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Taxonomy and Theory

A. Aaron Snyder

University of Wisconsin-Parkside

Taxonomy is not destiny. In the context of scientific theories, it is explanation rather than taxonomy which should play the leading role. (The domain of any theory consists not of mere items--as in philately or genealogy--but of phenomena.) Unless biological taxonomy is guided by underlying theory--presumably, evolutionary theory, genetics, and molecular biology--systematics risks degenerating into mere genealogy.

1. Hull's Dual View.

David Hull believes that certain taxa employed in history of science should be conceived on the model of biological species. He first discusses the nature of species, indicating (in 1.) what they are not--they are not "natural kinds"--and then (in 2.) what they are--i.e., they are "historical entities", "chunks of the genealogical nexus" which are individuated in relation to some arbitrarily selected and quite often atypical "type specimen". The connection between the two points, the negative and the positive, is that conspecificity is determined by actual spatiotemporal contacts of the sort required by descent, rather than by any putative similarities among conspecific organisms. He then analogizes scientific communities (in 3.) and conceptual systems (in 4.) to species as so conceived, urging that they too are not kinds determined by (doctrinal) similarities, but rather historical entities determined by actual contact and influence among their members; and therefore, they should be individuated by an historical version of the "type specimen" method. In both biology and, by analogy, in the history of science, relevant taxa are historical entities rather than natural kinds.

This important idea is unifying, but it is not unitary; i.e., there is the matter of the contrastive rather than. Perhaps these taxa are both historical entities and also natural kinds. However taxa are actually individuated--current practice may well differ between systematics and history of science--perhaps they should be individuated

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in terms of both descent and similarity, with issues of relative primacy between these two sorts of relations decided--not as a matter of current methodology--but as a result of the explanatory role (if any) which these taxa play in an evolving biological (or historical) theory. It may then emerge that there is no need for Hull's contrast: species (or scientific lineages) might be both historical entities and also kinds, and biology (or history of science) might be better off for the mix.

Hull believes that such a mix is ontologically impossible. Indeed, the contention that "historical entities" cannot be "natural kinds" (and vice versa) is a recurrent theme in his writing. (See, for recent examples: 1978, 1981a, 1981b.) The extension of this view to taxa in the history of sciences is merely a new twist to an older idea which itself deserves reexamination. I believe that biological species are both historical entities and also natural kinds. Species are "historical entities" because they are spatiotemporal and causally interconnected sequences of organisms; they are "natural kinds" because similarity-relations are essential to species-individuation (and, indeed, more important than descent per se). I attempt to provide a coherent account of species-individuation which clearly exhibits this duality (in 3.), and (in 4. and 5.) provide reasons for preferring this account of species to one which--like Hull's--conceives species as merely historical entities which are not natural kinds. Before doing this, I first consider such reasons as Hull provides, here and elsewhere, for his view that species cannot have such a dual nature.

2. Species as Historical Entities.

Hull defines historical entities as "the sorts of things which can change through time." (p. 479). Presumably, species are historical entities because "the characteristics usually attributed to species make no sense when attributed to classes as timeless entities. Species are the sorts of things which can evolve..." (1981b, p. 146). So historical entities are distinguished from atemporal classes because the former can evolve and the latter cannot. Elsewhere, however,historical entities are identified with "individuals", not merely temporal entities, but "spatiotemporally localized cohesive and continuous entities" rather than "spatiotemporal unrestricted classes, the sorts of thing which can function in traditionally-defined laws of nature." (1978, p. 336). So here historical entities are distinguished not merely from atemporal classes, but from the sort of spatiotemporally unrestricted classes which can function in laws of nature. Thus, when Hull says that species are historical entities rather than natural kinds, his contrast may be riding more than one horse. It is possible, of course, that species are not atemporal classes, but also that they are not so spatiotemporally restricted as to be individuals. This contrast may even ride a troika, since he also says: "If species are interpreted as historical entities, then particular organisms belong to a particular species because they are part of that genealogical nexus, not because they possess any essential traits. No species has an essence in this sense." (1978, p. 358).

Thus, it may be that species are historical entities (1) because they are temporal entities which evolve; and/or (2) because they are individuals which cannot function in laws of nature; and/or (3) because they are genealogical entities which are individuated by relations of descent rather than of similarity. And it may be, therefore, that species are not natural kinds for any or all of these three reasons.

The first is probably also the least controversial. Even if some naturalists have, in the past, conceived species as Platonic types which are "eternal, immutable, and discrete." (p. 480), this conception of species has little currency. Rather than saying that organisms are tokens or instances which exemplify species, we now say that species are comprised of their member organisms; this would be inept if species were ante rem universals. Instead, species are like causal sequences, or seminars, in that they are spatiotemporal entities comprised of their members which can change, need not be discrete, and are not eternal.

Hull says: "In this paper when I use the term 'species', I intend to refer to those supraorganismic entities which evolve regardless of how extensive they might turn out to be." (1978, p.336; italics mine). Of course species are temporal entities which evolve, even though as Hull recognizes in the same place, "whether the relatively large units recognized by taxonomists as species or whether much less extensive units such as populations are the effective units of evolution is an open question." (p. 336; italics mine). It is valuable to distinguish the question whether species evolve--they surely do--from the question whether evolutionary processes, such as selection, operate most directly at the species-level (or rather at the level of populations, organisms, traits, or genes). That latter question, as Hull recognizes, is still open; whereas the question whether species evolve is presumably closed. (This distinction vitiates one motive--and possibly the main one--for conceiving species as "localized cohesive and continuous.")

The second reason presents rather more difficulty. Hull says: "...if species are genuine natural kinds, their names could function in fundamental laws of nature. They just happen not to. On my view, species are spatiotemporally localized individuals. Hence it is understandable why no mention is made of particular species in any biological laws." (1981b, p. 151). Whether species-names could function in fundamental laws of nature would seem to depend not so much on whether species are natural kinds as on whether they are fundamental enough. Gold presumably is a natural kind, but the name of this element does not function in any "fundamental laws of nature" (at least none of which I am aware). This does not impeach its kind-ness, but rather its fundamentality. Species are, like particular elements, rather too specific to function in fundamental laws of nature. Conversely, the gravitational field of the universe, which is an individual rather than a kind, probably does function in fundamental laws of nature. (And the solar system, which is at least as much an "individual" as a species is, functions in Kepler's Law--though that

law may not be very fundamental.) So the fact that particular species are not mentioned in fundamental laws of nature (including biological ones) also does not provide much reason for denying that species are natural kinds.

Perhaps the issue is whether species-names can function in "law-like" rather than merely accidental generalization--regardless how fundamental. If this be the issue, then on the usual criterion for distinguishing the two--viz., whether they warrant counterfactual inference--species-names actually do function in law-like generalizations; e.g., "Tigers are vertebrates." and "Pigs can't fly.". Since species are "theory laden" taxa, it is not surprising that they do. (See 5., below.) So it must be the genealogical account which is crucial in denying that species are natural kinds, and my subsequent remarks, like Hull's current paper, will focus on this view.

3. Species as Natural Kinds.

Even some genealogical entities are natural kinds. The "genealogical nexus" as a whole is presumably a genealogical entity (if anything is), and yet it is also a natural kind, at least in virtue of the fact that all member-organisms share a DNA-based genetic code. Moreover, various "chunks" of that nexus, e.g., chlorophyll-users, are natural kinds. Unless "chunks of the genealogical nexus" are individuated in terms of similarity-relations, it is not clear why we should conceive the genealogical nexus in chunks at all, rather than as an unbroken continuum of descent-related organisms.

The fact that similarity-relations are essential to species-individuation does not entail that species "must be defined by means of characteristics that are severally necessary and jointly sufficient for membership." (p. 481). Hull sometimes joins Mayr (1969, 1982) in attacking "Essentialism", but he also admits that "cluster concepts" might designate natural kinds (1981a, p. 137f.). And some noted anti-Essentialists refer to sub-species and chronospecies, apparently on account of morphological similarities (Mayr 1963, p. 348f; Simpson 1961, pp. 163-176). Despite over-fishing in these waters, the catch consists of red herrings. The real issue is whether similarities are essential to species-individuation, not whether those similarities constitute an Aristotelian essence.

There is a purely logical reason why kinds need not have Aristotelian essences, viz., similarity (unlike "exact similarity") is not a transitive relation. The simplest natural kinds are those whose members all share some single unifying characteristic (e.g., every atom of gold has the same atomic number); but not all natural kinds are so simple in their individuation. I believe that Aristotelians constitute a kind of philosopher, even though I do not believe that 'Aristotelianism' designates a single trait shared by all and only Aristotelians. I even believe that Aristotelians are a polytypic kind, e.g., that Thomists constitute one "variety" of Aristotelian. Moreover, whilst believing that Aristotle was the most typical

Aristotelian, I believe that Thomas was also an Aristotelian, despite his doctrinal differences and little historical connection with Aristotle. It may be less clear whether "Kripkean Essentialists" are a variety of Aristotelian, but then the boundaries of philosophic taxa--like the boundaries of biological taxa--are not always very definite.

By way of first approximation to a natural kinds conception of species: those organisms are conspecific which, in virtue of genetic similarity, have the capacity for genetic exchange (i.e., donation and/or reception). A significant degree of genetic similarity is necessary (but not sufficient) for that capacity (e.g., consexuals). There is some tendency among "population thinkers" to conceive species as actual breeding populations, and therefore, to deny the relevance of breeding capacity or potential to species-individuation. (This is sometimes expressed by saying that "mere possibilities don't count"--as if actual capacities were mere possibilities.) But actual breeding requires capacity as well as opportunity. If there is reason to distinguish between organisms and their environment, then there should also be reason to distinguish between those organic factors (e.g., genetic capacity) and those environmental factors (e.g., spatiotemporal contiguity) which combine to determine interbreeding and hence descent. Since the population-concept already marks the actual interbreeding, it would be otiose to "double-up"; the species-concept could more usefully mark the genetic capacity in contrast to the actual behavior. In that case, species would consist of organisms which are genetically similar.

Since such genetic similarity usually derives from descent, it is tempting to accomodate a genealogical conception of species by adding a further clause which reads: "and this genetic capacity derives from (common) descent." This addition would not alter the fact that genetic similarity is essential to species-individuation, but I doubt that it would improve the account. For reasons which appear in 4., below, we should not require common descent for all conspecific organisms. According to this account--with or without the suggested addition--species are natural kinds. Ontologically, they are causally inter-connected sequences of genetically similar organisms (with descent being one of the possible causal inter-connections). This should make them historical entities as well.

4. Biological Behaviorism.

Alleging a warrant based on the evolutionary process, Hull contends that species-individuation requires "identity by descent": "The reason that the notion of 'identity by descent' is so important in biological evolution is that the only similarities and differences that matter in the evolutionary process (sic) are those that exhibit this sort of 'identity' or lack of it." (p. 480). But this view derives more from taxonomic method than from evolutionary theory.

Not all evolutionary processes result in taxa which exhibit "identity by descent". According to standard-model cosmology, evolution has occurred both at the physical level--from a radiation-

based to a particle-based cosmos--and subsequently at the chemical level, with heavier elements being relative late-comers to the cosmic scene. Nonetheless, neither physical particles nor chemical elements exhibit "identity by descent"; instead, both provide standard examples (e.g., gold) of similarity-based natural kinds. Even in biological evolution, it is not true that "the only similarities and differences that matter" are those which exhibit descent-relations. Random genetic mutations have mattered greatly in biological evolution (esp. pre-Cambrian). Mutant and non-mutant offspring are, genealogically, equally direct descendants, even though their evolutionary role may be radically unequal. What really matters in evolution is not genealogy but genetics.

Biological evolution occurs because units of genetic information are selected in competition among organisms which carry these units. At the underlying "hardware" level, genetic units consist of molecular configurations, e.g., stretches of DNA; and even if traits or "characters" are conceived as requiring "identity by descent", their underlying molecular configurations are not. (See 5., below.) It is no doubt methodologically useful to define species via descent-relations (see Hull's section 2.; also, Mayr et al. 1953, p. 236), while grudging genetic similarities secondary importance "only as an aid to inferring the genealogical nexus." (p. 486). But such definition is a "black-box" analysis which undercuts the explanatory bases of taxonomy in evolutionary theory, genetics, and molecular biology. (Cp., Behaviorist analysis of mental states without regard to neurophysiology.)

As in the case of classical Behaviorism, such "peripheralism" collaborates with operationalist tendencies which would derive the meaning of the species-concept from the taxonomic methods used in determining the extension of species. Even if, in current systematics, species are individuated via descent-relations to some arbitrarily selected (but unfortunately misnamed) "type specimen" which may be highly atypical of the membership of that species, it does not follow either that a species is or that "species" means a "chunk of the genealogical nexus" which is arbitrary with respect to similarity-relations among its constituent organisms. (Cp., Hull 1981a, pp. 140-143).

In fact, the type specimen method of species-individuation can work--when it does work--only because descent is roughly correlated with genetic similarity. Suppose this were not so: suppose that, unlike our world, common descent did not usually bespeak genetic similarities. If organisms were, usually, either wildly dissimilar from parents and siblings or else were wildly irregular in point of genetic similarity to their genealogically nearest "kin", it is most unlikely that the type specimen method could be employed in any theoretically interesting taxonomy. In that case, "systematics" would be mere genealogy with little theoretical content or explanatory value, and "kinship" would mean almost nothing. Happily, our world is not like this. Given the nature of organic reproduction--either sexual or

asexual--organisms are usually genetically similar to those to which they are genealogically close. Operationalism can mount a plausible pretense in systematics only because this is so; i.e., it is possible to pretend to care only about descent only because descent transmits genetic information.

It is not the reproductive process on which our conception of species should be based, but rather on sufficient genetic similarity, regardless of the reproductive process which produced that genetic similarity. Genetic similarity might result from processes which have little or nothing to do with descent per se. Clones are "descended" from their originals only in the sense of deriving their genetic code from them; but since they are genetically identical, it seems clear that they are conspecific. Even if "population thinking" leads to denying that asexual organisms form species, since they do not form populations (e.g., Dobzhansky 1951, p. 274; Mayr 1963, p. 27f.), this still need not preclude clones of sexual organisms being conspecific with their donors. Since I am a male, my clone should be male as well; the fact that he resulted from asexual reproduction would not make him an asexual organism. (Even some "natural" species, e.g., certain aphids, go both ways.)

It may seem that the conspecificity of clones and donors does not put much strain on a genealogical conception of species, since: "Both replication and reproduction are spatiotemporally localized processes. There is no replication or reproduction at a distance. Spatiotemporal continuity through time is required." (Hull 1978, p. 341). Then consider a cloning procedure which involves transporting donor cells over inter-stellar distances before these cells are used to produce clones of their "parent" organisms. (This might be a useful way of colonizing distant planets.) The clone and its "parent" might then be as separated in space-time as any two time-like related items in the cosmos. This surely places some strain on the idea that:"Reference to gene transmission results in species which are spatiotemporally restricted." (Hull 1981b, p. 144). Moreover, such species could even be temporally discontinuous, since its earth-bound portion might have become extinct while its donor cells were in transit. According to Hull: "Both mating and descent require contiguity." (1981b, p. 150); if so, then donor-clone species do not require "identity by descent" any more than they need be "spatiotemporally localized cohesive and continuous".

Nor does conspecificity always require even gene transmission, at whatever spatiotemporal distance. Genetic similarity has usually resulted from gene transmission (so far as we know), but it need not always. Suppose that we produce "progeny", not by cloning, but by synthetic replication of DNA. Using organisms as templates, rather than donors, we synthesize each element constituting their DNA; the synthetic DNA is then infused into an appropriate organic medium to produce genetic replicas of the template organisms. Here a genealogical notion of descent is wholly out of place. Nonetheless, these replicas should be conspecific with their templates, at least

insofar as our taxonomy really is motivated by evolutionary considerations rather than methodological ones. Imagine a mixed population including both replicas and also natural progeny of the template organisms. So far as we know, all subsequent evolutionary processes would be blind to the different means of their production. Current systematics might distinguish between descendants and replicas, but evolution would be indifferent.

Such thought experiments indicate that descent per se should not individuate species. What is primarily important is not breeding, but what gets bred.

5. Evolution and Identity.

"Two traits may be similar as one might wish, but they cannot count as the 'same' trait unless they share a common evolutionary origin. Even at the level of genetic material, the same distinction is made. Two stretches of DNA might have identically the same structure and yet not count as the same gene. The relevant identity is identity through descent." (Hull 1981b, p. 144). This contention, which is crucial to the controversy about species, rests on two fundamental confusions, one regarding identity and one regarding evolution. Those who maintain that species are historical entities rather than natural kinds are conflating numerical identity with qualitative identity and evolution as history with evolution as repeatable causal processes.

Wars are historical entities (e.g., the Viet Nam war can occur only once) and some wars have caused other wars in various ways (e.g., the Franco-Prussian War, WWI and WWII). But this does not entail that wars should be grouped only according to historical or causal sequence: one may be interested in a theoretical study of warfare as well as in military history. It is merely truistic that the numerical identity of wars and sequences of wars depends on their actual history; but it is not true that their qualitative identity does as well. It might be that no two (sequences of) wars are similar in any important ways; and therefore, since no two wars are "the same", there is no basis for a theoretical study of warfare. Even if no two wars are qualitatively identical, this will not be so because their qualitative identity depends on descent. Only if one confuses history with theory will one be likely to confuse these two notions of identity and thereby require qualitative "identity by descent".

Whatever may be the case for warfare, there is a role for evolutionary theory in addition to evolutionary history. Organic molecules, genes, traits, organisms, populations, and lineages can be similar in ways which are theoretically important even when they are not related by descent. (If this were not so, then for example, selection should differentiate between natural progeny and synthetic replicas; see 4., above.) The notion of qualitative identity by descent results from conflating "the evolutionary process" as an historical individual which perforce cannot recur with (the sum of) those evolutionary processes--variation and selection, reproduction and

mutation, etc.--which may well recur elsewhere and elsewhen.

Current systematics is concerned primarily with sketching the course which evolution has actually taken in the only genealogical nexus we know about, and therefore, it is supposed that systematics maps "the evolutionary process" (in a conflated sense). The conception of species as "chunks of the genealogical nexus" follows trivially from the conception of biological taxonomy as historical description of a given evolutionary nexus (ours); so also does the notion of "identity by descent". This is no more interesting than the fact that military history describes datable (and hence "historically unique") events. It does not imply that no two wars can be the same unless they are historically related. The fact that evolutionary history describes datable items also does not imply that organic items cannot be the same unless they are historically related. So far as (repeatable) evolutionary processes are concerned, sameness does not require identity by descent (e.g., synthetic replicas) and difference does not require lack of descent (e.g., mutants).

If biological theory is not mere historical description, then its taxonomy should attend not merely to our actual evolutionary history, but also to repeatable evolutionary processes (which could presumably determine the evolutionary history of any genealogical nexus anywhere and anywhen). In that case, its taxa should not consist of chunks of this particular genealogical nexus; instead, its taxa should group organisms according to those repeatable similarities and differences which are important to repeatable evolutionary processes. If we refuse to do so, then we deny the relevance of evolutionary theory to the history of our genealogical nexus.

The kind-ness of biological taxa should be more essential than their historical uniqueness--their "descent"--because evolutionary theory is more fundamental than evolutionary history. Whether this is also true in the history of science is another matter.

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