

WRITING SAMPLE
THE SPECIES OF SPECIES PLURALISM:
BETWEEN MONOGAMY AND PROMISCUITY ABOUT BIOLOGICAL SPECIES
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“Of late, the futility of attempts to find a universally valid criterion for distinguishing species has come to be fairly generally, if reluctantly, recognized.” – T. Dobzhansky (1937, 310)

ABSTRACT: Monism versus pluralism about biological species concepts remains contested terrain in the life sciences. Monists countenance one species concept. Pluralists embrace several. I reject three main schools of monistic species concepts using thin adequacy criteria, and endorse the phylopecies concept in light of these criteria. I then distinguish two “species” of pluralism based on their different responses to the cross-classification problem: is there a uniquely correct scheme for grouping biological entities? Chaste pluralists reject cross-classificationism, while promiscuous pluralists embrace it. Deciding between chaste and promiscuous pluralism hinges on the frequency of “messy situations” in taxonomy. Using the adequacy conditions and taking into account the frequency of messy situations, I give an abductive argument against the promiscuous pluralisms of Dupré, Kitcher, and Ereshefsky, against Ruse’s chaste pluralism, and in favor of a moderately chaste pluralism based on the phylospecies concept as the most reasonable general conclusion to draw, at least for most taxa. Nonetheless, promiscuous pluralism may be reasonable for prokaryotes. If so, we must distinguish local and global forms of pluralism as well. I conclude that chaste pluralism is compatible with species realism while promiscuous pluralism is not.

Given the diversity of life on Earth, the diversity of views about the nature of biological species is unsurprising. Controversy on the nature of species since the rise of evolutionary theory has come to be known as the “species problem,” which is actually a complex of interconnected problems including species’ ontological status, species realism, and the correct definition(s) of “species,” called species concepts.

If species were eternal fixed kinds with sharp divisions between them, there would be no species problem except a diagnostic one. One would need only discover the necessary and sufficient conditions for membership in each species and apply them. Before 1859, this view was common. In that milieu, Carolus Linnaeus wrote “species are as many as were created in the beginning by the Infinite” (1758). By that understanding, organisms reproduce their form, and it is the task of the taxonomist to identify and classify them. This isn’t too wrong because species are composed of organisms related by lineal descent.

But it’s not so simple. Life evolves. Species are less clearly defined and more ephemeral than previously thought. Attempts to provide an understanding of species that is consistent with their evolutionary contingency has resulted in a proliferation of species concepts. According to one recent estimate, there are no

less than twenty-two species concepts at play in contemporary biology (Mayden 1997). This has driven some philosophers and biologists to accept *species pluralism*, the view that there are multiple equally legitimate species concepts. Some theorists have resisted this move, holding to *species monism*, the view that there is a single correct species concept. In the debate on the species problem, just as “species” has taken on numerous different meanings, so too have “monism” and “pluralism.” David Hull observed that:

The apparent differences between [species monism and species pluralism] tend to disappear under analysis. Numerous senses of monism blend imperceptibly into just as many senses of pluralism... A clear contrast exists between the more simplistic notions...when pushed most authors retreat to some platitudinous middle ground... It should not be surprising that some biologists ignore the debate altogether. (1999, 25)

In this paper, I provide a detailed examination of the debate between species monists and pluralists, with an emphasis on the latter. I begin by covering some necessary background material in §1 about species in general, biological systematics, and taxonomy. Then, in §2 I introduce and defend evaluative criteria for species concepts and apply them to the four most prominent species concepts – biospecies, ecospecies, morphospecies, and phylopecies – arguing that the Phylogenetic Species Concept is the best of the bunch. In the most novel section of the paper, §3, I distinguish two broad species of species pluralism – *chaste pluralism* and *promiscuous pluralism* – following two different accounts of what legitimates the adoption of multiple species concepts and discuss the importance of “messy situations” in biological taxonomy for dividing the chaste from the promiscuous. I argue against promiscuous pluralism and in favor of a moderately chaste species pluralism based on the Phylogenetic Species Concept, but I further distinguish the possibility of *local* and *global* varieties of each pluralism in response to the ‘messiness’ of Prokarya. I conclude with some implications of these two species of species pluralism for species realism and environmental law in §4.

It is worth noting at outset that the species problem is not an inconsequential armchair problem, but ignites passionate debate because it matters. In biology, species play an important role in evolutionary theory and are the basal units of taxonomy. Environmental laws such as the United States’ Endangered Species Act of 1973 are often written in terms of species, meaning that a species’ protected status can hinge on the species

concept at play.¹ Also, how we view ourselves as well as our place in, and in relation to, the rest of nature is affected by our species concept(s). For example, some zoologists maintain that both chimpanzee species belong in the genus *Homo* alongside humans rather than in their current genus *Pan* (Pickrell, 2003). Given that “homo” is Latin for “man,” their inclusion would be akin to the final death throes of the *scala naturae*.

The species monism-pluralism debate is also connected to broader metaphysical issues such as the ontological status of species and the realist-antirealist debate. The entrenched views in the philosophy of biology are Kitcher’s set or class conception of species and the view of Mayr, Hull, and Ghiselin, which conceives of species as individuals because they have three non-class properties: they are spatiotemporally localized, discrete, and internally cohesive.² Consideration of these issues would take us too far afield into more general and controversial issues in metaphysics and epistemology. Suffice it to say that, despite early controversy on this point, there is now fairly widespread agreement that species are at least *spatiotemporally localized* sets if not individuals (Wilson 1991). The species concept I defend, the Phylogenetic Species Concept, is compatible with both conceptions.

§1: PRIMER ON BIOLOGICAL CLASSIFICATION

At the outset, it is important to give a brief primer on the meaning of “species,” biological nomenclature, and classification, particularly for nonspecialists so that key concepts and terminology are clear.³ The term “species” is ambiguous. It is used both for a particular kind of natural group (species taxa)

¹ The United States’ Endangered Species Act clearly invokes the Biological Species Concept: “the term ‘species’ includes any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature” (3:16). Since the enactment of the Endangered Species Act of 1973 until August 28, 2008, 10 of 44 delisted species cite “taxonomic revision” as the reason, not extinction or recovery. A controversial case in point is the red wolf (*Canus rufus*), heralded as a flagship of conservation biology in the United States and protected under the Endangered Species Act to the tune of millions of dollars. However, due to genetic evidence and because it readily hybridizes with both grey wolves (*C. lupus*) and coyotes (*C. latrans*), its species status is questionable according to several major species concepts (Stamos 2003, 300-301).

² Ghiselin (1979, 1987), Kitcher (1984), Sober (1984), Wilson (1991), and Hull (1999) are amongst the main articles on the individual-set debate about the ontological status of species. See Boyd (1999) and Wilson (1999) for fresh versions of the natural kinds view, which avoid essentialist assumptions about natural kinds, arguing in favor of species as “homeostatic property clusters.” Also, see Stamos (2003) for a defense of the idea that species are better understood as “relational complexes,” an alternative to the traditional individual-set dichotomy.

³ Those familiar with taxonomy and phylogenetic systematics can skip this section.

and as a unit of classification (the species category).⁴ Species are one of the basic categories of biological entities, with comparable importance in biology to genes, cells, and organisms (de Quiroz, 1999, 65). One of the main tasks of biology is to discover and describe species. Once species are identified, they are named and categorized. A taxon designates a group of organisms in a classification scheme.

Modern biological taxonomy is based on Carolus Linnaeus' *Systema Naturae* (1758). Linnaeus' system provides a hierarchical structure for classifying and naming all living things. While his system was pre-Darwinian, his general classification system still dominates, particularly its binomial nomenclature for naming species. Due to the explanatory success of evolutionary theory in uniting what were once disparate inquiries in biology, and its focus on objective, quantitative analysis over subjective assessments of morphological difference and similarity, Willi Hennig's (1966) new classificatory methodology, phylogenetic systematics, or cladism, has become increasingly dominant, particularly since the 1980's. The goal of cladism is to reconstruct life's evolutionary history and to reflect that understanding in a classification system. As such, it draws on and accords with the idea of common descent in evolution.

Cladistic analyses produce branching diagrams, also known as phylogenetic trees or cladograms, which graphically represent hypotheses about the phylogeny of life on earth. They are empirically testable, and revisable in light of new evidence. The basic category of phylogenetic systematics is a *clade*. A clade is a monophyletic group, i.e. an ancestor and all of its descendents, where "ancestor" is taken to be a single organism, tribe, or population. Since we cannot directly observe life's evolutionary history, phylogenies are inferred on the basis of biological characters – morphological data matrices and molecular sequencing data of DNA, RNA, and proteins – in the organisms or fossils under study.

Clades occur at all hierarchical levels in cladograms, i.e. each clade nests within numerous higher clades tracing lines of common descent, resulting in a series of internested clades tracing evolutionary history into the past. More inclusive, ancestral clades have numerous primitive characters common to all more specific clades, as well as specific derived characters, or *apomorphies*, which distinguish them from ancestral

⁴ Species taxa are particular species, for example, *Ursus americanus* and *Homo sapiens*. The species category is the set of species taxa, and is the basal rank of the Linnaean hierarchy. A species taxon is based on a concept of a natural group (group concept) whereas the species category is a rank concept referring to a particular level in Linnaean taxonomical system (rank concept).

clades. In other words, all clades (with the exception of terminal clades) are ancestral with respect to descendent clades, which are themselves ancestral to their descendent clades.⁵ Any novel evolutionary trait shared by two or more clades is a *synapomorphy*, and is the best evidence available of the clades' common phylogeny. In other words, a shared derived character present in two or more clades is evidence that they are more closely related than clades without that synapomorphy.

Any nonmonophyletic group is a *grade*. There are two kinds of grades: paraphyletic groups and polyphyletic groups. A paraphyletic group is a monophyletic group minus some of its descendents.⁶ A polyphyletic group does not include their members' most recent common ancestor. They are groups of organisms not closely related by evolutionary descent.⁷ These points are significant because most species concepts delineate grades rather than clades, and we have good reason to reject these species concepts, as argued below (§2).

Phylogenetic systematics, unlike Linnaean taxonomy, is rankless, capable of producing arbitrarily deep trees, and therefore requires a ranking component if species are to be distinguished from higher and lower clades. Here, it is helpful to distinguish systematics (the construction of phylogenies), from taxonomy (the classification of organisms), which may or may not be based on phylogeny. That is, there are clades at various hierarchical levels in the tree of life, so ranking criteria are needed to distinguish species taxa from ancestral and, when applicable, descendent clades, i.e. subspecies, populations, etc. The general tendency over the last half century is for taxonomy to track systematics; that is, our classification of life increasingly tracks its history.

⁵ For example, Vertebrata is a clade, defined by the apomorphy "having a vertebral column," which is the specific derived character common to all vertebrates yet not common to its ancestral clade, Bilateria (all animals with bilateral body symmetry). Yet having a vertebral column is one among many primitive characters common to descendent clades, and is useless for distinguishing descendent clades from one another.

⁶ For example, the Linnaean class Reptilia excludes the Aves clade, and is therefore a paraphyletic grade, since both are actually descendents of Sauropsids, one of the two dinosaur clades in the Amniota clade (humans and all other mammals are descendents of the other dinosaur clade, Synapsids). As Colin Tudge tersely puts it, the best we can say of reptiles is that they are "non-avian, non-mammalian amniotes" (2000, 85).

⁷ "Warm-blooded," is an example of a polyphyletic group. Mammals and birds are the group of warm-blooded organisms, but warm-bloodedness is not common to our most recent ancestor, Amniota, which was cold-blooded. Polyphyly is 'convergent evolution.'

§2. SPECIES CONCEPTS AND CRITERIA OF ADEQUACY

I will now introduce four of the most influential schools of monistic species concepts as well as propose and defend criteria of adequacy for evaluating them. Both play a key role in my arguments about species monism and pluralism. I'll start by introducing the species concepts and criteria of adequacy, then discuss each criterion individually, and finally, evaluate the former in terms of the latter. The most prominent species concepts are:

1. **Morphological Species Concept (MSC)** – A *morphospecies* is a population or group of populations that differs morphologically, i.e. anatomically, from other populations.
2. **Biological Species Concept (BSC)** – A *biospecies* is “a group of naturally interbreeding populations that is reproductively isolated from other interbreeding groups” (Mayr 1988).
3. **Ecological Species Concept (ESC)** – An *ecospecies* is “a number of related populations the members of which compete more with their own kind than with members of other species” (Colinvaux 1986, 152).
4. **Phylogenetic Species Concept (PSC)** – A *phylospecies* is a group of organisms with a common ancestor, i.e. a spatiotemporal lineage that maintains its integrity with respect to other spatiotemporal lineages. At some point in the progress of such a group, members may diverge: when such a divergence is distinct, the two populations are separate species.

If species concepts are to be evaluated, it must be done according to some criteria. These criteria should be minimal and well supported in order to serve as a neutral basis by which species concepts can be evaluated.

As thin as they are, the following criteria are quite helpful in evaluating species concepts. An adequate species concept should:

1. Identify natural groups of organisms.
2. Have as wide a scope as possible.
3. Be consistent with (and revisable according to) the best available scientific theories.

The first and most important criterion is that adequate species concepts identify natural groups. This idea is not new. Plato wrote that the wise man “cuts nature at its joints” (2003, 265d-266a). The boundaries between species are the joints where systematists ‘cut’ nature. Plato’s intuition, which most people share, is that there is a *real* difference between species. There are natural groups of organisms that exist independently of human cognition, and which existed before Hominines evolved over the last few million years and began to identify, classify, and study them. If a scientist decides that she is going to distinguish lions from tigers, she is making a *natural* distinction because they really are different. If she decides she's going to separate those same

organisms based on the astrological signs under which they are born, by color, by those over 100g and those under, etc., we rightly conclude that she is making an *arbitrary* distinction. She fails to cut nature at its joints.

There are several *prima facie* plausible criteria for delineating natural groups. Nature's joints aren't as obvious as Plato let on. Morphological similarity, interbreeding relationships, common niche occupancy, total genetic similarity, monophyly etc. are all plausible candidates. This is part of the reason for the species problem: many species concepts, even folk species concepts do 'well enough' in practice, converging on the same natural groups in most cases, just as Newton's theory of gravity does 'well enough' for building bridges, even though Einstein's general relativity is more accurate. This casts doubt on promiscuous pluralism and species eliminativism, as I argue below (§3).

The second criterion concerns scope. All else equal, wider is better. This is a standard adequacy criterion for theory evaluation in the philosophy of science. In the present circumstance, an adequate species concept should account for all natural groups.

The third criterion is that species concepts should be consistent with the best available scientific theories and revisable in light of new evidence as science progresses. We don't know everything there is to know about biology. We know *that* evolution has occurred, but the science of speciation – the causal mechanism(s) responsible for the formation of new species – is highly controversial. As Levin nicely puts it, "species concepts based on the products of evolution are not shackled with implicit or explicit assumptions of causation" (1979, 384).

With these thin criteria of adequacy for species concepts, I will now examine the species concepts above in light of them. The MSC is the species concept implicit in folk taxonomy, designating natural groups according to similar appearance. Tigers are a species because they look similar, and lions are not in the same species as tigers because they look different. The MSC does well on some criteria. It is wide in scope since all organisms can be morphologically compared. It makes no claims about speciation. However, the MSC is inadequate because it cannot account for the fact that organisms look similar *because they are related to one another*. Simpson's analogy is apt: "two individuals are not twins because they are similar but, quite the contrary, are similar because they are twins" (Simpson, 1961, 69).

Also, the MSC cannot establish the requisite degree of similarity for delineating species. Setting the bar too high results in the absurd conclusion that males of closely related sexually dimorphic putative species are one species and females of the same closely related putative species are placed in another species. Setting the bar lower to account for sexual dimorphism results in implausibly broad species, and the motivation to lower the bar to account for sexual dimorphism shows that another species concept is doing the real work. Nonetheless, most species are diagnosed in the field based on phenetic criteria readily identifiable by ordinary human perception, and these delineations aren't too often that wrong.

The ESC fares poorly too, particularly under the first criterion. It appeals to conspecific competition for niche occupancy amongst “a number of related populations,” building in an assumption of relatedness. Therefore, the ESC is not a basic species concept. Another problem is that many putative species don't occupy a single niche. Some cichlids are opportunistic scavengers as juveniles and predators as adults. Males and females of dimorphic ‘species’ can occupy different niches. To prevent the absurd result of classifying these organisms as different species, the niche in question can be expanded, but again, another species concept is doing the real work. A second problem is that two ‘species’ can “easily occupy identical niches when living in different places, and even when living in the same place” (Ghiselin 1987, 140-141). This means that if ‘species’ x goes extinct in a particular locale and another ‘species’ y takes over this niche, then x simply is y . ESC mistakes natural groups with their ecosystemic role, yet “an individual remains the same irrespective of its activities” (Ghiselin 1987, 139). To paraphrase Forrest Gump, “species is as species does,” but that can't be right. The ESC, treated as a basic species concept, designates implausible natural groups.

The PSC is the best species concept under these criteria because monophyly is the best candidate for delineating natural groups of organisms. Lineal descent is a basic causal process in biology, even in pre-evolutionary biology such as Linnaeus' own species concept. Species are groups of organisms related to one another. Lineal descent is the modus operandi of cladism. Using monophyly as the criterion for natural groups best captures the relatedness of organisms in the species, and does so in a systematic way. This is further supported by the fact that inductive generalizations from one member of a clade to another member of a clade are more reliable than any other criterion as the basis of such inductive generalizations. By this, it is

meant that inductive generalizations of the form: ‘if organism o in group g has property p and if organism x is also in group g , then x has p ’ are more true using monophyly as the basis for inclusion and exclusion from g than using any other criterion for group inclusion (Wilkins 2003, 630). Species delineations based on interbreeding (BSC), niche occupancy (ESC), etc. are less reliably projectable than using monophyly as a basis. In other words, monophyletic groups are the best candidates for natural groups of organisms.

Secondly, it is in principle applicable to all organisms related by common descent, i.e. all organisms on earth, because the PSC relies on phylogeny for natural groups, so it is potentially maximally wide in scope. Whether or not this is true in practice is discussed below (§3). Also, the PSC is consistent with and revisable according to the science of speciation. Since the PSC is based on lineal descent, it is not shackled to specific causal mechanisms responsible for speciation. Lineal descent tells us nothing about *how* lineages maintain their identity through time or speciate. Also, descent alone is inadequate because all organisms are related by descent, yet there is obviously more than one species. Evolutionary biology is required to explain the continuity and branching of species, making the PSC quite revisable. The PSC does well according to these three criteria.

The BSC is the most prominent version of species monism and most influential species concept, present in most dictionaries and biology textbooks. Mayr’s definition of the species category is that “species are groups of interbreeding natural populations that are reproductively isolated from other such groups” (1988, 318). In other words, a species is a group of populations that naturally interbreeds, yielding fertile offspring. Particular species taxa are inferred from this species concept, i.e. species are identified on the basis of the BSC. Accordingly, there is a species-specific genotype protected by numerous isolating mechanisms such as sterility with members of other species, behavioral barriers, mate recognition, etc. (1988, 344-53). The BSC is popular because it “works well enough in studies of most kinds of organisms, most of the time” (Wilson 1992, 49). Also, the BSC improves on the MSC since it moves beyond mere appearances – for example, the BSC can account for sibling ‘species’ such as the Western and Eastern Meadowlark which are nearly identical phenotypically, yet do not interbreed – and can account for sexually dimorphic species, which obviously interbreed. The BSC delineates plausible candidates of natural groups.

Despite its prominence, the BSC has significant problems, all of which derive from interbreeding as the grouping criterion. There is more to life than sex, as it were. As a result, the BSC is too inclusive and too exclusive in different respects. The BSC is too inclusive because of the “too much sex” problem (Templeton, 1989): there are putatively separate species which are reproductively compatible. According to the BSC, these ‘species’ are a single species rather than several. The BSC appeals to populations of naturally interbreeding organisms, which means that occasional hybridization occurring in the wild is unproblematic if the populations remain distinct. Hybridization in captivity is likewise unproblematic since such interbreeding does not naturally occur. While the BSC can accommodate these two sorts of phenomena, it cannot accommodate more rampant hybridization, common most notably in plants. A classic case is American oak ‘species’ which have routinely hybridized throughout their history, yet which are nonetheless quite differentiated in other respects. Proponents of the BSC simply bite the bullet and accept it as one large, diverse species (Ghiselin 1987), but this is counterintuitive and theoretically driven. The BSC gives an implausible account of natural groups.

The BSC is too exclusive because of the “not enough sex” problem: it does not apply to asexual ‘species’. It does not fare well under the second criterion of adequacy for species concepts, scope. It does not apply to asexual organisms, excluding all ‘species’ whose lineages are maintained via such varied reproductive modes as binary fission in Bacteria and Archaea, asexual cloning, parthenogenesis in multicellular animals, particularly lizards, and vegetative propagation, apomixis and polyploidy in plants. Mayr responds to this objection as follows:

A... difficulty which confronts us in our attempt at a species definition is that there is, in nature, a great diversity of different kinds of species. Even if we do not consider such aberrant phenomena as the apomictic species in plants and the strains of bacteria, there is, even among animals a great variety of situations which are generally classified as species... The question as to whether the species of birds, of corals, or protozoa, and of intestinal worms are the same kind of evolutionary phenomena is entirely justified. (1942, 114)

John S. Wilkins summarizes the problem quite aptly: “if most kinds of organisms are ‘aberrant,’ something is wrong with the way we specify ‘normal’ ” (2003, 628). Some authors have claimed that this is a *reductio ad*

absurdum of the BSC (Mishler 1987, 407). Others have noted that most advocates of the BSC are zoologists.⁸ Botanists are less likely to endorse this concept, and microbiologists and paleontologists even less so, as the BSC is less suited to the species they study.

Mayr was not deaf to the fact that many putative species are not species according the BSC. He addresses the possibility that there are different kinds of species. Mayr's solution is to restrict the term "species" to "biological species, the largest cohesive population," and notes that "only that which has the propensity for speciation... deserves to be called a species, and this does not include asexual entities" (1988, 354). As if asexual 'species' never speciated; sexually reproducing species are the products of asexual ones! Mayr notes that his solution is unfortunately imperfect because there are "entities in nature that do not qualify as biological species, but which fill the same place in the ecosystem as do biological species" (1988, 354-355). Mayr recognizes natural groups other than biospecies, which he calls "paraspecies," but refuses to recognize them as *genuine* species, privileging biospecies to the term "species" since paraspecies lack internal cohesion via interbreeding, and are therefore classes not individuals, which he regards as a threat to species realism.⁹

Mayr's mistake is the myopic focus on interbreeding, and the fatal flaw is the fact of asexual species. A species concept accounting for both is preferable. The PSC can, and the BSC cannot, which makes the former greater in scope. Also, the BSC falls afoul of the third criterion, as it is shackled to interbreeding as the sole mechanism of species cohesion. Mishler notes that the adherence to the BSC "has actually retarded progress in understanding speciation processes" (1990, 167). It is not that interbreeding is unimportant; it is hugely important – for interbreeding species. The PSC allows for interbreeding to be a significant causal factor responsible for maintaining lineages and speciation where it applies. The PSC is a superior species concept.

⁸ Mayr was an ornithologist. The title of one of his books, *Systematics and the Origins of Species from the Viewpoint of a Zoologist*, is rather telling in this regard.

⁹ Mayr seems to think species are real if only if they are individuals, implicitly appealing to nominalism about universals. Yet the PSC is consistent with species as individuals, since all species are spatiotemporally localized, discrete, and have at least some degree of internal organization. A more plausible understanding of realism hinges not on the realist-nominalist debate about universals, but on the mind-independence of the groups identified. This is discussed below in §4.

§3. THE SPECIES OF SPECIES PLURALISMS

Thus far, I have argued that the PSC has certain advantages over prominent monistic species concepts, but how the PSC is a form of species pluralism is still unclear. Before discussing the specifics of the PSC as a species pluralism in detail, some general remarks about species pluralism are in order. “Species pluralism” can mean many things. What all species pluralisms have in common is the rejection of monism, which holds that a single species concept is uniquely correct. All species pluralists advocate multiple equally legitimate species concepts. From this point, they diverge.

One of the main claims of this paper is that there are two distinct kinds of species pluralism, and distinguishing them can help illuminate some of the debate on the species problem. Dupré, a most radical pluralist, calls his own view “promiscuous pluralism” (1999). Perhaps in response to Dupré, Wilkins’ calls his more austere view a “chaste pluralism” (1999). What I wish to show here is that all pluralists fall on either side of the chaste-pluralist divide. Chaste pluralisms have in common the idea that there are numerous legitimate species concepts, yet nonetheless a single legitimate way to group organisms, resulting in a single, internally consistent taxonomy. These views are *chaste* in advocating a single coherent classification of species, which they share with monism, yet are *pluralistic* in advocating different species concepts by which we do so, which they hold in common with promiscuous pluralisms. Promiscuous pluralisms advocate numerous legitimate species concepts, and so are *pluralistic*, and several *equally legitimate* ways to classify organisms, and so are *promiscuous*. The crux of the disagreement between chaste pluralists and promiscuous pluralists is what I will call the cross-classification problem: is there a uniquely correct schema for grouping biological entities? Chaste pluralists claim that there is such a unique scheme and resist cross-classificationism. Promiscuous pluralists deny this and legitimize multiple schemes, often embracing cross-classificationism.

The subspecies of chaste and promiscuous pluralisms have further differences. The differences between chaste pluralisms reflect contrasting views of the relationship between species concepts and the uniquely legitimate taxonomy of species which they delineate. The differences between promiscuous pluralists reflect disagreement about which species concepts are admissible and how to address the cross-classification problem. Perhaps there are other axes at play in the pluralism debate. My aim here is only to distinguish the

chaste-promiscuity axis, what it concerns, what the merits of each are in light of the criteria of adequacy, and what else hinges on this distinction.

What ultimately matter are the ideas, not the labels. Nonetheless, distinguishing these two species of species pluralism is important because ambiguity mires the discourse, obscuring points of agreement and disagreement about the real issues. Sometimes, monists purport to object to pluralism, but conflate these two varieties of pluralism, and are really only objecting to one form of pluralism. For example, Ghiselin (1987) lays the wood to ‘pluralism’, but his objections are properly interpreted as applying only to promiscuous pluralism. Also, some ‘pluralists’ refer to other self-avowed ‘pluralists’ as monists. For example, Marc Ereshefsky, a promiscuous pluralist discussed below, claims “monists have launched a number of objections to species pluralism” (2007), yet counts Wilkins amongst the monists, which is curious because Wilkins is a pluralist as defined above, and counts himself as such (2003). By identifying these two species of species pluralism, such misunderstandings and wrongheaded accusations can be reduced with the ultimate aim of making progress on the species problem.

With criteria for the adequacy of species concepts, the distinction between chaste and promiscuous pluralism, and the cross-classification problem on the table, I will introduce and assess the merits of the species of species pluralisms individually. I’ll first discuss two versions of chaste pluralism and then three versions of promiscuous pluralism.

Michael Ruse defends a most chaste pluralism: “there are different ways of breaking organisms into groups, and they *coincide!* The genetic species is the morphological species is the reproductively isolated species is the group with common ancestors” (1992, 356). Ruse is a pluralist in that he regards numerous species concepts as legitimate, and is chaste by holding that all these species concepts pick out the same natural groups. Presumably, picking one species concept over another is merely a matter of convenience. While Ruse is correct for many species, Ruse’s pluralism can be quickly dismissed, as it is simply too optimistic. There are messy situations. Take, for example, the American Oak(s) complex discussed above (§2), which is a single species according to the BSC, and many species according to the MSC and PSC. There are different ways of breaking organisms into groups, and they do *not* coincide.

A more moderate form of chaste pluralism, which contains a monistic grouping criterion and pluralistic ranking criteria, is the most plausible for most ‘species’.¹⁰ As argued above (§2), the PSC is the best species concept. However, since monophyly selects groups at various levels of organization throughout the phylogenetic tree, ranking criteria are needed to distinguish species from higher and lower clades. It is here that the PSC is pluralistic because “different factors may be ‘most important’ in the evolution of different groups, a universal criterion for delimiting fundamental, cohesive evolutionary units does not exist” (Mishler 1982, 495). Assuming that there is a universal criterion is the error of species monism. Different causal forces maintain species, and a plurality of criteria is needed for explaining their cohesion and speciation.

Unsurprisingly, these are just the sorts of forces that some species concepts appeal to, creating their initial plausibility as species concepts in their own right: breeding barriers (BSC), selection constraints (ESC), etc. The relative importance of the various relevant causal factors in the cohesion and differentiation of species is best left to practicing biologists in particular subfields. It may even be useful to develop specific species concepts for individual subfields in biology reflecting the causal agents most responsible for the maintenance of the lineages of concern in each field. As such, we arrive at the following definition of the species category:

A species is the least inclusive taxon recognized in a classification, into which organisms are grouped because of evidence of monophyly (usually, but not restricted to the presence of synapomorphies), that is ranked as a species because it is the smallest ‘important’ lineage deemed worthy of formal recognition, where ‘important’ refers to the action of those processes that are dominant in producing and maintaining lineages in a particular case. (Mishler and Brandon, 1987, 406)

How many species concepts are needed to provide species ranks to monophyletic groups? Treating species modes as synapomorphies means that this is an empirical question: “there should be as many species concepts as there are ways, common to evolved clades, of *being* species” (Wilkins 2003, 633).

A pluralism of species concepts is to be preferred, contra promiscuous pluralism, not because of our diverse theoretical and practical interests, but because “no species mode is synapomorphic to all natural groups of organisms” (Wilkins 2003, 634). There is no common process or set of processes that could be

¹⁰ This makes my view similar to Mishler *et al* (1987) and Wilkins (2003), yet distinct from Cracraft (1992), who advocates a different version of the PSC by not distinguishing grouping and ranking criteria. Cracraft takes the least inclusive monophyletic groups to be species. Recently, Mishler has converted to this view as well, and is discussed below.

formulated as a set of necessary and sufficient conditions, providing a single species concept. The diversity of natural groups simply doesn't allow it. This species pluralism is chaste because it yields a single, non-cross-classifying taxonomy, yet is pluralistic in that this taxonomy consists of different species modes maintained by different combinations of evolutionary forces in different cases and open to revision as the science of speciation progresses. It accounts for the unity (lineal descent) and diversity (evolutionary mechanisms) of species.

I will now discuss three versions of promiscuous pluralism, starting with John Dupré's radical promiscuous pluralism. His view is that:

There is no God-given, unique way to classify the innumerable and diverse products of the evolutionary process. There are many plausible and defensible ways of doing so, and the best way of doing so will depend on both the purposes of the classification and the peculiarities of the organisms in question whether those purposes belong to what is traditionally considered part of science or part of ordinary life. Just as a particular tree might be an instance of a certain genus (say *Thuja*) and also a kind of timber (cedar) despite the fact that these kinds are only partially overlapping, so an organism might belong to both one kind defined by a genealogical taxonomy and another defined by an ecologically driven taxonomy. (1993, 57-58)

The complexity of the world and our diverse goals drive Dupré to pluralism. His view is promiscuous in that he embraces the cross-classification problem: the sameness relations we use to group organisms "may often cross-classify one another in indefinitely complex ways" and "none of these relations is privileged" (Dupré 1993, 6, 1981, 82). For Dupré, *any* similarity between organisms qualifies as a grouping criterion, including not just whichever are of interest to biologist, but all folk taxonomies such as foresters' classification of wood-types, dog show judges' categories, and even a culinary taxonomy based on "texture or flavor" are legitimate (1999, 11; 1981, 83)!

Dupré's pluralism runs egregiously afoul of the thin criteria of adequacy for species concepts defended above. By allowing any similarity amongst organisms to count as a basis for delineating species, he allows for extremely unnatural groups. As Ghiselin objects, "anything goes" (1987, 136). There is nothing wrong with informal taxonomies based on wood quality, the color wheel, the texture and flavor of meat, or date of birth, but there is no reason to think the delineated groups are *species*. To place taxonomies based on

idiosyncratic or practical criteria on equal footing with taxonomies based on contemporary biology is wrong-headed.

Philip Kitcher's pluralism is less promiscuous than Dupré's pluralism. For Kitcher, only "biologically interesting" species concepts are admissible. Kitcher's view is that:

There is no unique relation which is privileged in that the species taxa it generates will answer to the needs of all biologists and is applicable to all groups of organisms... The species category is heterogeneous because there are two main approaches to the demarcation of species taxa and within each of these approaches there are several legitimate variations. One approach is to group organisms by structural similarities. The taxa thus generated are useful in certain kinds of biological investigations and explanations... The other approach is to group organisms by their phylogenetic relationships. Taxa resulting from this approach are appropriately used in answering different kinds of biological questions. (1984, 309)

Kitcher borrows the structural-evolutionary distinction from Mayr, but takes it a step further. Whereas Mayr privileged the evolutionary approach (1976, 360), Kitcher thinks that these two kinds of biological investigation "can be carried out relatively independently of one another," "neither of which has priority over the other," and each "demand different concepts of species," resulting in cross-classifying taxonomies in many cases (1984, 320). Kitcher would have it that there is a dialectical equilibrium between these two approaches in biology, a case of reasonable disagreement.

However, in light of the prominence of evolutionary biology, Kitcher's acceptance of structural and historical accounts as contrasting, equally legitimate approaches to biology is puzzling. Since the advent of evolutionary theory, species have been considered either the units or products of evolution.¹¹ Kitcher's essay is dated in this respect. Phylogenetic systematics was only beginning to overtake other approaches to systematics in the 1980's. More troublesome for Kitcher is that structural and historical approaches are no longer separate takes on biology in dialectic equilibrium. It was common knowledge in the 1980's that the modern evolutionary synthesis united Mendelian population genetics with Darwinian natural selection, integrating laboratory work on genetics with the fieldwork of population biologists, but in the 1990's, biology underwent a second synthesis. Evolutionary developmental biology (evo-devo) integrates structural considerations into an historical account, making developmental biology explicitly historical (Goodman,

¹¹ This does not discount the importance of structural biology, for example in explaining how lineages are maintained via developmental canalization, reproductive behavior, etc. and providing operational criteria for identifying species in the field or laboratory.

2000). Structural and historical biology do not need their own species concepts because they are no longer separate approaches. This distinction is no longer “biologically interesting”. The thesis-antithesis spawned a new synthesis wherein structures are viewed historically.

Marc Ereshefsky’s “eliminative pluralism” is the most restrictive promiscuous pluralism. This is the most promising version of promiscuous pluralism and deserves lengthier treatment. Ereshefsky’s view is pluralist in that he regards three species concepts as legitimate: the BSC, PSC, and ESC, and is promiscuous because these three species concepts cross-classify biological entities, each of which he thinks is equally legitimate. Ereshefsky creates a hypothetical case involving three monophyletic insect populations, A, B, and C. B and C occupy the same ecological niche, while A occupies a separate niche. A and B are interbreed and are interfertile, whereas C is asexual, reproducing via parthenogenesis. It is a messy situation. Each of the three species concepts classifies these insect populations into different species, “all of which are equally legitimate” (1992, 674-676). Ereshefsky generalizes this case; messy situations abound. Invoking Darwin’s metaphor of the Tree of Life (1872, 171-172), Ereshefsky argues that:

All of the organisms on this planet belong to a single genealogical tree. The forces of evolution segment that tree into a number of different types of lineages, often causing the same organisms to belong to more than one type of lineage. The evolutionary forces at work here include interbreeding, selection, genetic homeostasis, common descent, and developmental canalization. The resulting lineages include lineages that form interbreeding units, lineages that form ecological units, and lineages that form monophyletic taxa.... Of course this picture of evolution could be wrong; perhaps some of the above-mentioned forces do not exist, or those forces lack the ability to produce stable taxonomic entities. These are, after all, empirical matters. But given what contemporary evolutionary theory tells us, the forces of evolution segment the tree of life into different and incompatible taxonomies. (1992, 676-677)

Ereshefsky’s pluralism is more reserved than Kitcher or Dupré. Rather than embrace the promiscuity generated by his pluralism, he sees it as a problem. Instead, he advocates species eliminativism because the term “species” simpliciter has outlived its usefulness. “Species” should be eliminated and replaced by terms which more accurately reflect the kinds of lineages commonly referred to as species: biospecies, ecospecies, and phylopecies (1992, 680). There are three equally legitimate internally consistent taxonomies based on three partially non-overlapping concepts of natural groups.

For Ereshefsky's argument to succeed, these three "evolutionary forces" must be equally important, and this is where his argument goes awry. He recognizes this problem in saying that:

The monist [or chaste pluralist] would contend that one type of lineage is more important for understanding the course of evolution, thus only that type of lineage should be designated by the term 'species'... If we are to understand how evolution has occurred on this planet, we must study the various types of theoretically important lineages in the world. No particular type of lineage is prior to that study. (1992, 677)

Ereshefsky's concern is valid: putting any particular kind of lineage prior to the study of how evolution occurred prevents us from achieving that understanding, but the application is partly mistaken. He rightly accepts that evolution has occurred; natural groups exist and require explanation. As argued above (§2), species concepts shackled to evolutionary causal mechanisms are problematic given the incomplete state of biological knowledge and because the relevant evolutionary mechanisms vary in importance throughout the tree of life. His concern is therefore well placed against the BSC and ESC, as the former designates species according to interbreeding and the latter groups organisms according to organisms subject to similar selection pressures.

However, the PSC groups organisms according to monophyly reflecting lineal descent. The PSC differs from the BSC and ESC in this respect, deriving directly from the fact that evolution has occurred. The PSC is neutral with regards to the biological forces that maintain lineages and cause them to speciate. Ereshefsky is right that both interbreeding and selective pressures are such forces, but lineal descent is the fact that organisms are born from other organisms, a fact that needs explained in terms of evolutionary forces. It is the particular hypotheses about the evolutionary forces responsible for the continuity and divergence of lineages that are contentious, not that there is such continuity and divergence. Monophyly is not an evolutionary force. Clades are the products of such forces, and this is precisely why pluralism is necessary for the PSC. Therefore, Ereshefsky's argument that we should not put any type of lineage prior to the study of evolutionary forces is unsuccessful.

His second claim, that contemporary evolutionary theory tells us that the forces of evolution "often" segment the tree of life into cross-classifying taxonomies, remains to be considered. There are indeterminate biological states of affairs, i.e. there are 'species' involved concurrently in multiple evolutionary processes,

‘pulling’ them in different directions. In some cases, species boundaries are blurred. Species are speciating, just as we should expect in light of evolution. Such situations are referred to as “messy situations.” That there are messy situations is part of the reason there is a species problem. We get different ‘species’ (in some cases) depending on the grouping criterion. If we take these criteria together, we get an internally inconsistent, cross-classifying taxonomy.

Messy situations are motivation for embracing cross-classificationism, as promiscuous pluralists do. This inconsistent taxonomy is motivation for species eliminativism, the view that we should eliminate species altogether from our ontology, evolutionary theory, and vocabulary. Therefore, the frequency of messy situations is crucial in deciding between chaste and promiscuous pluralisms. If they were universal or the norm, then we should be at least promiscuous pluralists if not species eliminativists. Conversely, if they were non-existent or relatively uncommon, this favors chaste pluralism or species monism, and surely species realism.

In principle, it would seem that the frequency of messy situations is an empirical question, but it is one that it is difficult to resolve because the biological sciences are incomplete, empirically and conceptually. Monists and chaste pluralists regard messy situations as exceptions rather than the rule, whereas promiscuous pluralists regard them as the rule rather than the exception.

David Stamos says “the question is whether the case of dandelions [a messy situation] is typical or atypical. Biologists seem to be agreed that it is the latter” (Stamos, 2003, 331). McDade surveyed botanical monographs covering 1,790 species, concluding that approximately 15% of those putative species are, “at this horizontal time slice, involved in one or more biological processes that blur species boundaries” (1995, 614), i.e. 85% of the species surveyed are not messy situations.¹² Budd and Mishler echo McDade’s conclusion in summarizing the findings of a symposium on species and evolution in clonal organisms, specifically mosses, ferns, diatoms, grasses, rosaceous trees and shrubs, parasitic helminths, reef-corals, and bryozoans:

¹² Note also that this study is of botanical monographs, and that the incidence of messy situations in plants is greater than animals.

[I]n every group covered, regardless of sexuality, discrete entities did exist that systematists have called "species." Furthermore, degree of discreteness did not appear directly related to degree of sexuality... discrete entities were shown to persist unchanged over long periods of time, often millions of years in duration... rapid divergence during speciation was followed by a much longer time interval during which no evolutionary change occurred. (1990, 166)¹³

In his discussion of asexual rotifers, Templeton notes “the asexual world is for the most part just as well (or even better) subdivided into easily defined biological taxa as is the sexual world. This biological reality should not be ignored” (Templeton, 1989, 8).¹⁴ Stamos makes the connection with species realism:

If messy situations were the norm, then I would seriously doubt that species are real. Conversely, if there were no messy situations, then I would seriously doubt that evolution is a fact. Messy situations, however, do exist although they are not the norm. And evolution is a fact. (2003, 332)

As these authors see it, most species are ‘good’ species, and messy situations are relatively uncommon, making monism or chaste pluralism the more plausible general conclusion to draw. However, note the type of organisms these authors all draw attention to are eukaryotes: McDade (plants), Budd and Mishler (various multicellular clonal eukaryotes), and Templeton (unicellular eukaryotes). The defining characteristic of eukaryotes is a cellular nucleus, a development that appears to be monophyletic.

In recent years, promiscuous pluralists such as Dupré (2007) and Ereshefsky (2010) have drawn attention to the nucleus-less prokaryotes (Bacteria and Archaea).¹⁵ Ereshefsky thinks that prokaryotes make the existence of a general species category for all life dubious. O’Malley and Dupré echo this: “prokaryote taxa simply refuse to show the clear, consistently definable characteristics often associated with eukaryotic species and classification” (2007,175). The chief reason for this is that various forms of horizontal gene

¹³ E.O. Wilson echoes Budd and Mishler: “Asexual and self-fertilizing forms tend to maintain remarkable integrity. The vast majority, even though freed from the evolutionary constraints of sexual compatibility, do not vary in all directions, do not fan out to create wide continuous variation and taxonomic confusion. The gene combinations of the organisms are prone to exist in clusters, enabling systematists to place most specimens with ease” (1992, 48).

¹⁴ Holmen, the author of the rotifer study that Templeton was discussing, notes that for asexual rotifers, “species are real and can be maintained by nonreproductive factors”.

¹⁵ Dupré and O’Malley argue that a biased and “indefensible focus on macrobes has distorted several basic aspects of our philosophical view of the biological world” (2007, 156), and that a better understanding of microbes will transform standard conceptions in ontology, evolution, taxonomy, and biodiversity.

transfer (HGT), i.e. any process which transfers genetic material from one organism to another where that organism is not the offspring, is common among prokaryotes, yet plays no role in reproduction, which is by simple fission. While there are some notable exceptions of horizontal gene transfer in Eukarya¹⁶, lineal descent is by far the norm, which explains why monophyly is such a powerful tool. Prokaryotic phylogeny is not simply a vertically branching tree, but also a horizontally reticulated web or network (Makerenkov, 2004). If Eukarya is predominantly a branching tree, then the prokaryotic ‘roots’ of the phylogenetic tree, like some actual tree roots, are reticulated as well as branching.¹⁷

However, to conclude that promiscuous pluralism is the correct view about species full stop in light of prokaryotes is too quick. It is telling that Ereshefsky considers one’s view of a prokaryotic species concept to be an *attitudinal* affair. He counts himself a pessimist about the prospects of a prokaryotic species concept (2010, 559-560) and critiques the PSC for prokaryotes, concluding, “not only do we have reason to doubt the existence of a natural prokaryote species category, we have reason to doubt the existence of a natural species category for all of life” (2010, 562).

There are two responses to promiscuous pluralism regarding prokaryotes. The first is a bit of historically informed optimism. We do well to recall that it has only been since the 1990’s that DNA, RNA, and protein sequencing were brought to the fore and adapted for phylogenetic analysis, and that the ‘Bible’ of bacterial systematics, *Bergey’s Manual of Systematic Bacteriology*, only adopted an explicitly phylogenetic systematics for Bacteria and Archaea in its 2nd edition only a few years ago (Staley, 2009).¹⁸ Also, the history of phenetic approaches in microbiology remains entrenched. It’s simply too early to know how fruitful the PSC is for prokaryotes.

¹⁶ Perhaps the most notable example is that, according to the widely accepted endosymbiotic theory, mitochondria, chloroplasts, and the Golgi apparatus originated as bacterial endosymbionts to precursors of eukaryotic cells.

¹⁷ Debate about whether horizontal lines or lateral lines predominate prokaryotic phylogeny is ongoing. Beiko’s et al.’s study of 16S rRNA, a housekeeping gene commonly used in phylogenetic reconstruction, in 144 prokaryote genomes finds a “largely vertical” phylogeny with notable laterality among closely related taxa and among less-related organisms inhabiting similar environments (2005).

¹⁸ The other Bergey’s manual, *Bergey’s Manual of Determinative Bacteriology*, is explicitly pragmatic in its approach: “The arrangement of the book is strictly phenotypic; no attempt has been made to offer a natural classification. The arrangement chosen is utilitarian and is intended to aid the identification of bacteria... These groups are not meant to be formal taxonomic ranks, but are a continuation of our tradition of dividing bacteria into easily recognized phenotypic groups. We feel this arrangement is more useful for diagnostic purposes.” (Holt, 2000, vii)

Not all are so pessimistic. Commenting on Wertz's et al.'s (2003, 1244) six different phylogenetic trees based on six different housekeeping genes in a single genome, Ereshefsky asks, "Which is *the* correct phylogeny of the genome in question? There's no obvious answer" (2010, 557). Fair enough, but there is one and only way extant organisms came to be the way they are, *one* phylogeny of organisms, and phylogenetic trees (or webs) are *hypotheses* about this phylogeny based on molecular sequencing.¹⁹ Cracraft and Donoghue note that a decade of progress in phylogenetic systematics has made the prevailing attitude in the field highly optimistic, adding "we will have a universal tree, and the operative questions are when, how well supported it will be, and how we are going to... tap the tree's benefits" (2004, 560).

At any rate, while 97% similarity values of 16S rRNA are the norm for distinguishing strains into species, similarity values as high as 99% easily distinguish many putative bacterial species, and significantly, 16S rRNA similarity values corroborate the extent of DNA hybridization to a high degree of confidence, suggesting that these values are not independent (Keswani et al, 2001, 669-673). Furthermore, relying on a single gene may prove less reliable than using many, and it is for just this reason that Multiple Locus Sequence Typing (MLST), a phylogenetic methodology which sequences several (typically 5-8) genes to infer prokaryote phylogenies, while cost-prohibitive, works. MLST was able to distinguish phenotypically indistinguishable strains of *Streptococcus pneumoniae*, and corroborated earlier DNA hybridization tests which indicated that *S. pseudopneumoniae* was a new species (Staley, 2009). How far such new sequencing and bioinformatic techniques will go towards resolving prokaryote phylogenies into species remains to be seen.²⁰ Reserving judgment seems more prudent than the outright rejection of the PSC for prokaryotes. "There's no obvious answer" cuts both ways.

The second response is perhaps more philosophically interesting. We might wish to differentiate between *local* and *global* chaste and promiscuous pluralisms, i.e. advocate one species of species pluralism for one domain but not all domains. Ereshefsky anticipates this, "one might wonder if a eukaryote species

¹⁹ Ereshefsky seems to think that phylogenies are of *genes*, but phylogenies are of *organisms* on the *basis* of genes.

²⁰ Ereshefsky rejects quantitative approaches such as using 70% DNA hybridization and 97% 16S rRNA similarity values to delineate species as merely "pragmatic" because they lack a "deeper theoretical reason" for why these values are chosen (2010, 558). It may well be that there is a deeper theoretical reason which is beyond our present grasp. I suppose it is circular to say that, for now, it's reason enough that these values pick out species?

category remains intact” (2010, 566), but only references his previous arguments in favor of promiscuous pluralism (1992, 1998, 2001), which I’ve critiqued above. Nominalism and pragmatism about prokaryotes is a common view. Some accept all bacteria as one large, diverse species (Stamos, 2003) whereas others reject that bacteria comprise species at all:

‘Species’ that change up to 15 percent of their genetic constitution on a daily basis can no longer be called species. ... ‘speciation of bacteria’ is an oxymoron, since all bacteria are linked through their promiscuous genetic system. (Margulis, 1993, 99)

In light of this, a reasonable view could be to advocate chaste pluralism for eukaryotes and promiscuous pluralism or species eliminativism for prokaryotes. This may appear to violate the maximal scope criterion discussed above (§2), but does not, because the virtue of wide scope need not entail that all organisms comprise species. Local promiscuous pluralism would be motivated not by our diverse interests as Kitcher or Dupré would have it, but because of the way things are. Even if he was probably wrong that sexual reproduction is necessary for specieshood, Mayr might have been right all along that species are not be a universal biological phenomenon. If there is anything to this line of reasoning, then any *global* pluralism, chaste or promiscuous, is unsatisfactory.

§4. CONCLUSION

In this paper, I have argued that monistic species concepts such as the MSC, ESC, and BSC are inadequate, and that the PSC fares the best according to thin and reasonable criteria of adequacy for species concepts. I then differentiated two species of species pluralism: chaste and promiscuous, and argued against three extant versions of promiscuous pluralism and Ruse’s most chaste pluralism. Ruse’s pluralism cannot account for messy situations. Dupré’s pluralism posits wildly implausible criteria for natural groups. Kitcher’s pluralism relies on a dated distinction between historical and structural approaches to biology. Ereshefsky’s pluralism mistakenly construes lineal descent as an evolutionary process and overestimates the importance of messy situations, at least for Eukarya. I then developed and defended the PSC as a moderate chaste species

pluralism comprised of a monistic grouping criterion, i.e. empirically delineated natural groups based on evidence of monophyly, and pluralistic ranking criteria based on the causal processes responsible for maintaining lineages in particular cases. If this is correct, then any form of species monism is untenable. The PSC works well for Eukarya because messy situations are atypical. Whether it is adequate for Prokarya remains to be seen, but even if it is not, global promiscuous pluralism does not follow, even if it turns out to be locally correct for Prokarya.

I'd like to conclude by briefly suggesting some further philosophical and practical upshots of the arguments presented in this paper. I don't pretend to fully defend these suggestions here. The philosophical upshot has to do with species realism. I take it that realism about x means that x exists and does so independently of our thoughts about x . So, species realism is the view that species exist and do so independently of our thoughts about them. Some have objected that species pluralism entails antirealism about species (Stanford 1995, Ereshefsky 1998). This is surely true of promiscuous pluralism. Kitcher calls his view "pluralistic realism", and Dupré claims he is a species realist because the plurality of species concepts draw on "real, objective properties of the objects" (Dupré 1993, 17). However both views violate the mind-independency criterion of realism by allowing our interests to delineate groups of organisms. While their views may be versions of realism because they rely on features of the natural world, their views are not realism about *species* because not all objective properties of organisms are equally legitimate for identifying natural groups. Species realism is not simply realism about the external world, or realism about any shared organismal properties, but realism about species. Moderate chaste pluralism is compatible with species realism, and promiscuous pluralism is not. Furthermore, that species are real is compatible with the possibility that not all organisms are 'in' species. If this is the case, then Ereshefsky's antirealism about a global species *category* for all life is warranted, even if many species *taxa* are real.

The second upshot is practical. Environmental laws to protect biodiversity are often written in terms of species. Clear guidance is needed, not a cacophony. Furthermore, protecting species seems wrongheaded if species aren't real entities as promiscuous pluralism entails and species eliminativism acknowledges. Moderate chaste pluralism is consistent with environmental legislation such as the Endangered Species Act, which is

written in terms of the BSC. However, reformulating the species definition in environmental legislation in terms of the PSC allows for the protection of endangered yet noninterbreeding putative species. One's mode of reproduction is not a justifiable basis for legal protection. Our present legislation is guilty of sexual discrimination.

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