

On the Metaphysics of Species*

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This paper explains the metaphysical implications of the view that species are individuals (SAI). I first clarify SAI in light of the separate distinctions between individuals and classes, particulars and universals, and abstract and concrete things. I then show why the standard arguments given in defense of SAI are not compelling. Nonetheless, the ontological status of species is linked to the traditional “species problem,” in that certain species concepts do entail that species are individuals. I develop the idea that species names are rigid designators and show how this provides additional motivation for SAI.

1. Introduction. One of the most intriguing debates in philosophy of biology concerns the ontological status of species. Traditionally species have been understood as classes of organisms; yet many philosophers of biology believe that species are individuals whose parts are organisms. It is surprisingly difficult to discern from this debate the metaphysical implications of the view that species are individuals. Moreover, the arguments that have been given for the species-as-individuals thesis (SAI) are not compelling, since it is possible to interpret species as classes while accommodating these arguments. This paper explains the logical and metaphysical implications of SAI, and shows that once these are clarified, a forceful argument for SAI is available, provided one accepts a certain kind of species concept. SAI is usually associated with the concept of a species as a breeding population, but a common way of showing the connection is problematic. I give new arguments that show that certain species concepts do entail that species are individuals, while others entail they are classes. Finally, I discuss rigid designation for species terms.

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Many philosophers believe species terms are rigid designators, yet still think species are natural kinds. I show how treating species terms as rigid designators provides further motivation for SAI.

In this paper, I follow what I take to be standard metaphysical terminology. The point is not to force this terminology on the debate about species, but to be explicit about how I am using certain terms, and to avoid confusion about relevant distinctions.

2. Logical and Metaphysical Implications of SAI. Ghiselin ([1974] 1992, 1997) and Hull (1976, [1978] 1992, 1981) argue that species are individuals in the same sense that organisms are individuals. They do not claim that species are organisms, but that species and organisms belong to the same ontological category. Like organisms, species have parts, not members. In denying that species are classes Ghiselin and Hull maintain that the relation between organism and species is part to whole, not member to class. I understand classes to be the logical constructs of set theory, and I use “class” and “set” interchangeably. To understand the relevant notion of *individual*, we ought first to review the logical distinction between individual and class as articulated in mereology. Mereology, the logic of parts and wholes, was coined “the calculus of individuals” by Goodman and Leonard (1940), and was developed largely as an alternative to set theory. (See Simons 1987.) Individuals and classes are logically similar in that both give us ways of thinking about many things as one thing. According to Goodman and Leonard, both notions serve as “devices for distinguishing one segment of the total universe from all that remains,” and both individuals and classes are “potentially divisible” (45). What separates individuals from classes are the very different ways in which they can be divided. Goodman and Leonard write:

The difference in the concepts lies in this: that to conceive a segment as a whole or individual offers no suggestion as to what these subdivisions, if any, must be, whereas to conceive a segment as a class imposes a definite scheme of subdivision—into subclasses and members. (45)

Hence the claim that species are individuals, where an individual is understood as *logically* distinct from a class, tells us that species have many things as parts, including organisms, bits of organisms and sums of bits of distinct organisms. We lose a reason for giving certain of its parts—the organisms—any special status. If organisms are the “important” parts of species, this fact will not flow from the logic of individuals as it did from the logic of classes; it will emerge from a more detailed understanding of the kind of individual a species is. (See Section 4.)

Ghiselin (1997) maintains that species have no instances, explaining that “it is possible for a class, but not an individual, to have instances” (38). As the terms are usually understood, classes have members, not instances. *Universals* have instances. The denial that species have instances is just the assertion that they are *particulars*, since a particular just is something without instances. The claim that species are particulars is extra to the claim that species are individuals, and friends of the class view need not reject it. They maintain that species are sets, not that they are universals. Sets are thought to be better understood than universals, since the membership relation can be made more intelligible than instantiation. Since sets have no instances, they too are particulars rather than universals.

According to Hull, a principal feature of both organisms and species that indicates their ontological category is their spatiotemporality. Species are “spatiotemporally localized cohesive and continuous entities (historical entities).” Classes, meanwhile, are “spatiotemporal unrestricted classes, the sorts of things which can function in traditionally defined laws of nature” ([1978] 1992, 294). Such statements have drawn criticism for employing a notion of “class” as a spatiotemporally unrestricted entity (Grene 1989; Kitcher 1987, 1989). Grene and Kitcher observe that this is nowhere part of the logical concept of class, and that it is not clear what it could mean when applied to classes. Kitcher argues that in the only way to make sense of “spatiotemporally unrestricted,” most sets of physical objects are spatiotemporally restricted, since the members of such a set are contained within a space-time region of the universe. This shows how the class view of species accommodates Hull’s idea that species are restricted to localities—for Kitcher a species is restricted to a locality just in case all its *members* are restricted to that locality. However, important distinctions remain between individuals and sets with respect to spatiotemporality. Sets typically are thought to be abstract, hence not locatable in space and time. The members of a set may be concrete, but the set itself is an abstract object. Individuals are thought to differ from sets in being concrete. A significant metaphysical implication of the emphasis on the spatiotemporality of species is that species are concrete rather than abstract objects. Not only are the organisms that make up a species concrete, the species itself is a spatiotemporally located, concrete object. Ghiselin also emphasizes concreteness in his defense of SAI; according to Ghiselin (1997), “all individuals, without exception, are concrete” (42).¹

1. Probably this is too strong. If Ghiselin is using “individual” equivocally to mean both individual and particular, then there are candidate counterexamples. Tropes and numbers are sometimes thought to be abstract particulars.

Hull introduces the term “historical entity” to emphasize the *contiguity* of species. Kitcher (1989) sees species as “historical” in that they consist of things temporally related to each other, and he maintains that ancestor-descendant relations are sufficient for temporal relatedness. Kitcher argues that both individuals and sets of organisms may be historically connected in this way, so the claim that species are historical is independent of their ontological status. Grene (1989) agrees. She accepts the historical nature of species, but believes nothing follows about whether species are individuals. If the historicity of species is to be relevant to their ontological status, then, it should imply more than that the organisms that comprise a species are historically related. Hull’s claim that species are historical is meant to imply that species have beginnings, persist, and cease. That is, they are persisting objects just as organisms are persisting objects. Abstract objects, including classes and universals, do not persist through time since they are outside of space and time. Only a concrete particular individual can persist. From a metaphysical point of view, to say that something is “historical” means that it persists through time.

If species are persisting objects, in what manner do they persist through time? Hull (1989) suggests that a “historical entity” is spatiotemporally extended (187). Thus species are four-dimensional objects, having temporal as well as spatial parts. This is a tempting proposal, since we can also view organisms as four-dimensional, so that organisms are spatiotemporal parts of larger and longer 4D species. Four-dimensional species persist by having temporal parts existing at different times. How, then, do 4D species change? As I explain in Section 3, a principle motivation for SAI is the thought that individuals but not classes can evolve, so we would expect SAI to give an adequate account of species change. Hull (1989) accepts that *Cygnus olor* the 4D space-time worm does not change, but he claims its time slices do. Since we can talk meaningfully about *Cygnus olor* evolving, Hull concludes that “*Cygnus olor*” is ambiguous between the spatiotemporally extended object and any of its momentary time slices. This strategy is unhelpful, however, since a momentary time-slice cannot change, precisely because it is momentary. Instead, four-dimensional SAI ought to follow the account of change typical of four-dimensionalism generally. Four-dimensional objects are thought to change by having temporal parts with different properties. If my hair is shorter today than it was yesterday, I have a temporal part with long hair and a later temporal part with short hair. (See Lewis 1986, 202–204; Sider 2001, 1–10.) Supposing this is an adequate account of change, it is not obvious it has advantages over accounts of species change that can be offered if species are classes. (See Section 3). This suggests we ought to consider, too, a three-dimensional

version of SAI, which perhaps can offer a more robust account of species change.

Persisting 3D objects do not have temporal parts, but exist in their entirety at distinct times. A 3D object changes if between two moments of its existence it gains or loses a property. Three-dimensional SAI entails that my great-grandmother is not a part of *Homo sapiens*. She was once part of the species, and her surviving bones remain parts of the species, but 3D objects do not have parts that existed entirely in the past. Three-dimensional objects exist wholly in each moment of their existence. *Homo sapiens* is all here now, and its parts are the humans that exist now plus the remains of dead humans. Species, like other 3D objects, have histories: *Homo sapiens* existed 10,000 years ago when it consisted of different organisms, just as I (if I am 3D) existed 10 years ago with different cells. Thus the claim that species are historical is consistent with both 3D and 4D versions of SAI. In Section 4, I show what considerations would settle whether species are better understood as 3D or 4D individuals.

I have argued in this section that SAI has the following logical and metaphysical implications: Species are wholes with parts rather than classes with members; species are particulars having no instances (not universals); species are concrete rather than abstract; and species are persisting objects. The metaphysical force of SAI is that species are concrete particular persisting individuals. It is left open whether species persist by being wholly present at different times or by being temporally extended.

3. Biological Arguments. The principal motivations for SAI flow from biological usage of species terms and the theoretical role of species in evolutionary biology. Hull ([1978] 1992, 1981) maintains that given the way biologists conceive species, once a species goes extinct it cannot re-evolve. Hull insists this is not a contingent fact but a conceptual fact because biologists conceive species as “segments of the phylogenetic tree” ([1978] 1992, 305). Species cannot re-evolve because “once a segment is terminated, it cannot reappear somewhere else in the phylogenetic tree” ([1978] 1992, 305). One response to Hull’s conceptual prohibition against re-evolving species is to deny it. Conceptual claims are evaluated by testing intuitions regarding concept applicability in counterfactual situations. Schwartz (1981) claims that if beings genetically indistinguishable from humans evolved on a distant planet or were created in a laboratory (not made from human DNA), we would consider them members of *Homo sapiens*. Caplan (1981) thinks the fact that species do not re-evolve is merely a contingent fact about the extremely low probability of the same genotype re-evolving. It does not belie the

fact that biologists continue to conceive species as “classes of organisms that have a high degree of genetic similarity” (136). Hull (1981) counters that the prohibition against re-evolving species follows straightforwardly from the principle of monophyly, accepted by most taxonomists. According to Hull, “If taxa must be monophyletic, then once a species is extinct, numerically the same species cannot re-evolve” (147). If the same genotype evolved on two independent occasions, the taxonomic principle of monophyly would prevent our classifying the two populations as conspecific.

Hull rightly insists that our ordinary intuitions regarding concept applicability are not particularly relevant, because the conceptual prohibition against re-evolving species flows from biological usage. But as Hull’s claim is nonetheless a conceptual claim, it remains subject to intuitions regarding concept applicability in counterfactual situations—only we must restrict our intuitions to the usage of terms within evolutionary biology. How would biologists treat a case of the re-appearance of a genotype? This question is not easy to answer. It involves a counterfactual scenario, and biologists generally do not engage in the kind of conceptual analysis that is common in philosophy. It is difficult to determine from their actual usage how evolutionary biologists might treat species in remote counterfactual situations. Does the prohibition against re-evolving species flow from the principle of monophyly, as Hull thinks, or does the principle of monophyly flow from the fact that genotypes (contingently) do not re-evolve? Certainly the extremely low probability of the same genotype re-evolving makes monophyly a convenient taxonomic principle. If we consider a counterfactual situation in which genotypes re-evolve with some frequency, it is not so clear that Hull’s conceptual claim is correct. Under those circumstances, the principle of monophyly might not be so important or convenient to taxonomists. Biologists might want to say the dodo evolved several times. Actual biological usage is unlikely to settle the matter.

According to evolutionary theory, species are the entities that evolve. This central role of species in evolutionary theory may provide additional reason to think species cannot re-evolve. Ereshefsky ([1991] 1992, 392) presents the following argument, also found in Hull (1976, 180–181): Species are entities capable of evolution by natural selection, which requires parent-offspring relations among their constituent organisms. These relations require that species be spatiotemporally continuous. Therefore species are spatiotemporally continuous entities. If this argument is correct, evolutionary theory entails that species cannot re-evolve, since spatiotemporally continuous entities do not have the sort of generational “gaps” that re-evolving species would have. However, the argument does not show that species cannot be gappy. It only shows that if

a species were discontinuous, there could be no evolutionary path connecting the discontinuous organisms, since evolution requires generational continuity. The purported counterfactual examples of gappy species considered by Schwartz and Caplan are precisely those in which there is no evolutionary link between organisms of the same genotype—organisms evolved on a distant planet, or were cooked up in a laboratory. Even if species were considered by definition entities capable of evolution by natural selection, this would not support the claim that species must be continuous, as shown by an analogous argument: an automobile is (by definition) a vehicle capable of self-propulsion. Self-propulsion requires fuel. Therefore, automobiles have fuel. The conclusion clearly doesn't follow. What follows is that an automobile must have fuel in order to run. Similarly, members of a species must be generationally continuous if there is to be evolution by natural selection operating across the generations.

Since species evolve, evolutionary theory requires that species be capable of change. According to Hull, "species are the sorts of thing which evolve, split, bud off new species, go extinct, etc." (1981, 146). Hull argues that on most conceptions of individuals, they have beginnings, change, and perish. Classes do not change; they are defined extensionally, so if a member of a class is added or removed, it becomes a new class. In response to Hull, philosophers have attempted to account for species change while construing species as classes. According to de Sousa (1989):

We can always talk informally about classes changing, while at the metaphysical level we can construe the changes that do take place in terms of a succession of classes resembling one another in certain systematic ways. (121)

De Sousa compares the "identity" of a changing class to Humean personal identity. For Hume the illusion of a changing substance is created by the imperceptible succession of closely related ideas. Similarly, species change is understood as the succession of closely resembling classes. If at the metaphysical level there is nothing but a series of closely resembling classes, then there is no continuous entity that changes and persists with which we can identify the species. De Sousa's approach entails that there are no continuous species, just as there are no continuous persons on the Humean account. Both are just loose ways of talking.

Kitcher ([1984] 1992) offers another account of species change. He identifies a species with a set of organisms consisting of a founder population plus some of its descendants. The subset consisting of the organisms that are alive at a particular time is a "stage" of the species. Kitcher then proposes the following:

To say that the species evolves is to say that the frequency distribution of properties (genetic or genetic plus phenotypic) changes from stage to stage. (319)

The advantage of Kitcher's account over de Sousa's is that it provides an entity with which to identify a continuous species. Though this set strictly does not change, we can meaningfully talk as if it does in terms of its differing "stages." If this account of species change seems unsatisfying, it should be noted that it is not very different from the account of species change provided by four-dimensional SAI: a species changes in virtue of having distinct stages. The difference is that Kitcher conceives the stages as subsets of a larger set, while 4D SAI conceives them as temporal parts of a larger whole. Unless we insist on a more robust account of species change, which a 3D version of SAI might provide, we can account for species change equally well whether we take species to be individuals or classes.

Another motivation for SAI is the lack of biological laws about species. Hull ([1978] 1992, 309) notes that generalizations like "all swans are white" are not true and biologists do not expect them to be true. They expect to find exceptions. Hull's explanation for this is that laws of nature are "spatiotemporally unrestricted"—a genuine law holds at all times and places. Statements mentioning individuals are not fully generalizable, and so cannot be laws. There are no laws about *Cygnus olor* for the same reason there are no laws about the planet Jupiter. The study of the properties of *Cygnus olor* is not a search for laws, but an investigation into the features of an individual.

Kitcher thinks Hull is "far too quick to foreclose the possibility of biological laws about particular species" ([1984] 1992, 321). Kitcher agrees that "all swans are white" is a bad candidate for a biological law. But the reason is that nonwhite swan-offspring could be produced without being inviable or resulting in a new species. Kitcher thinks we may still discover features

so deeply connected with the genetic constitution of members of the species that alterations of the genome sufficient to lead to [their] absence would disrupt the genetic organization, leading to inviable offspring or to offspring of a new species. (320)

Were we to discover some property P of swans the absence of which results in either inviability or speciation, P could feature in a biological law about swans, arguably. As Sober (1984) has observed, however, inviable offspring are still members of their species, so if Kitcher's generalizations took the form "All swans are P " they would not be true; hence they would not be laws. Instead, Kitcher's laws ought to take the

form “All viable swans are *P*” or “All fit swans are *P*.” Such laws do not purport to state necessary features of swanhood, but this is not needed to answer Hull’s argument. One need only show that there are lawlike generalizations that may be discovered that mention the names of species. Without reason for ruling out the discovery of such generalizations, our failure to discover them is not compelling reason to accept SAI. At the same time, advocates of SAI need not foreclose the possibility of discovering law-like generalizations mentioning the names of species. Consider “All viable organisms that belong to *Cygnus olor* are *P*.” If the status of this statement as a law depends on whether it mentions an individual, then whether it is a law depends on the ontological status of *Cygnus olor*. Such statements could be true, if not laws, even if species are individuals. Neither the discovery of these generalizations nor our failure to discover them determines the ontological status of species.

Generally, philosophers have responded coolly to SAI. Species are paradigm examples of natural kinds, and natural kinds are typically understood as classes. Without compelling reason to accept SAI, many philosophers will not do so. The biological arguments that have been advanced in favor of SAI are inconclusive, I believe, because biological theses are open to different metaphysical interpretations. Actual biological usage seems inadequate to settle conceptual claims about re-evolving species. The fact that species are entities that evolve does not entail they cannot be discontinuous; and meaningful talk of evolutionary change need not be limited to concrete persisting individuals. Our failure to discover features of organisms the absence of which results in inviability or speciation does not show there are none, and the discovery of such features does not entail that species are classes, either. The arguments given by Hull and others stemming from biological theory seem inadequate to prove decisively an ontological claim about species. In what follows, I give a metaphysical argument that shows how to determine the ontological status of species.

4. Species Concepts and Ontology. Advocates of SAI argue that species are individuals in virtue of the cohesiveness, functional interdependence, or causal connectedness of the organisms that comprise a species (Ereshefsky [1991] 1992; Hull 1976; Sober 2000). Their argument can be presented as follows:

- 1) An entity is an individual in virtue of the cohesiveness (functional interdependence/causal connectedness) of its constituents.
- 2) An entity is a set in virtue of similarity relations among its constituents rather than cohesiveness.

- 3) Given a common understanding of species as breeding populations, cohesiveness (functional interdependence/causal connectedness) is required for organisms to constitute a species.

Therefore,

- 4) Species are individuals rather than sets.

This argument is problematic for two reasons. First, it is vulnerable to the objection (from Kitcher) that a set can display cohesiveness among its members. Second, it has the odd consequence (accepted by Ereshefsky [1991] 1992; Sober 2000) that being an individual is a matter of degree, since there are degrees of cohesiveness. Having clarified the metaphysical implications of SAI in Section 2, we can see how problematic it is to think there are degrees of individuality. A halfway house between abstract and concrete, or between universal and particular, seems inconceivable. The appropriate answer to Kitcher's objection that members of sets may be cohesive leads to a better metaphysical argument for SAI, which does not have the consequence that individuality comes in degrees.

For any collection of objects there is a set consisting of those objects as members. There is the set of humans currently living and the set of past, present, and future humans. This latter set seems what Kitcher ([1984] 1992) has in mind in identifying a species with a founder population plus some of its descendants. Since the set exists, why deny that species are sets? In response we should note that individuals are as easy to find as sets: there is a three-dimensional mereological sum of humans currently living, and a four-dimensional sum of past, present, and future humans. But to accept that sets and sums are equally easy to find is to deny both the first and second premise of the above argument. It is not cohesiveness or lack thereof that makes something a sum or a set, since any collection of objects constitutes both a sum and a set, and either may be cohesive. To adjudicate the ontological status of species, we must determine which, if any, of those sets and sums we are referring to when we talk of species.

Traditionally, species have been thought to be natural kinds, which are sometimes understood as universals. Since neither camp in this debate considers seriously the view that species are universals, I set it aside. If species are natural kinds, then, they are sets, the members of which share theoretically interesting features in virtue of which they belong to the set. Members of the natural kind *gold* have atomic number 79, theoretically interesting because it explains chemical properties. A set cobbled together arbitrarily, whose members share only the feature of belonging to the set, is not a natural kind. It is an extensionally defined set, identified solely by its members, and it is scientifically uninteresting. Analogously, not all individuals are scientifically interesting individuals. A mereological sum cobbled together arbitrarily is no more scientifically interesting than an

arbitrary set. To be scientifically interesting, its parts must be parts in virtue of theoretically interesting features. If species are to be theoretically interesting entities, there must be theoretically interesting features in virtue of which organisms are conspecific. Thus the *species problem* is central to the ontological status of species. A *species concept* answers the species problem by providing criteria for conspecificity. These criteria determine whether organisms are conspecific by being parts of the same whole, or members of the same class.

Two kinds of species concept purport to answer the species problem: *Intrinsic Species Concepts* and *Relational Species Concepts*. The former maintain that intrinsic features of organisms are decisive criteria for conspecificity. A species consists of organisms closely resembling each other with respect to certain intrinsic features, either morphological or genetic. Relational species concepts use relations among organisms to delineate species. Most influential is Mayr's *biological species concept*, according to which "a species is a group of interbreeding natural populations that is reproductively isolated from other such groups" (1991, 26). The ability to interbreed is a relational property of organisms that divides them into species.² Simpson (1961) uses ancestor-descendent relations in defining an *evolutionary species* as "a lineage (an ancestral-descendent sequence of populations) evolving separately from others and with its own unitary evolutionary role and tendencies" (153). Relational species concepts maintain that morphological and genetic similarities may provide evidence of conspecificity, but the determining factors are relations among organisms.

Ghiselin and Hull endorse Relational Species Concepts, and Mayr (1987) claims SAI is implicit in his biological species concept. They view species as reproductive communities, in which interbreeding functions as a cohesive force to form an organized complex whole (Hull 1981; Ghiselin 1997; Mayr 1987). Kitcher ([1984] 1992, 1989) argues that species are sets, but thinks this view can be married to various species concepts, including Mayr's biological species concept. According to Kitcher ([1984] 1992), species are "sets of organisms related to one another by complicated, biologically interesting relations" (317). Kitcher (1989) proposes that a species is

a set of organisms subject to a particular relation (or, more precisely, the ordered pair of a set and a relation), where the relation obtains just

2. In calling Mayr's biological species concept "relational," I am not alluding to Mayr's own assertion that *species* is a relational term. For Mayr, species are relational in that a species can be identified only in relation to distinct species from which it is reproductively isolated (1991, 27). I am emphasizing the relational features of organisms that serve as criteria for conspecificity.

in case there is that kind of reproductive behavior that is supposed to be crucial to the persistence of species. (186)

Kitcher is surely right that there are sets whose members are subject to such relations, but he is wrong in concluding that the species problem is independent of the ontological status of species. If our criteria for conspecificity are relations among organisms that depend on spatiotemporal relations, then it is a mistake to say species are sets. Organisms thus differentiated into a species do form a set, but the set is not what interests us theoretically. If the theoretically interesting features of organisms in virtue of which they belong to a species are relations to other organisms depending on spatiotemporal relations, then the whole rather than the set is theoretically interesting. Such relations give the whole its structure. If a set is theoretically interesting, either its members have theoretically interesting intrinsic features in virtue of which they belong to the set (as in natural kinds), or, if the set is defined by intra-member relations, those relations are not spatiotemporal. (The set of natural numbers may be defined relationally, but the relevant intra-member relations, e.g., the successor relation, are not spatiotemporal.)

To see this, consider the set of molecules in my body, and the individual which is a mereological sum of those molecules. Which, if either, is my body? My body is not a set of molecules, since human bodies are concrete, and sets are abstract. But what makes something concrete? It is not sufficient to be constituted by concrete objects, since both the set and the sum of molecules are so constituted. Something is concrete if its constituents have spatiotemporal location within it. Members of a set have no spatiotemporal location within the set. Even in ordered sets, the order is logical, not spatial or temporal. Kitcher sees sets of physical things as spatiotemporal in that their members are contained within a space-time region of the universe, but no member of any set is contained within a space-time region of the set. Given our understanding of human bodies, molecules belong to my body not in virtue of any intrinsic feature, but in virtue of spatial relations to other molecules. Thus to belong to my body a molecule must be spatially located within my body, so my body is concrete and the molecules its parts. But my body is not a mereological sum of molecules. Central to our concept of human bodies is that they have a certain structure, and mereological sums needn't have any structure; the sum would exist were the molecules stacked in a heap. My body is another type of individual—a *structured whole*. And we do not think of human bodies as entities with a certain molecular structure. We are more interested in the organization of bodily organs. My organs are parts of my body in virtue of being spatially interrelated. In addition to and depending upon these spatial relations, my organs are

interrelated in complex ways to form a structured whole. It is *this* structured whole which is my body: not any set, and not a mereological sum.

If our concept of a certain entity entails that a necessary condition of being a constituent is that something occupy a space-time region of that entity, then our concept entails that the entity is an individual, since only individuals have space-time regions. If our concept of a certain entity entails that a necessary condition of being a certain kind of constituent is that something stand in theoretically interesting relations to other constituents, such that these relations depend on their being spatially or spatiotemporally interrelated, then the concept entails not only that the entity is an individual, but that the entity is a structured whole. Intrinsic Species Concepts identify species by theoretically interesting intrinsic features of organisms that make them conspecific, and thus entail that species are theoretically interesting sets, or natural kinds. Relational Species Concepts use either the capacity for interbreeding or ancestor-descendent relations as criteria for conspecificity. These are theoretically interesting relations among organisms requiring spatial or spatiotemporal relations. Since spatial or spatiotemporal relations are necessary for conspecificity, Relational Species Concepts entail that species are individuals. Depending on these spatiotemporal relations, organisms must bear further theoretically interesting relations to each other in order to be conspecific. Thus Relational Species Concepts are concepts of structured wholes. I shall not here defend any particular species concept, but I have shown how species concepts (or the theories governing them) determine the ontological status of species.

Hull (1976) thinks a certain level of cohesiveness beyond integration by descent is necessary for species to be individuals. Kitcher (1989) and Ruse ([1987] 1992) object to SAI on grounds that even if species are somewhat cohesive, they are much less so than paradigmatic individuals. However, given the way species concepts determine the ontological status of species, degrees of cohesiveness are irrelevant to whether species are individuals. What matters is whether a certain spatiotemporal organization is required for something to be a species, given our species concept. In the same vein, degrees of cohesiveness do not entail corresponding degrees of individuality. Ereshefsky ([1991] 1992) argues that some species may be neither individuals nor sets, but "historical entities," which are continuous in that their organisms are linked by ancestor-descendent relations, but not individuals because they lack adequate cohesiveness. Certainly there may be continuous individuals that are not very cohesive, but there is no third kind of entity between individuals and sets. Individuals may have degrees of cohesiveness, but there are no degrees of individuality.

We can now address a puzzle left over from Section 2. If species are individuals, how can the organisms, as opposed to the other parts of a species, be in some way privileged parts? If species are individuals they are structured wholes, whose structure flows from certain relations among their constituent *organisms*. Structured wholes have *important parts*, which are parts that bear certain relations to other parts, in addition to and depending upon spatiotemporal relations. Just as organs and not molecules are the important parts of human bodies, organisms are the important parts of species. Important parts are interrelated so as to form the structure that interests us.

We can also intelligibly address whether species are better understood as 3D or 4D individuals. Mayr (1991) notes that his formulation of the biological species concept is strictly applicable only to synchronic populations, as populations cannot interbreed unless they exist contemporaneously. Simpson (1961) formulated his evolutionary species concept partly to rectify this limitation. He explicitly wanted his species concept to have a temporal dimension so as to be applicable in paleontology. For Simpson, the relevant relations among organisms are ancestor-descendent relations, which depend on both spatial and temporal relations among organisms. Since organisms are located within species along both a spatial and a temporal dimension, the whole is four-dimensional. On Mayr's account the relevant relations among organisms depend only on their spatial relations, so his species are three-dimensional. If we attempt to incorporate a temporal dimension into the biological species concept by articulating a notion of "potentially interbreeding" that applies diachronically, we have organisms located along both a temporal and a spatial dimension within species, so species are four-dimensional.

The way to determine the ontological status of species is to ask which entities we are talking about when referring to species. The fact that the organisms of a species are interrelated in certain ways does not show that species are individuals. Even if there is a structured whole consisting of the organisms of a species, it does not follow that the structured whole is the species. That depends on what we mean by "species," that is, on our species concept. Also, given the way species concepts determine the ontological status of species, SAI does not settle questions about species realism. If species are infected with interest-relativity, it enters with our species concept. It is still open whether species concepts give us useful and theoretically perspicuous ways to carve reality, or whether there is one correct species concept that we strive to articulate, and that picks out the objectively interesting sets or individuals.

5. Species Names as Rigid Designators. Hull and Ghiselin think the names of species are proper names, which explains why biologists are

unable to define species taxa in terms of necessary and sufficient conditions. Hull writes, “Species names cannot be defined in the traditional manner because they cannot be defined at all” (1976, 180). Hull and Ghiselin endorse Kripke’s (1980) idea that proper names are *rigid designators*—terms that denote the same thing in every possible world where that thing exists. But they recognize that Kripke denies species names are proper names. Kripke argues that many general terms are rigid designators—notably the names of biological species and chemical substances, which he thought were natural kind terms. For Kripke, proper names are introduced into the language by an initial baptism. We point to Socrates and declare: *this person* shall be called “Socrates.” The name is then conveyed to other language users through an historical chain so that today we refer to Socrates using the name “Socrates.” “Socrates” does not refer by means of a description that uniquely describes Socrates; it refers directly. Kripke and Putnam (1975) argue that natural kind terms work in a similar fashion. We introduce a natural kind term into the language by a kind of baptism. We point to a bit of stuff or to an organism and declare that “water” shall refer to *this kind of substance*; that “tiger” shall refer to *this kind of animal*. “Tiger” henceforth applies to any animal of the same kind as the animal pointed to. Like “Socrates,” “tiger,” and “water” do not refer via description. But unlike “Socrates,” “tiger,” and “water” are considered general terms. “Tiger” is *true of* the members of a certain class—the natural kind *Panthera tigris*, or, if *Panthera tigris* is a universal, the class of its instances.

Hull and Ghiselin may not be concerned about the semantics of “tiger”—their concern is “*Panthera tigris*.” It is consistent with their view that prescientific species terms are general terms denoting classes, introduced into the language as Kripke and Putnam maintain. For Kripke and Putnam, we pick things out and name them in a prescientific way, and experts later discover the true nature of those things. If SAI turns out to be true because a Relational Species Concept is correct, biologists will have discovered that species are individuals. This can be incorporated into Kripke-Putnam semantics, so long as the reference of “tiger” is fixed in a metaphysically neutral way, e.g., “‘Tiger’ shall refer to any animal that belongs to the same species as *this animal*.” “Belongs to” is ambiguous between “is a member of” and “is a part of,” so fixing the reference of “tiger” in this way allows us to discover later the ontological status of species. “Tiger” is still a general term denoting a class of organisms, even if those organisms are parts of the individual *Panthera tigris*. I argued in Section 4 that advocates of SAI should accept classes of organisms consisting of parts of species; our prescientific species terms can refer to such classes.

If “*Panthera tigris*” is a proper name rigidly designating an individual, it is introduced into the language with an initial baptism. We cannot point

to a species as we can point to Socrates, because it is too big (and perhaps too long), so the initial baptism of *Panthera tigris* involves pointing to one of its parts and declaring that the species of which *this* is a part shall be called "Panthera tigris." Hull and Ghiselin claim that treating species names as proper names accords well with the codes of biological nomenclature. When a species is named, a specimen or "type" is placed in a museum with a name attached. But "type," they insist, is a misnomer, as it is not required that other organisms belonging to the species resemble the "type." Hull writes:

The type need not be typical. In fact, it can be a monster. . . . On the class interpretation one would expect at the very least for a type specimen to have many or most of the more important traits characteristic of its species, but on the historical entity interpretation, no such similarity is required. ([1978] 1992, 307)

The nomenclature rules do suggest that species names are nondescriptive. What matters is that organisms are conspecific with the official specimen, not whether they fit some description. But why not say, following Kripke, that they are nondescriptive general terms?

If species terms are nondescriptive, rigid designation provides motivation for viewing them as proper names. While it is relatively straightforward to say what proper names rigidly designate, rigid designation for natural kind terms is problematic. The extension of "Socrates" is the man Socrates, and "Socrates" refers to this man in every world where he exists, so "Socrates" rigidly designates its extension. The extension of "water" is the set of water samples. Intuitively, other possible worlds contain different water samples, so the extension of "water" varies from world to world. If "water" designates its extension, "water" is not rigid. "Water" is rigid if it designates its *actual* extension, but then worlds we would intuitively describe as having different water samples do not have any water at all.³ What, then, do natural kind terms rigidly designate? Philosophers who address this issue typically maintain that natural kind terms designate abstract properties or universals.⁴

The difficulty of locating designata for general terms is reason for thinking general terms are not rigid designators. If we do not want to say biological species are universals or other abstract objects, species names cannot be general terms *and* rigid designators. As the rules of biological nomenclature suggest species names are rigid designators, SAI provides

3. Several commentators observe this difficulty. See Cook 1980; Donnellan 1983; Forbes 1981; Salmon 1981.

4. Forbes (1981) thinks "water" rigidly designates the abstract property *waterhood*. For Salmon (1981), natural kind terms rigidly designate universals.

an appealing account of their designation: like other proper names, “*Panthera tigris*” rigidly designates its extension, a concrete particular individual. Worlds with different tigers are worlds in which the species has different parts; “*Panthera tigris*” still refers to that species. The pre-scientific class term “tiger” is a general term whose extension is the class of organism parts of *Panthera tigris*. As this class varies from world to world, it is reasonable to conclude “tiger” is not rigid.

6. Conclusion. SAI is fleshed out as the thesis that species are concrete particular persisting individuals. SAI does not follow from the fact that species evolve, nor that they do not re-evolve, nor from the fact that we have no biological laws about species. SAI is not implied by the fact that the organisms that comprise a species are functionally interdependent or cohesive. Groups of cohesive organisms may satisfy our criteria for being a species whether we adopt a Relational Species Concept or an Intrinsic Species concept. It is the species concept that determines whether the entity we are talking about is a (cohesive) set or a structured whole. Species concepts indicate the theoretically interesting features of organisms that make them conspecific, and these features indicate whether organisms are conspecific by being co-members or co-parts. As there is reason to think our biological species terms are rigid designators, the suggestion that they are proper names designating concrete particular individuals provides an appealing alternative to viewing them as general terms rigidly designating abstract properties or universals. This is consistent with our prescientific species terms being general terms true of the members of a class, even if that is a class of parts of a concrete particular individual.

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