemic obscurity into science.

Now the moderate or strong realist may say that I am overcomplicating the question of identifying essences. If species, for example, are defined by common ancestry, then perhaps the extrinsic property of sharing a common lineage might be sufficient to capture the essence, and thus the identity conditions, of a given species (Bird 2018, 1422). And species are taken to be *the* paradigmatic HPC kind (Boyd 1999).

But this is an inadequate rejoinder to the weak realist. Firstly, species *may* not be the only HPC kinds, even within the biological sciences. Indeed, Wilson, Barker and Brigandt (2007,

202) suggest that "the exclusive focus on species has impoverished debates about biological kinds," given that stem cells and genes are also plausibly HPCs, to say nothing of psychological and neurophysiological kinds. These other biological kinds are not so amenable to being defined in terms of a single extrinsic property such as common lineage. Secondly, it isn't clear that common lineage is *sufficient* to define a given species, given the causal interwovenness of common lineage with other factors such as interbreeding, niche-sharing and genetic mechanisms such as transposition (Wilson, Barker and Brigandt 2007, 204). And thirdly, it is also unclear that there is anything like a *perfectly* objective definition of "common lineage," given the vexed debates about phylogenetics and the "tree of life" that have been occurring in recent years (Doolittle 2009, 2010; LaPorte 2005). The plausibility of such a perfectly objective definition is important for defending the claim that species, as paradigmatic HPC kinds, have mind-independent essences.

Moreover, even in philosophy of chemistry, there is still debate about whether it is atomic mass or nuclear charge that defines elements (Tahko 2015, 813; Hendry 2006, 868). The isotopes of a given element all share the same nuclear charge, but they differ in terms of atomic mass. Different isotopes can contribute to significant differences in properties, as is evident in the contrast between heavy water (D_2O) and "regular water" (H_2O) (see LaPorte 2004). (The former is, for one thing, much less hospitable to life and much more useful in nuclear reactors). Likewise, chemical formulae such as H_2O are not sufficient to characterize microstructure. The microstructure of water, for example, differs considerably between its phases (Needham 2011). Given the chemical complexity of even something as *seemingly* simple as water, there is a question about whether a rigorous definition of chemical compounds would have to resort to macroscopic properties (e.g. thermodynamic properties such as triple points), or could make do with microstructure (Needham 2008, 2011). And there is the further question of whether a perfectly objective definition of microstructure could even be provided. Is it the macroscopic or the microstructural properties (or both) that are then essential to water?

The underlying scientific issues are complex, and I cannot remotely do them justice. What matters for my critique of moderate realism is just the following question: is there a mind-independent fact about what are the essences, or natures, of chemical elements or compounds such as water, much less species and brain states? How is one to know, and why ought one to believe, that there is such a fact? Why ought one to believe that there is such a fact if it isn't clear how one could come to know it? For if one can't (even in principle) come to know it, it can't settle theoretical debates. The moderate or strong realist owes a story here. It seems more plausible to say that there are perhaps advantages and disadvantages to different ways of defining elements, and *a fortiori* for defining species and certain compounds such as water. Scientists may well be making a pragmatic decision in deciding between different ways of giving such kinds' identity conditions, weighing values like simplicity and consistency and predictive power, rather than discovering a mind-independent essence. (That is not to say, of course, that scientists aren't discovering mind-independent *properties*. Rather, the question of *which* properties are definitional is not a mind-independent fact). At any rate, such a story would be consistent with WER as outlined in the previous and the following sections. That story bypasses all these epistemic difficulties about how one could come to know kind essences and why one should believe that there are such essences.

Even if we could know that certain facts are essential to a kind, how could we know whether we have captured the complete essence, particularly for more complex HPC kinds in the biological sciences? And if we don't have the complete essence, how could we formulate adequate identity conditions for HPC kinds? My answer to the latter question is simply to adopt the weak realist identity conditions outlined in the previous section. But that option is not open to the moderate or strong entity realist.

Now one could in principle abandon commitment to mind-independent essences for HPC kinds (E2), while retaining commitment to the existence of complex universals (E3). But

Bird (2018) commits to complex universals having essences in order to argue for the existence of kinds, since Bird (2018) accepts that essence implies existence. One would forfeit this argument for the existence of complex universals if one denied that such universals have essences. And affirming E3 but denying E2 would be dialectically odd, as pointed out in section 1.

Mind-independent essences would admittedly allow for perfectly objective identity conditions for HPC kinds. But there is good reason to doubt that it is possible (even in principle) to offer such perfectly objective identity conditions for biological and at least some chemical kinds. Thus it isn't clear why one would be well-motivated in paying the steep epistemic costs of committing to moderate realism, much less strong realism, for biological and chemical kinds. And even moderate realism about physical kinds incurs many of the same epistemic costs. It is not clear these costs need to be paid if my argument in the following section is correct.

5. Weak Realism and the Objectivity Challenge

If WER couldn't offer standards for HPC identity conditions which were *sufficiently* objective to be useful in scientific practice, then WER would be in trouble. Perhaps the epistemic costs of a moderate or strong realist view such as Bird's (2018) are necessary to provide such sufficiently objective identity criteria for HPC kinds.

The question here is about the *standards* for determining which properties are to define those property clusters which are natural kinds, not about which property clusters count as natural kinds. The former question is about, say, whether we should use genomic and proteomic sequences instead of the four humours in our *identity criteria* for the human species. (I take it that the answer is obvious). The latter question (concerning individuation into kinds) is about, say, *which* clusters of psychological and neurological properties ought to count as

natural kinds, or *which* early hominid variations ought to count as natural kinds rather than classifications of convenience.

Obviously both these topics are vastly complex, and I cannot add much detail. The only point I want to make in this section is that the weak entity realist can plausibly offer objective standards for HPC kinds' identity conditions, *without* resorting to essences. Now the weak entity realist must still abandon the strong or moderate entity realist's aspiration for *perfectly* objective identity conditions for HPC kinds. For if one says that HPC kinds do not have mind-independent essences, then one is giving up on there being an immutable and perfectly objective standard of correctness for defining a given HPC kind. But, as I pointed out above, meeting such a standard may well seem like an unrealistic aspiration, at least for practicing biologists and even chemists. And the biological sciences are the ones that paradigmatically deal with HPC kinds.

Nevertheless, scientists might adopt many different research goals, and many different disciplinary matrices, in investigating the same phenomena. Boyd (1999, 148) understands a disciplinary matrix as "a family of inductive and inferential practices united by common conceptual resources" (1999, 148). Perhaps the weak realist account offers no way of determining which selections of determinable properties are *better* for kind identity criteria than others, aside from explanatory success (and perhaps parsimony) within a disciplinary matrix.

Indeed, the moderate or strong realist can turn considerations of explanatory success *against* the weak entity realist. How, after all, could one adjudicate between competing disciplinary matrices? Such matrices could focus on different research goals and determinable properties, while still aiming to investigate the same or similar phenomena. Yet competing sets of kind identity conditions might lend themselves equally well to explanatory success within their respective disciplinary matrices. Which identity conditions then are the *correct* ones?

First, it's important to recognize that the classic account of property clusters (Boyd 1991, 1999) presupposes an objective causal structure. Certain disciplinary matrices are doubtless better than others—some are more successful in getting at causal mechanisms, or uncovering more information about such mechanisms. Those matrices which better get at such causal structures will support more reliable generalizations. Boyd (1999, 147) offers a simplified example of exposing sodium salts to flame. One can make a reliable generalization about the flame turning yellow in virtue of certain facts about the causal structure of the world; the generalization is reliable because "it is appropriately related to the causal structures of the phenomenon in question" (Boyd 1999, 147). So it is hardly as if the property cluster account dispenses with objectivity about science.

By "objective causal structure," I mean only that there are certain generalizations and counterfactuals about property clusters which are true independently of our conceptual schemes and attitudes, given the lawlike regularities which prevail in our world. Scientific investigation of causal structure is concerned with discovering these. I do not mean to take a metaphysical position on what *grounds* such regularities or *makes true* the corresponding counterfactuals. Likewise, while certain counterfactuals may be objectively true, this need not imply a perfectly objective way of defining the *terms* of such counterfactuals, or the properties, mechanisms or property clusters which are being generalized about. One can, for example, hold that certain generalizations about the evolution of species are objectively true, without maintaining that there is a perfectly objective way to define what a species is.[9]

[9] This sort of objectivity does not imply that kinds or property clusters have essences. As I point out in section 4, the essentialism rejected by WER holds that, for any property cluster kind K, it is a *perfectly* objective and mind-independent fact that certain properties and only these properties are to count in the definition of K. E.g. such essentialism would hold that it is perfectly objective fact whether a species is to be *correctly* defined in terms of common lineage instead of genetics, or in terms of both common lineage and genetics, or in terms of some other properties. (This is the sense of essence which is invoked by Bird (2018) and has prevailed in analytic metaphysics, especially since Fine 1994). WER need not deny that there are facts about K which *could* answer the question: what is K? WER need only hold that the determination of *which* properties and types of properties are included in

To the point about deciding between disciplinary matrices which enjoy similar explanatory success, Franklin-Hall (2015) thus proposes an account of kinds as "categorical bottlenecks." Such bottlenecks are categories that would effectively serve a *range* of research goals and epistemic interests. So especially idiosyncratic research goals, best fulfilled by idiosyncratic kind categories, would be excluded by the bottleneck account.

I would propose something similar not just for the kinds themselves (as in Franklin-Hall's (2015) *taxonomic* anti-realism), but for the *properties* that count in kind identity criteria (see section 1). Consider the set $S_{D,n}$ of determinable properties which, for a given disciplinary matrix M_n, provide the identity conditions for kinds (per PCI in section 3). A good reason for including "DNA sequence," "amino acid sequence" and "evolutionary lineage" in the set $S_{D,bio}$-- the set of determinables for the biological kinds—is that such properties best serve a *wide range* of research goals across a *wide range* of scientific practices. Indeed, such properties facilitate reliable and replicable generalizations and inductive inferences across molecular biology, evolutionary biology, and translational and even clinical medicine.

For the weak entity realist about kinds, the relevant range of research goals and interests could depend on what would best allow us, given our (human) cognitive capacities, to discover as much as possible about the *causal* structure of the world, while being able to make reliable generalizations about such causal structure (Franklin-Hall 2015, 946). We need not claim that the kind identity criteria which best serve such a range of research goals correspond to the essences of some complex universals which are the natural kinds. We can adopt the more modest approach of the weak realist account:

Some Constraints on Determinable Properties for Kind Identity Conditions:

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a correct definition of K is not completely mind-independent, and can vary to some degree based on pragmatic judgments and aims.

For a given disciplinary matrix M_n, and a corresponding set of determinable properties $S_{D,n}$:
1) Include in $S_{D,n}$ those properties which best contribute to explanatory success within M_n
2) Consistent with parsimony, do not select "extraneous" determinable properties, or properties which do not contribute to explanatory success within M_n
3) Ensure that the properties in $S_{D,n}$ serve a wide range of research goals
4) Ensure that the range of research goals selected in (3) allow scientists to discover as much as possible about the causal or dispositional structures $C_1…C_n$ studied by M_n, consistent with being able to make reliable generalizations about $C_1…C_n$.

The weak entity realist can apply such standards to ensure greater scientific objectivity in kind identity criteria. I think the burden is then on the moderate or strong realist to show why a commitment to essence makes an important difference. The strong or moderate realist wants to say that we can have completely objective identity criteria for kinds in virtue of kinds' having essences. But given that the weak realist's standards are well-aligned with scientific practice, at least for biological and chemical kinds, the strong or moderate realist is at a dialectical disadvantage unless she can show *at least* one of two things. Either she must (1) show how to overcome the epistemic difficulties posed by essentialism for HPC kinds (see section 4), or (2) show that weak realist's standards for property clusters' identity conditions are not in fact objective enough for scientific theorizing about HPC kinds. Ideally she should show both, given that showing (2) alone does nothing to ameliorate the epistemic difficulties of essentialism. And I am not aware of a thorough case for either (1) or (2).

The aim of this paper has been to further build on Bird (2018)'s and Hawley and Bird's (2011) work in explaining the kinds of questions with which entity realism is concerned, while building a counterargument to Bird (2018)'s defense of SER and less ambitious theories of MER. Strong realism remains unattractive (I've argued) for either biological, physical, or chemical kinds, given its greater theoretical complexity and lack of obvious explanatory payoff. Both strong and moderate realism pose epistemic difficulties which can be avoided by a weak realist

account. The weak realist account can likewise provide identity conditions for kinds which are sufficiently objective to conform to current scientific practice. The weak realist case is especially strong where such scientific practice provides good reason to doubt the plausibility of kinds' having mind-independent essences, as for biological and at least some chemical kinds. Accordingly, the motivations for strong and moderate realism need to be made clearer, especially if such views are to be defensible and interesting as a theory of chemical and biological as well as physical kinds.

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