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Nature and its Classification, Birmingham Oct. 14 2007

Species as an Unnecessary Concept in the Theory

This paper takes up the issue commonly referred to as *the species problem*; it is an attempt to deconstruct the concept of species, and thus put the problem to rest.

My main claims are, first, that the species category in taxonomy is redundant; and second, that the concept *species* is not necessary in evolutionary theory.

The first claim has been suggested before, in different contexts and variations, most notably by Marc Ereshefsky[1]. The gist of my second claim has been hinted at by several authors; however, the problem of species has not ceased to exist. And so, my aim in this paper is to bring together several of these different points of view into one argument, and make the second claim explicit, in the hope of nudging the paradigm further towards a tipping point.

1. The Failure of the Species Category

As we observe the living world, it seems to be ordered in groups or clusters of organisms. For different reasons, which I will not explore here, we feel compelled to classify these sets of organisms into categories, to name them, and to consider them actual ways in which the world is carved. Some of those we call species.

But what is a species, or what is "species"? As I said, it is apparent that organisms tend to cluster. The attempts to classify these clusters, have always involved the assumption that they are all somehow of the same kind: that these groups of organisms are equally species. More accurately, these attempts stipulated the status of Species as a concept of which these clusters were different examples or tokens. In the classificatory

[1] Ereshefsky 1992, 1998, 2001

scheme, the term Species is a taxonomic rank, and thus a search for a unifying definition of this rank ensued.

Various different ways of defining species can be found in the literature. There seem to be 26 to 28 separate definitions[2] – theoretical, practical, some which merge the two aspects – these definitions employ different criteria in order to demarcate particular groups of organisms as species. Unfortunately, not a single definition has been suggested that could be applied to all organism-clusters that biologists might want to distinguish.

Let me briefly list a few of the main categories of such definitions, according to the defining criterion which they employ. (These definitions are often mislabeled 'concepts' – but I will adhere to this labeling for now).

1. **Descent** – lineage-based concepts, such as phylogenetic species concepts, and evolutionary, cladistic, Hennigian or genealogical concepts, which group organisms into species based on the lines of descent, determined by statistical analysis of characteristics, the fossil record, etc.
2. **The Ecological** species concept, which views ecological isolation as the chief factor in speciation and in species recognition;
3. **Reproduction-based definitions** such as the Biological Species Concept. This approach focuses on reproductive isolation: it views a species as a group of interbreeding individuals, which cannot reproduce with members of other such groups.

[2] According to my own count (in my dissertation, yet unpublished) and similarly according to John Wilkins's count (Wilkins, *Species definitions: a reader from antiquity to today*, Peter Lang, forthcoming; and personal communication).

4. **Definitions based on Typological properties**, such as phenotypic, morphological and taxonomic concepts, which group organisms into species based on structural similarities;
5. **Genetic makeup**, such as the Genotypic Cluster Concept which holds that species form genetically distinguishable groups of individuals, distinct from others by genetic gaps [few or no genetic intermediates with other such clusters.]

No successful definitions have been found which capture necessary and sufficient properties that determine membership in Species – at least not for all **types** of species, as I will demonstrate shortly. Most definitions are successfully applicable only within a limited scope of cases. Overall, those definitions and delineation concepts are applied very inconsistently, and different ones may be called upon in different contexts; so much so, that the claim or aspiration for a unified Species kind, category, or rank that is arrived at by way of those species definitions, seems rather manifestly to not hold. But let me demonstrate these claims.

A. The limited scope of particular definitions; example: the BSC

First I would like to very briefly point out what I mean by the failure of particular definitions to apply to all types of species.

One of the most well-known species definitions is the Biological Species Concept (BSC), which defines a species as a group of organisms that can interbreed with one another, but are reproductively isolated from other groups. This definition works very well for certain kinds of species (such as most mammals and birds). It has great intuitive appeal, as it proposes a criterion for species recognition which at once suggests a theory of speciation, a recognition criterion and a definition of what a species is. But despite the fact that it offers a seemingly clear-cut criterion, it does not in fact apply to the vast majority of organisms. Most organisms do not reproduce sexually; in fact, two out of the three domains into which the taxonomic tree divides all life forms – Bacteria and Archaea – are entirely asexual. This significantly restricts the scope of application for this concept.

The scope of the BSC is further restricted by the fact that even within the third domain, Eukaryota, many genera and species reproduce asexually (e.g. numerous insects, plants and fungi). Furthermore, even within parts of the tree where sexual reproduction is common, there are often groups which reproduce asexually. (Such are, for example, the Whiptail lizards of north America, of the genus Cnemidophorus, which includes both sexually- and asexually reproducing (parthenogenetic) species.)[3]

Similarly, other species "concepts" or species definitions fail as well – although not all of them in ways that allow for such a brief overview.

B. Failure to converge

Now, not only do species definitions each apply only to a restricted scope of organism clusters; in addition, and most crucially, species demarcated by different types of definitions do not necessarily converge. In fact, most often they do <u>not</u> converge. Applying e.g. ecological, phylogenetic, or genetic definitions would very often not draw species lines around the same organisms.

Failure to Converge : A Case Study

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[3] Birds (Aves), are uniformly sexual reproducers, but even within this class there are problems with the BSC, such as ring species, which pose great difficulties to species delineation.

A good demonstration of that is the case of the kelp flies of the North Atlantic and North Pacific shores, which form the *Coelopa frigida /nebularum* species complex. This complex is at different times regarded as containing one, two, or three separate species of kelp flies.

There are two variants or species that are most commonly identified in it: *Coelopa frigida,* mostly of the north Atlantic ocean, and and *Coelopa nebularum*, mostly of the north Pacific. I will now briefly discuss the failure of different species concept to converge on a delineation and division of these populations into species.

In comparing four separate populations of these flies[4], they each demonstrate morphological differences from all the other populations, which may suggest the existence of at least two separate species. [See figures.]

However, in laboratory conditions, no mechanisms of reproductive isolation were found to exist between any and all of those populations, so following the Biological Species Concept, all four populations could be considered a single species.

Grouping the populations into a single species is further supported by applying the Genetic Cluster Criterion[5]: there is less genetic differentiation[6] between *C. frigida* and *C. nebularum* than between any of them and other, clearly defined and undisputed species of the same genus.

The Hennigian species concept would yield the same result – a single species[7]. However, this is not the same result that a purely phylogenetic approach, divorced from questions of interbreeding, would yield: the two variants of the Phylogenetic Species

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4 Laamanen, Petersen, and Meier (2003), *Journal of Zoological Systematics & Evolutionary Research*,41:2, pp. 127-136.

5 The authors do not refer to it as such, but this is in fact the approach they employ.

6 Based on analysis of Ef 1-a and 16S rDNA

7 Based on the possibility for interbreeding, which it employs in defining the species status of concurrent populations.

concepts that were applied (PSG 1 and 2) regard *C. frigida* and *C. nebularum* as two separate species.

C. Pluralism => Eliminativism

What this example should have rendered apparent is that these definitions aim at diagnosing different things. Each of these approaches to defining species, describes a different aspect of the populations in question, and postulates a different criterion for the demarcation or diagnosis of a species. So species are in fact seen as

– a lineage occupying an adaptive area which evolves separately from lineages outside of its range;
– or it could be defined as a reproductively isolated population;
– or, alternatively, as genetically distinguishable groups of individuals;
– or as the smallest detected samples of organisms that have unique sets of characters --and so on and so forth.

These definitions do not converge, and they cannot be reduced to a single criterion. The question then arises regarding <u>their object</u>. Can they really be regarded as defining the same thing? As I have just pointed out, they address wholly different aspects of the groupings of organisms – and in doing so they actually cut out the continuum of biodiversity into different clusters which they go on to label 'species'.

I would like to claim that this non-convergence of the different definitions is good evidence for why it cannot be held that Species is a single category. that is, it is good evidence for species pluralism. Quite obviously, the organic world is multifaceted; each one of the different definitions captures a legitimate aspect of it, and suggests a different classification scheme, based on the particular facet that it addresses. Each of the criteria used in the major kinds of definitions – reproduction, ecological niche, genealogy – captures aspects of the clusters that are <u>deeply relevant to the theory</u>, and so although they suggest different ways to slice up the world, these manners of classification are not exclusive.

The intended role of species definitions is to describe what is taken to be <u>functionally relevant entities in the theory</u>. Ideally, such entities have a single definition. But, as the theory of evolution indeed entails the operation of different selective forces and multiple interactions and influences, acknowledging the legitimacy of the different aspects seems justified precisely because the different groupings or clusters of organisms occur as a result of different factors. The <u>pluralistic</u> attitude towards classification, while not suggesting a <u>single</u> comprehensive definition of the species category, <u>does</u> reflect functionally relevant entities in the theory. Only what is reflected is a multitude of possible classifications.

One reaction to this discrepancy is a move in the opposite direction: insisting on the assumption that there is indeed only <u>one kind of thing</u> that should be regarded as species, and therefore that there is only one correct definition or a single approach to what distinguishes a species. The fact that none of the many definitions based on the theory-significant characteristics supplies a single good definition, or anything that even approximates such a definition, leaves us with two possibilities. The first, that a good definition simply has not yet been found, but will eventually be discovered. However, at this point in time, this seems to be merely a logical possibility, the likelihood of which is extremely slim. For *Species* to be a unified category, we need to find a definition that captures all of the different aspects I enumerated. But these seem to have been rather well established as substantially different from one another, as attested by their failure to converge and their mutual irreducibility. Thus the monistic view, the aspiration to find a single concept, is left with the second possibility, that – of the available definitions – only one is correct. However, adhering to a single definition entails regarding only limited portions of the living world as species, and the products of all other 'cut out' criteria as non-species, or simply as irrelevant. Interestingly enough, this position in fact leads back to the point that I am trying to make: it is another admission to the fact that all clusters are not of the same type.

It could be argued that given the aggregation of organisms as such a manifest phenomenon, we are required to find a way of binding together all the different concrete definitions of species, the ones carving out the manifold according to particular criteria, into a single integrative one, that would play a useful role in the theory. But I maintain that this is, strictly speaking, begging the question: whether or not these clusters are indeed of the same kind (that is, species) was precisely the question we set out to explore, and found the answer to which to be 'no': they are not clustered in the same way. They do not all fall under the same category; the various definitions diagnose things of different kinds. The category *species* is therefore misguided, and rather gravely misleading.

I have implicitly made the claim that the concept *species* has little if any role to play in the theory. I now turn to making this claim explicit, examining this from the Natural Kinds perspective.

2. Failure of the Species Concept from the Functional Kinds Angle

The question of whether or not species are natural kinds has been widely discussed, and I shall not repeat the whole debate here. Right now I want to make one point, which is that not only is *Species*, the concept, not a natural kind; but also, more crucially, that *species* is not a functional component in evolutionary theory.

The benefit of having natural-kind-like entities in a scientific theory is that these allow for generalizations. I use the term "natural kind" in this context to denote a class of individuals that is an object of theoretically significant inductive inferences. Note that this notion of natural kinds is in the vein of Quine's idea of functional groupings, rather than of the Kripke-Putnam-inspired discourse of essential properties and rigid designation which I leave out of this paper for the sake of brevity.

To be a natural kind is to be a class that allows for scientifically relevant inductive generalizations. The members of such a class share theoretically-significant features that are linked to causal mechanisms. They are grouped by more than just the one criterion that identifies them, which is what warrants the inductive generalizations.

Now, we have seen that different sorting criteria lead to different concepts of species. As I have claimed earlier, I do regard several of those suggested delineations as functionally relevant: they suggest definitions of clusters based on different evolutionary forces. Some of those are, for example, the ones dubbed 'biospecies', 'phylospecies', and 'ecospecies'[8]. But each of these is a different kind of concept. They each allow for generalizations over their own kind, as they suggest different causal models to what bound their members together. They are, in this sense, and in their respective contexts,

[8] E.g. Ereshefsky 1998 and others.

useful functional kinds. But the explanations they each suggest are very different from one another. Thus **they** cannot in turn be joined under a functionally relevant kind: a concept that would bind them together would not capture their different causal structures, and thus would not have much of a role to play in the theory.

Analogously to what I have claimed above regarding the classificatory category of species – that it does not exist, since what it is supposed to classify are entities of different types – we now have the same case on the conceptual level. *Species* as a functional concept, as a theoretically-significant kind, cannot hold: it purports to bind together several concepts that have little in common other than the fact that they each characterize a kind of cluster. The different definitions of organism groupings that employ functionally significant explanations should perhaps be named 'ecogroup', 'biocluster' and 'phylobunch': without the common designator *species* there would be less temptation to view them as entities of a kind.

So I suggest the elimination of the concept *Species*; it does not seem to do much but incorrectly bind together concepts of different kinds, based on a shared characteristic that in itself has no explanatory value: that organisms cluster is a result of different forces, not the causal mechanism that could be captured by a scientific concept or a theory-significant kind-term. It does not do much more than what the concept binding all round things would do. The 'members' indeed share this one property: they are round; they are clusters; but this is far from being a theoretically significant explanatory term.

3. The Role of *Species* in the Theory

When clearing up a misconception one has a duty to look for its cause, since whatever caused it would remain as the proper object of questioning. What is it then that motivated the bundling of different clusters into one overarching, misguided concept? What question was it intended to answer?

The question is, “what evolves?”. *Species* has been offered as an answer, but in fact acted merely as a placeholder for ‘that which evolves’. “What evolves?” is thus what stands in need of explanation, to which *species* should no longer be offered as an answer, because instead of advancing us towards a solution it effectively casts a veil over it.

Where to look for the answer is well beyond the scope of this paper. At this time, I can only point towards some interesting formulations, and suggest that answers may lie with such approaches as Ereshefsky and Matthen’s Population Structure Theory[9]; more broadly, within the approach of rank-free taxonomy; and that helpful clues are found e.g. in the form of recent work on clades as reproducers[10].

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

10 Haber and Hamilton (2006), *Biological Theory*, 1:4, pp. 381-391.