Philosophica 37, 1986 (1), pp. 101–126

SPECIOUS INDIVIDUALS*

Kristin Guyot

Much is made of tigers, house cats, and other sorts of beasts in philosophical discussions of natural kinds. The hypothesis that species are not kinds but individuals has, however, recently gained currency among biologists and biologically-oriented philosophers[1]. This is an exciting turn of events, both philosophically and biologically. Twentieth century philosophers have long held that the ontological categories of items mentioned in theories are fixed by convention. Realist philosophers have undermined Positivism and with it conventionalism[2]. But, for the most part, philosophical discussions of natural kinds have concerned entities whose ontological categories are presumed to be understood. Parties to the dispute over the status of species are engaged in a novel enterprise. I will show that one outcome of the dispute is to make salient an inadequacy in the traditional account of natural kinds.

According to Scientific Realism the causes of the processes studied by any science determine the natures of its categories. Having atomic number 79 is the essence of gold because atomic number determines valences hence the combinatorial properties of chemicals. Similarly, the properties definitive of species composition must be evolutionarily potent. Changes in biologists' conception of species or disputes about their nature should reflect theoretical controversies or developments. Laudibly, most advocates of the hypothesis that species are individuals take the issue to be empirical and attempt to settle it by appeal to evolutionary theory. Thus the issue is nontrivial. To be wrong about the natures of evolutionary categories is to be wrong about the causes of evolution.

I will argue, however, that although the hypothesis that species are individuals (let's call it '*I*') is rich in biological import, its justifications have generally been superficial. *I*'s champions tend to adduce quite abstract features of evolutionary processes in its defense, but such features are incapable of confirming it. The mere occurrence of evolution, even evolution by natural selection, is compatible with the rival hypothesis the species are kinds (let's call it '*K*'). *I*'s truth hinges on the fine points of the evolutionary process. Moreover, *K* has not been given a fair trial. Its opponents formulate it naively and claim to refute it by demolishing premises which its advocates would disavow.

In the meantime, due in part to *I*'s shortcomings, some of its advocates have reformulated it in a way which diverges so far from its ancestral state that they are actually endorsing *K*. These surreptitious developments do biology and philosophy a disservice. *I* originally emmanated from a detailed conception of how evolution occurs. Part of that conception has been undermined. To advocate *I* in indifference to the insights which motivated it belittles biological progress and rides roughshod over the philosophical concerns which motivate the distinction between individual and group.

The most philosophically sound conception of the nature of individuals shows that, given the empirical facts, species cannot be individuals. Although *I* is false, it seems to contain important germs of truth which could be used to illuminate aspects of evolutionary theory. Although I cannot claim to have brought them to light, I hope I have hand-waved in a fertile direction.

Individuals

Although in one sense, that of object or thing, anything is an individual; e.g., a pair of shoes is one thing, one pair; the set of all topiary trees is one individual, one set; and all bits of gold comprise a single scattered object; the use of 'individual' in *I* is more refined. Organisms are paradigmatic individuals in the appropriate sense — species are individuals just in case they belong to the same ontological category as Reagan and Bonzo[3]. The anti-conventionalist tenet that there is a real distinction between scattered objects and true individuals is presupposed by parties to the dispute.

Most philosophical theories of the nature of individuals state that a collection of entities distributed in space or time are the parts of one individual just in case they exhibit certain continuity relationships. Two styles of continuity, spatial and temporal, are required[4]. Continuity is often explicated in a topic-neutral manner. Hirsch, for instance, explains continuity as follows :

"... the simple continuity analysis is satisfied by a succession

> S of object-stages if and only if : first, each object-stage in S coincides with a continuous region of space; second, S spans a continuous stretch of time; and, third, the places which coincide with temporally neighboring stages is S overlap sufficiently (perhaps more than half).
>
> ... spatially continuity... means that an object... at any moment of its existence, (occupies) a continuous region of space and does not exist in a macroscopically fragmented form. We might define a continuous region of space as one in which any pair of points can be connected by a continuous curve lying wholly within the region. Thus an object with holes in it may occupy a continuous region..."[5]

Contrary to such accounts, Shoemaker persuasively argues that temporal continuity cannot consist of mere temporal proximity — continuity is causal[6]. Suppose, for example, that in the possible world envisioned by Star Trek's writers, Scotty is beamed up from point x just as Spock beamed down to x. Temporal parts of Scotty and Spock occupy a continuous spatio-temporal region. Yet the region is filled by no single person. Stages of Spock and Scotty would fail to comprise a single person even if the two were identical twins and the stages were qualitatively similar. Properties of successive stages of an individual must be causally determined by properties of earlier stages. "Simple" continuity is insufficient for individuality.

What is true of temporal relationships is true of spatial relationships. Holding hands makes bodies spatially continuous in the simple sense but it does not merge them into one body. Minimally, physiological interactions are necessary.

The examples naturally suggest that styles of continuity are sortal-dependent. Different types of causal interactions must obtain between the parts of different kinds of individuals. States in the mental life of a single person must be determined by earlier mental states, physiological interactions unite cells and organs into bodies. Wiggens has argued along these lines that individuation depends on the existence of sortals[7]. For every individual there is a sortal kind which says what that individual essentially is; e.g., a pencil, a radish, etc.; and different sorts of individuals exist by virtue of distinct styles of continuity. He argues that only with the help of sortals could the referents of our utterances about individuals be determinate. Advocates of simple continuity analyses must perceive the world as analogous to a field of tombstones with each individual neatly spaced from its neighbors. But the world is more like a briarpatch, a confusion of entangled individuals. Separate individuals can consist of the same stuff and such individuals can have different lifespans. Socrates and his body cohabited, for a while, a single spatio-temporal region, and the man was survived by the body. Yet time-slices of Socrates before his demise were continuous with those of his body post-mortem. Simple continuity accounts of individuation are insufficient to pry apart overlapping individuals. They generate erroneous censuses.

Cases of persistence and annihilation through change bring Shoemaker's and Wiggens' insights together. They show that continuity relationships are a species of causal relationships and that distinct styles of causal interactions are required for different kinds of objects. Consider Reagan, for example. It seems intuitively clear that if a neurosurgeon were to reorganize Reagan's mind in the form of Danny Santiago's with the latter's personality and theoretical beliefs, the person to whom the bill is subsequently submitted would not be Reagan — pre- and post- operative mental states would not be connected in the right way. But if Reagan had gotten a superior education and thereby in the natural course of things acquired attitudes and beliefs indistinguishable from Santiago's he would have been a better man not a different man. The persistence of persons depends on the maintenance of certain causal relationships among mental states. Earlier beliefs shape later beliefs, earlier desires and beliefs lead to subsequent action. But a different set of causal relationships governs the persistence of Reagan's brain. If the surgical intervention involved only minor neurological tampering then the operation had no effect on the brain's longevity. The causal relationships crucial to the persistence of organs were not violated by the tampering which eradicated the man. Spatial and temporal continuity relationships are sortal relative and causal.

Two philosophical points flow from these conclusions. First, this account of the unity of individuals explains the commonality of concrete individuals and more ethereal individuals like universities and labor bargaining units. Pedestrian concrete objects like tables and buttons may be essentially physically continuous (though this probably depends on little more general than the natures of tables and buttons, reflection shows that it does not hold for clocks), but physical continuity must involve causal continuity and different styles of causal continuity are germane to different objects. Although the causal interactions which glue persons together usually occur in a medium which is physically continuous, they need not. Neurologists could conceivably discover that states of mind, e.g., memories, beliefs and desires, cohere by virtue of radio waves rather than neural transmitters. Perhaps people could be instantiated by collections of radios which signal each other from afar. (Computers are sometimes organized in a similar manner). And, of course, universities are normally physically disjunct, statutes and human behavior bind them together. What all individuals have in common is that their parts are bound together by causal spatial and temporal continuity relationships. All individuals are metaphysically akin. And hence, as *I*'s advocates claim, spatially fragmented objects like species could really be individuals of the same calibre as organisms — provided that they are appropriately causally continuous.

The second point is that if continuity relations are causal and sortal relative then a common philosophical maneuver is suspect. Philosophers periodically describe hodgepodges of parts of things claiming, to various ends, that the parts comprise no individual. In the spirit of this position, for instance, the phases of the Terminal Tower which precede the year 2000 combined with slices of the Empire State Building thereafter would be claimed to be no individual. Such intuitions are apt to be informed by a simple continuity account of cohesion. The causal sortal-relative theory of individuation implies that since it is trivially true that the building phases are causally connected in many ways, the proposition that they comprise no individual depends on there being no sortal which individuates in terms of any of those kinds of connection. In the contexts in which such examples usually appear, the existence of a natural kind sortal would be at issue. Since naturalness is relative to types of causal processes, what is presupposed is the lack of a sortal covering the building phases which is natural relative to any potential science. Since our repertoire of special sciences is, no doubt, an impoverished sample of the disciplines which could be pursued, the natural kinds which are recognized as such by us must be a small fraction of the total. The claim that there is no natural kind relative to any process which has such-and-such properties seems to me to be very risky; and so the assertion that a particular collection comprises no individual at all seems very onerous. I cannot see why in general we should believe such claims.

One cannot infer from this, however, that *I* is easily defended, for *I* does not claim that con-specific populations comprise some individual or other, but that *species* are individuals. If species are individuals the species category must be a sortal. The species category must determine the relevant continuity relationships. Some biologists have claimed that *I* obviates the need to argue that species are "real," i.e., natural.[8] That cannot be right. If species are of any biological interest then the species category must be a natural kind sortal. *I* cannot deliver a free lunch.

I and K

The opposing metaphysical categories of individual and group mark, in part, a distinction in the way matter is organized. The components of any individual are so by virtue of their continuity. Membership in kinds may be temporally restricted; e.g., antiques; or etiologically restricted, e.g., Ventura's work; but some kinds, unlike any individuals, are capable of being populated by distinct individuals whose sorority is independent of continuity. Although some kinds are essentially restricted to one member, the debate between *I* and *K* concerns the question of whether species are groups with, in general, a potential plethora of members or spatio-temporally cohesive units. If the components of species must be continuous then *I* gets counted as true. Thus *I* and *K* sanction different taxonomic principles. Populations which are relevantly causally isolated from us, say, rational-bipedal Plutoneans, could be *Homo sapiens* if certain versions of *K* were true, but those creatures are aliens on every version of *I*.

I

Mayr and Dobzhansky were among the first to formulate the distinction between *I* and *K* and to suggest that biparental species are analogous to individuals. Mayr wrote :

> "... the typological species concept treats species merely as random aggregates of individuals which have the "essential properties" of the "type" of the species... This static concept ignores the fact that species are not merely classes of objects but are composed of natural populations which are integrated by an internal organization and this organization (based on genetic, ethological, and ecological properties) gives the populations a structure which goes far beyond that of mere aggregates

> of individuals... In a species an even greater supraindividualistic cohesion and organization is produced by a number of factors. Species are a reproductive community. The individuals of a species of higher animals recognize each other as potential mates and seek each other for the purposes of reproduction. A multitude of devices ensures intraspecific recognition in all organisms. The species is an ecological unit which, regardless of the individuals of which it is composed, interacts as a unit with other species in the same environment. The species, finally, is a genetic unit consisting of a large intercommunicating gene pool whereas each individual is only a temporary vessel holding a small portion of this gene pool for a short period of time. These three properties make the species transcend a purely typological interpretation of the concept of a "class of objects."[9]

Dobzhansky made much the same point :

> "Sexual reproduction has brought about a new form of biological integration. Individuals are combined into reproductive communities, Mendelian populations. These supraindividual entities are considered supra-organisms by some authors (Allee et al. 1949). In any case, they owe their cohesion, as pointed out above, not only to common descent, but, and primarily to mating and parentage bonds. The sexual unions and the gene segregations occur in every generation in Mendelian populations, and determine both the continuity and the changeability of their collective genotypes, gene pools... Mendelian opulations, rather than individuals, have become the units of the adaptively most decisive forms of selection".[10]

I has its origins in studies of the effect of interbreeding on the evolution of populations and *I* owes much of its current popularity to the Biological Species Definition. That hypothesis defines species in terms of interbreeding, a form of spatial continuity : Species are "groups of actually or potentially interbreeding natural populations which are reproductively isolated from other such groups."[11] *I*'s original rationale is to be found in the evolutionary role of interbreeding.

The evolutionary significance of relationships of breeding depend on the falsity of bean-bag genetics. The value of any gene depends on the genetic background in which it is expressed; hence the fates of any organism's genes depend on the composition of its reproductive community or gene pool. A mutation which is favorable when expressed in concert with one organism's genotype will be filtered from the organism's legacy if it is deleterious when recombined with other prevalent genotypes. Selection favors good-mixers. At the same time genotypes which mask the effects of deleterous alleles, which produce good phenotypes come what may, may be favored by selection. Selection favors canalization. Through selection breeding relationships strongly influence the course of evolution.

What holds within reproductive communities holds between them. Interbreeding among populations creates strong selective forces within populations. Those forces tend to confine the populations to the same evolutionary track and to inhibit change. The effects of a constant influx of migrant alleles are felt on every locus. Genes must hold up well against the variety of genetic backgrounds prevalent in the species. Mutations are, similarly, stringently tested. And again, selection will often favor genotypes which absorb genetic variation without perturbation. Interbreeding populations tug at each other, dampening the effects of otherwise divergent selection and mutation.

And, of course, migration inhibits divergence merely by counteracting the effects of centrifugal selections.

The significance of interbreeding has then both static and dynamic components. Interbreeding populations are genetically and adaptively coherent, they are coadapted. And their evolutionary fates are shared -- they tend to evolve along the same trajectory because they intercommunicate or they intrinsically discriminate among novel alleles similarly, or they resist perturbation entirely. Mayr writes :

> "The need for coadaptation and for the harmonious integration of genes sets severe upper limits to the number of genes that can be accommodated in a gene pool, since many genetic combinations are incompatible. The rapid elimination of disharmonious combinations after hybridization is proof of this conclusion. There is a tendency in the integrated gene complex to establish an ever-greater cohesion, to achieve a steady improvement of developmental and of genetic homeostasis... A well-integrated genetic system may come into perfect balance

> with its environment and become so well stabilized that evolutionary change will no longer occur. Such a system will be able to cope with the regular input of mutations and the normal environmental fluctuations without having to undergo any change. Its future is at best evolutionary inertia..".[12]

Interbreeding populations share an ecological role. Adaptive divergence depends on breaking the grip of developmental and genetic homeostasis. As long as populations interbreed novel alleles suiting organisms to unique features of local environments will tend to sink under the strain of selection. Divergence depends on reproductive isolation. But reproductive isolation is not enough ! For each population carries with it the burden of its history. Populations share a common genetic milieu which restricts the incorporation of new mutations and tends, through developmental homeostasis, to mask the effects of genetic alterations. Significant adaptive change cannot occur unless the old genetic environment of a population is disrupted — it requires genetic revolution.

Such radical change is unlikely to be fueled by selection. Selection tends to be a conservative force. Selection against novel alleles arises partly from factors internal to populations (because of the way allelic substitutions ramify through phenotypes). And genetic diversity is buried behind, as Muller put it, a "phenotypic facade."[13] In the former case selection is a tangled web of opposing forces, in the latter case, it finds no raw material. Thus Mayr assigned random forces, the founder effect and drift, a pivotal role in speciation. Adaptive divergence must often be triggered by random change. He writes :

> "Speciation is potentially a process of evolutionary rejuvenation, an escape from too rigid a system of genetic homeostasis. Speciation disrupts the cohesion of the gene pool by temporarily depleting its gene contents and by inevitably forcing the population into a slightly or drastically different environment... The greater the change, the greater the probability that the daughter species can enter a new ecological niche and be successful in it."[14]

The Biological Species definition is motivated by the effects of interbreeding on the genetic and adaptive composition of populations, on their evolutionary histories and potentials. Since interbreeding between populations makes them spatially continuous in a certain sense and relationships of ancestry and descent are temporal continuity relationships, one might think that whatever justifies the Biological Species Definition *a fortiori* justifies *I*. But such a defense of *I* would be problematical. Mayr's original definition stipulated that the populations of a species are capable of interbreeding, it did not require actual interbreeding. But merely having that capacity does not make populations spatially continuous — they can potentially interbreed without ever interacting. Some biologists have subsequently required actual rather than potential interbreeding, but their arguments have been of a dubious epistemological stripe.

Empirical and theoretical data, and the justification of the Biological Definition, strongly suggest that Mayr's original definition in terms of potential interbreeding was correct. Empirical considerations show that requiring actual interbreeding would be too strong. Although to my knowledge no general census of the extent of interbreeding within species has been conducted, Ehrlich and Raven's investigation of checkerspot butterfly populations concluded that interbreeding is minimal.[15] Biologists did not react to the study by crediting Ehrlich and Raven with discovering a bevy of new species - biologists act as if actual interbreeding is unnecessary.

Moreover, there are theoretical reasons for thinking that interbreeding, even if it *always* occurs, is inessential to species. Although interbreeding is a strong cohesive force, once a genetic homeostatic system is distributed among populations, by whatever mechanism; be it prior interbreeding, inheritance, or selection; the populations will exhibit the characteristic marks of a species, they will be united ecologically, adaptively, and dynamically, with or without interbreeding. Simpson argued along these lines that the Biological Definition is strictly speaking false. Species are groups of populations which share a unitary evolutionary role and tendencies (where roles can be understood ecologically and adaptively and evolutionary tendencies concern potential directions of change).[16] If the Biological Definition is justified by the effects of interbreeding on the evolution of participating populations and those effects can accrue without interbreeding, then Simpson's functional definition of the species would seem to be justified. Since both Mayr and Simpson believe that uniparental organisms belong to species, not species-by-courtesy but the real thing, some such functional conception must lie buried beneath the surface of traditional taxonomic thinking.[17]

The hypothesis that populations can share an evolutionary tendency without interacting does not seem particularly controversial. Eldredge and Gould, for example, make use of constraints internal to populations in explaining the evolutionary stasis posited by the Punctuated Equilibrium theory of macroevolution.[18] To be sure, interbreeding is a major architect of integrated genetic systems, but once such mechanisms are in place, by whatever means, genetically similar non-interacting populations resist divergence.

These conclusions about species combined with our previous hypotheses about the nature of individuals lead to more radical doubts about interbreeding (and *I*) than disputes about the actual extent of interbreeding. Even if Ehrlich and Raven are wrong and interbreeding always occurs between con-specific populations if interbreeding is not what makes them con-specific, in the weak sense of not being causally necessary, then species are not individuals. Here is the argument : Continuity relationships are sortal relative. If species were individuals then the essence of that category would have to dictate some continuity conditions. If Simpson is right that the species is functionally defined and Mayr et. al. are right that interactions between populations are not causally-necessary for their behaving appropriately then the species category does not specify or require any continuity relations. Even if interbreeding is in fact a cause of the unity of species if it is not causally necessary then species are not individuals — for they do not have the right modal properties. If a population could belong to a species, by sharing its evolutionary role and tendencies, without interbreeding then that species is not an individual.

The truth of *I* depends on the existence of a force effecting spatial continuity among con-specific populations. The only nominee for the role is interbreeding. If actual interbreeding is not necessary for species, and our arguments entail something much stronger, even potential interbreeding is unnecessary, then species are not spatially continuous. *I* simply cannot be true.

Some advocates of *I*, e.g. Hennig, have proposed a weaker version which is immune to this criticism.[19] They require populations of a species to be temporally continuous but exclude the spatial continuity requirement. According to them, species are lineages, they consist of populations which have descended from one immediate common ancestor, or one interbreeding group included in the species.[20] Species are branches of a geneological tree. This is not a weakening of *I*, however, but its abandonment. A family group is not an individual. Consider the following example : The editor of a failing philosophy journal has a photo of Russell. She makes a negative of the photo and offers copies to new subcribers. Several subscribers, desiring photos for both home and office, repeat the proceedure generating more Russell photos. The photos are related in the same way as members of lineages but no one would ever have called such a group an individual.[21] True, there are etiological restrictions on the set of all copies of the Russell photo, but such restrictions are common among groups; e.g., American antiques, Ford cars, etc. The metaphysically interesting distinction is not between those groups and groups like the set of all tailpipes but between all of them and true individuals like organisms. Lineages differ from some other kinds in that their members must have certain etiologies but they are groups nonetheless. (The merits of this version of *K* will be weighed. in a later section.)

K's Frailties

Most arguments against *K* attempt to show that if species are kinds they cannot evolve and go extinct. There are a variety of reasons why *K* is supposed to be incompatible with evolution, viz.; all kinds have essences but there are no suitable specie-essences; kinds cannot evolve or go extinct; evolution requires temporal continuity. The first argument generally proceeds as follows : 1) If species are kinds there must be suites of theoretically interesting properties which define their membership. 2) But all properties of organisms can be transformed in evolution while they remain members of the same species as their ancestors. 3) So species are not kinds.

Myriad things are wrong with this argument but the most salient is that its spurious plausibility is gained by its naive formulation of *K*. Proponents of the argument deploy the second promise by adducing examples of possible *K* definitions like "man is a rational animal", and "beavers build dams."[23] They then proceed to point out that these are either contingent truths or false. *K*'s detractors thereby assume that *K* is a living fossil trapped in the mire of special creationism. If the essences of species must be properties of organisms then well-worn counterexamples to typology, teratological specimens and the like, refute *K*. But sophisticated versions of *K* will define species in terms of properties of *populations*. But then the contention that evolution obviously precludes *K* is absurd. After all, Mayr's definition of species in terms of properties of populations, their breeding capacities, is a version of *K* — it countenances spatially and temporally disjunct species. Mayr's hypothesis may have defects but being trivially false is not among them. Peculiar organisms are no more the bane of *K* than sterility is of *I*.

Another series of arguments revolves around colloquial ways of talking about evolution and extinction. Rosenberg summarizes the series as follows :

> "... it *(I)* makes good sense of the notion that species evolve, whereas treating them as fixed kinds makes a conceptual mystery of this matter. If species were kinds, talk of extinction would be misplaced; on the other hand, the integral connection of this notion to the concept of species will not countenance the appearance of organisms indistinguishable from extinct species as a case or the reappearance of the same species. This, too, reflects taxonomic practice hard to accept if species are kinds."[24]

One thread running through such arguments is that kinds are abstract entities which stand outside of time and place — they cannot literally come into being and perish. Radium would not become extinct if all its samples transmutated. The argument appeals to ordinary language but ordinary language is not sacrosanct. Of course it would be devastating for *K* if it had to be mute on evolution and extinction but it does not. What *K*-theorists are saying when they say that one species evolved from another is that populations belonging to the former evolved from populations belonging to the latter. When they say that a species has gone extinct they are saying that all samples of the species have perished.[25]

For what it is worth, it is arguable that *I* and certain versions of *K* give identical accounts of evolution and extinction. Suppose species were sets. Any set's membership is essential to it. If 'Nadja' names the set which contains this paper and the number 216 nothing could be identical to Nadja which does not contain precisely those objects. Now consider the singleton set which contains just Reagan. This set came into being no earlier than he did and will disappear with him — no Reagan, no set. Sometimes a special atemporal sense of existence is brandished about, a philosopher's sense of being which permits non-existent things to remain extant. But notice that if a set containing Reagan is eternal in this sense then so is the man, he too must be prowling about for all eternity. My feeling is that we cannot let that sort of thing go on. Sets evolve and go extinct. *I* is no better off than a set-theoretic *K*.

The second aspect of the extinction argument is that *K* cannot explain why biologists never place temporally disjunct populations in the same species — kinds are capable of taking on new members, why not include personable post-armageddon populations in *Homo sapiens*.

There are two problems with the argument. In the first place, not all versions of *K* are compatible with resurrection. Secondly, it is not obvious that species cannot be resurrected. Whether or not a version of *K* permits species to be reborn depends on how it is formulated. *K* is compatible with etiological, temporal or spatial restrictions on species. Membership in the kind which includes all and only Proust's works closed forever with his death. More to the point, the view that species are lineages is, unbeknownst to many of its proponents, a *K*-theory, but the membership conditions for lineages guarantee their temporal continuity. Again, by underestimating *K*.s resources, *I*-theorists wind up barking up the wrong tree.

Finally, it is not obvious that species cannot be temporally disjunct. *Galeopsis tetrahit* is an allopolyploid annual herb which arose from the hybridization of *G. pubescens* and *G. speciosa.* It occupies its own niche, reproduces biparentally, and does not backcross. Suppose all the *G. tetrahit* plants and seeds died off but the species was replaced shortly thereafter by further hybridization. Who would deny that *Galeopsis tetrahit* was resurrected ? Indeed, when Muntzing crossed *G. pubescens* and *G. speciosa* in his lab and derived a strain capable of interbreeding with the wild *G. tetrahit*, V. Grant credited him with artificially synthesizing a population of that species.[26]

These two hybrid populations arose from the same parent stock but that does not seem necessary for resurrection. One hypothesis about the origin of viruses is that they arise from the genomes of higher organisms. This is the best explanation of viral origins, according to Campbell.[27] Now consider a recently extinct viral species, e.g., smallpox. If viruses were to arise and proliferate today which were phenotypically and genetically identical to populations of smallpox viruses, then regardless of the sources of the populations smallpox would be a menace once again. There is no biologically potent distinction between the old pox and the new virus. For all we know similar things happen daily to our favorite viruses. It is not obvious, in the natural world anyway, that the dead cannot be raised.

Both followers of *I* and its detractors have said that *I* is incompatible with resurrection. As many philosophers have noticed, however, there are conditions under which individuals can be disassembled and reconstructed. The watch one retrieves from the repair person who disassembles it is not an imitation, it is the same watch. I doubt, however, that *I* is compatible with the viral facts since the species is reconstituted from all new materials (the view that species are lineages is clearly incompatible since the virus's ancestry can change). In any case, our intuitions on the individuation of species do not support *I*-theorist's conclusions. Species may well persist through temporal gaps.

Hull has argued that species must be temporally continuous. He adduces this argument in refutation of *K* :

> [The processes which contribute to the evolution of biological species]... require continuity through descent. If species are to be units of evolution, they need not be composed of similar organisms; instead they must be made up of organisms related by descent... In addition to spatiotemporal continuity, species must also possess a certain degree of unity... if species are chunks of the genealogical nexus, they cannot be viewed as classes. Instead they possess all the characteristics of individuals...''[28]

Hull's argument seems to be this :

(1) Species evolve.
(2) If something evolves it is temporally continuous.
(3) Species are spatially continuous.
(4) If something is spatially and temporally continuous then it is an individual.
(5) Species are individuals.

Premise (4), correctly interpreted, is true. Let's assume, counterfactually, that (3) is also true. (2) is the interesting premise and Hull defends it with the claim that species can evolve only if they are composed of organisms related by descent. Strictly speaking, the claim is false. The frequency of traits in a cohort can evolve if some organisms die. It is sustained evolution which requires reproduction. But still, reproduction need not occur within the evolving group, migration may replenish its stock. It is a population's evolution ***by natural selection*** which requires reproduction — selection operates on fitness differences, differences in reproductive capabilities.

There are still serious problems with the second premise, however. It may be true that temporal continuity is necessary for evolution by selection without its being the case that all the components of evolving species are continuous. The separate members of a species might be each internally continuous while staying mutually discontinuous. The claim that, e.g., *Homo sapiens* evolve, can be interpreted in two ways. On its most straightforward interpretation it is analogous to the claim that America is aging. It attributes changes to the members of a group, in this case, populations. If Hull is otherwise correct populations must be temporally continuous, they are individuals. The other interpretation of the claim is put less misleadingly with the non-standard locution '*H. sapiens* evolves.' The intended proposition is analogous to what would most likely be meant by the utterance 'America is aging' articulated during a bicentential speech. If Hull is right and the second interpretation is correct then *H. sapiens* is continuous hence an individual. But he gives no argument that species' evolution must be understood in this way. If his argument is supposed to undermine *K* then its *modus operandi* is akin to the fallacy of composition. It mistakes properties of the members of species for properties of species. Of course, if *K*'s supporters could not make sense of evolution then the argument would confirm *I*, but they are embarassed by no such inability. To say we evolve is to say that frequencies of traits in *H. sapiens* populations continue to change.

Conclusion

Species are not individuals but there is a germ of truth in that hypothesis. Intuitively, membership in species is restricted in some ways related to *I*. It does not seem, for example, that some multituberculate species would re-emerge if only a rodent population came to resemble it sufficiently closely. And the subspecies rubric is not used for ecotypes, which are unrestricted kinds, but for individual populations or populations in particular areas. It is unclear what the restrictions are, however. Species are discontinuous, but we seem to require conspecific populations to be fairly localized in time and space. *G. tetrahit* can re-emerge, multituberculates can not. Potentially interbreeding contemporaneous populations on earth are con-specific, species composed of contemporaneous Neptunean-plus-Martian forms seem suspect. Thus there seem to be temporal and spatial restrictions on species membership, though species are kinds.

There are reasons to be cautious about these intuitions, however. They could be misleading in two ways. First, when we consider the question of whether species could be unrestricted kinds, e.g., what would an extraterrestrial have to be like to be a tiger, we are entertaining an hypothesis which is wildly improbable. The mere improbability of extraterrestrials evolving so as to be relevantly similar to tigers may foster the feeling that no such things could be tigers. But the improbability of the event does not bear on the question of whether they would be tigers. There may be a type of fundamental particle, for example, whose creation requires such a bizarre confluence of events that only one such particle exists. Nonetheless, a complete fundamental particle physics would cover the properties of that kind of thing. Science deals with the possible as well as the actual.

Secondly, it may be the case that species names in fact denote samples of species on earth while the issue of whether species are unrestricted remains in spirit unsettled. Someone who is enamored of the idea that biology is an historical discipline is apt to view species names as the names of particular groups which have evolved on earth. But the truth of this view would not settle the question of restrictions. For particular species names might denote earth populations while there is nonetheless an unrestricted species-level kind corresponding to each species. The issue does not really concern the semantics of species' names but the requirements of the species category.

If we take seriously the idea that species are groups of populations which exhibit unitary evolutionary roles and tendencies, I think we can begin to see why species are restricted kinds. Let's imagine a group of populations which are perched on some far corner of the universe and whose members are qualitatively identical to tigers (they have roughly the same distributions of genotypes and phenotypes as tigers). The question to be considered is whether there is some sense in which tigers and these extraterrestrials share a unitary evolutionary role and tendency.

Species' evolutionary tendencies were discussed earlier in this paper when the justification of the Biological Species Definition was reviewed. Populations share their evolutionary tendencies or potential by sharing a set of genetic and developmental homeostatic mechanisms (their gene pools are similar), and because of similar selection. If tigers and the extraterrestrials are con-specific they must share a certain evolutionary potential. But there is an important sense in which disjunct populations cannot share a disposition to evolve in any particular direction or set of directions. The problem is that having a certain evolutionary potential is not an intrinsic property of populations. It is true that some aspects of evolutionary potential are intrinsic; e.g., genotypes constrain future evolution by limiting the directions of possible mutation; but constraints arising from the need for coadapted gene pools play a large role. This mechanism, however, operates through *selection* and which selection pressures impinge on organisms, which alleles get screened out, depends on their environments. Populations in different environments must have different evolutionary potentials.

Random factors in evolution compound the problem for disjunct populations. Drift and accidental differences in the direction of mutation help prevent disjunct populations from sharing a set of evolutionary tendencies. In so far as evolution is propelled along a certain course by accident, populations are not disposed to evolve in any particular way. Among populations in similar conditions, however, the centrifugal effects of random events are dampened by migration, interbreeding and similar selective regimes. Thus there is a mechanism by which proximate populations can sustain a unitary tendency in the face of drift. Once again, sharing similar environments is integral to sharing a set of evolutionary tendencies.

If this is right, however, then one might think that populations with both similar gene pools and relevantly similar environments can share an evolutionary potential. One might conclude that the extraterrestrials are tigers provided that they live in environments similar to earth's tigers. But this proposal will not work. The resultant notion of species is too fine-grained. Small differences in genotypes and environments would correspond to distinct species. The differences between populations belonging to distinct species would be biologically meaningless.

The problem of biological meaninglessness can be explicated by analogy to a problem which is often said to plague species considered temporally, viz., fuzzy borders. If the universe were occupied by the multitude of species which is theoretically capable of inhabiting it, contemporaneous species existing in different worlds could be placed in a phenotypic and genotypic continuum. The way in which morphological space, etc., is occupied on earth, hence the gaps between contemporaneous species, reflect historic accident more than any sort of structure inherent in the environment or the hereditary material. According to Simpson, for example, the ecological gap between browsing and grazing horses arose by competitive exclusion.[29] Horses were initially browsers but some horses evolved traits which preadapted them for grazing. That horse population proceeded to scale the grazing adaptive peak. The intermediate niche, part browser part grazer, was inhospitable because the browsing peak was already occupied. Competition made the intermediate niche an adaptive valley. But in the possible ecosystems in which, due to lack of appropriate genetic variation, or lack of plant species capable of supporting herbivores with parochial tastes, or accident, the browsing and grazing peaks are empty, stable intermediate forms are viable. Gaps between contemporaneous species on earth reflect features peculiar to the history of life on earth. If the universe was full of life, stable forms could be imported which connect earth's species in a graded series.

In summary, the hypothesis that species are unrestricted kinds implies that the two quite similar horselike forms, our grazers and the hypothetical intermediates, must be distinct species. Species' evolutionary potentials are tied to their environments — it was not within the power of our horses to occupy the intermediate zone, they cannot be con-specific with any stable intermediate forms. But the ecological, genetic, etc., differences between horses and the intermediates could be quite negligible. If species are defined in terms of genes and environments, their evolutionary potential, the laws of regularities they support are quite specific. No biological cause is furthered by identifying species with such fine grained unrestricted kinds.

The same point can be put in another way. Species so defined fall prey to the defects of the subspecies category. Variation among species would be "clinal." The same facts which Wilson and Brown deployed so effectively against the subspecies category would now defeat the species.[30]

This is not to say that there are no generalizations, or causal necessities, which hold for these finely individuated species. Surely there are. But the naturalness of biological kinds does not depend merely on the causes of biological processes, it has a pragmatic component. The problem with fine-grained kinds can be brought out by relating kinds to explanation. Garfinkle has argued that explanations do more than mention causes, they cite causes which are general.[31] If there was no more to explanation than causation, an adequate biological explanation of why, for example, melanism increased in frequency in *B. betularia* could be given by accounting for the paths of the molecules which comprised the actual moths. Melanism's increase could be explained in this way, but it is not a good evolutionary explanation. Melanistic forms were cryptic, hence they avoided predation. The causally efficacious property of being melanistic is not exhibited by virtue of any single molecular configuration, all melanistic moths are treated in the same way by the relevant selective agent, viz., predation. Selection is indifferent to molecular distinctions between melanistic moths. Explanations in terms of melanism have a generality which molecular explanations lack and that makes them better. We want our theories, our explanatory tools, to be widely applicable.

In sum, if species are unrestricted kinds whose members share their evolutionary tendencies and such tendencies are defined merely in terms of genetic and environmental similarities then distinctions between species are biologically frail, species are not natural kinds (in the sense of theoretically fruitful groupings). But then there could be no theoretical motivation for sorting wildly disjunct populations together in one species.

This argument looks like a *reductio* of the hypothesis that species are groups of populations which share a role and tendency. If that definition makes particular species theoretically sterile groupings, why bother with it ? I set out, however, to justify the intuition that species are spatially and temporally restricted kinds. One might wonder how the two are related. The answer is that the argument shows that I have misinterpreted that hypothesis about the nature of species and the function of species distinctions in evolution. Populations do not share an evolutionary role by having a certain *type* of niche or *type* of habitat. Sharing a unitary role is interfacing with a particular environment as a whole — interacting with the same groups and coadapting with them, responding to pressures as a group. Populations which share roles and tendencies do not merely share a particular range of possible evolutionary futures, they actually evolve along the same trajectory within a particular ecosystem (understood broadly). That is, particular species are used to count particular evolutionary processes or events. Species are spatially and temporally restricted because those processes are localized.

Another way of putting the point is that particular species bear the same relationship to evolutionary theory that particular atoms bear to chemical theory, or particular proletariats bear to political theory. They are the entities which enter into the relationships covered by the theory, they stand at the lowest ontological level relative to the theory. Other authors have come to this conclusion but they have inferred from this that species must be individuals. That inference is erroneous — there is no reason, for example, to think that particular proletariats — e.g., the U.S. proletariat, the Hong Kong proletariat — are anything but restricted kinds.

In conclusion, I have shown that if the Simpson-Mayr conception of the species is approximately correct then each particular species is a kind whose membership is restricted to certain regions and intervals of time. I will attempt no precise definition of species. Our species seem to be world-bound, but they need not be spatially continuous, their members need not actually interbreed. And they need not be temporally continuous, they may be resurrected, but not after the passage of eons or great environmental upheavals. Muntzing could recreate *G. tetrahit* because the new population could interface with the same environment in the same way. Multituberculates are, however, gone forever. Species are the participants in distinct evolutionary processes, not distinct *types* of processes. Such types would have to be too finegrained to be interesting. Our species mark distinct causal channels in the flow of evolution in our ecosystem.

Natural Kinds

Hull has argued that even if species are not individuals they cannot be kinds. He writes :

> "I think I have adduced ample reasons in this paper for concluding that, at the very least, species are not classes. Spatiotemporal continuity [our temporal continuity] is necessary for species to function as units in the evolutionary process. Whether or not spatiotemporal continuity is necessary for something to be an individual it is sufficient for its not being a class.[32]

Since temporal restrictions alone do not preclude anything from being a kind, I take it that what Hull means is that restricted kinds cannot be *natural* kinds, natural kinds cannot be restricted. We owe this doctrine to Positivists' attempts to give a syntactic characterization of laws of nature — natural kind predicates are just the predicates appearing in statements of law, laws are unrestricted generalizations. Positivists were not left with much more to say about laws and kinds given their Humean account of causation. The foundationalist epistemology which motivated Positivism has failed, however. We need not be hindered by their scruples. The view that laws must be unrestricted was the result of a survey of laws of physics — laws are invarient across time and space. From a Realist's perspective, if this is true, it is true because time and place are causally inert relative to the events of interest to physicists. But this situation is not logically necessary. It is not impossible for natural kinds to be restricted, perhaps the laws of physics really change over time or different laws obtain in different regions. Moreover, being natural is a relational property of kinds and if the justification of the view that natural kinds are unrestricted is a certain causal claim then it is not obvious that what is true for physics is true for biology. I think that Hull's claim is unpersuasive.

Restrictions on species membership make salient an ambiguity in the notion of naturalness. In one sense 'natural' means lawful — Positivist's official view is that natural kinds are just the kinds mentioned in laws. But 'natural' also contrasts with 'conventional', the true definitions of natural kinds are discovered rather than stipulated. Now, it may well be that no deep evolutionary truths are peculiar to particular species (and I've argued as much), in that sense they are not natural kinds. But the individuation of species is based on a theory about how evolutionary processes occur. In the sense which contrasts with conventional, species are natural kinds despite spatial and temporal restrictions. A Realist theory of natural kinds could unify these two senses. The Realist's metaphor (which still stands proxy for a theory) is that natural kinds cut the world at its causal joints — their defining properties are causally potent,(hence the relevance of laws); the individuation of kinds and their members is informed by causal structure, their natures are discovered.

Brown University, Providence

NOTES

*I thank Richard Boyd for many helpful discussions, and my audiences at Brown and University of North Carolina where portions of this paper were read.

[1] See Eldredge and Cracraft, 1980, p. 91; Ghiselin, 1974; Hull, 1976 and 1978; and Rosenberg, 1985.

[2] See, for example, Boyd 1973, and Putnam 1975.

[3] Hull writes : species "possess all the characteristics of individuals — tht is if organisms are taken to be paradigmatic individuals" (Hull 1976, p. 174). See also Hull 1976, p. 176.

[4] To avoid confusion the term 'temporal continuity' will stand in for what is often called 'spatio-temporal continuity'. 'Spatial continuity' will denote continuity between contemporaneous parts.

[5] Hirsch, 1982.

[6] Shoemaker, 1979.

[7] Wiggens, 1980.

[8] Ghiselin, 1974.

[9] Mayr, 1957, p. 13.

[10] Dobzhansky, 1951, p. 260.

[11] Mayr, 1963, p. 19.

[12] Mayr, 1970, pp. 329—330.

[13] Muller, 1949, p. 425.

[14] Mayr, 1970, p. 330.

[15] Ehrlich and Raven, 1967.

[16] Simpson, 1961, p. 153.

[17] Mayr, 1970, p. 31; and 1951, p. 381. Simpson, 1961, p. 161.

[18] Eldredge and Gould, 1972.

[19] Hennig, 1966.

[20] It is not clear how the view that species are lineages should be formulated, but the important point for our purposes is that species consist of uninterrupted lines of ancestry and descent.

[21] Phil Quinn suggested this analogy to me.

[22] Hull, 1976, p. 180.

[23] Rosenberg, 1985, p. 207.

[24] Rosenberg, 1985, p. 208.

[25] Kitcher, 1985, makes much the same point.

[26] Cf. note 25.

[27] Campbell, 1983.

[28] Hull, 1976, p. 174.

[29] Simpson, 1944, p. 93.

[30] Wilson and Brown, 1953.

[31] Garfinkle, 1981.

[32] Hull, 1976, p. 190.

REFERENCES

BOYD, R., (1973), *Realism and Scientific Epistemology*, forthcoming.

CAMPBELL, A., (1983), "Transposons and their evolutionary significance", in Nei & Koehn (eds.), *Evolution of Genes and Proteins*.

DOBZHANSKY, T., (1951), *Genetics and the Origin of Species*, 3rd ed., Columbia Univ. Press, New York.

EHRLICH, P., and RAVEN, P., (1969), "Differentiation of populations". *Science*, *165*, 1228—1231.

ELDREDGE, N., and CRACRAFT, J., (1980), *Phylogenetic Patterns nd the Evolutionary Process*. Columbia Univ. Press, New York.

ELDREDGE, N., and GOULD, S., (1972), "Punctuated equilibria; an alternative to phyletic gradualism." In T. Schopf (ed.), *Models in paleobiology*, Freeman, San Fransisco, 82—115.

GARFINKEL, A., (1981), *Forms of Explanation*. Yale Univ. Press, New Haven.

GHISELIN, M., (1974), "A radical solution to the species problem" *Syst. Zool.*, *23:* 536—544.

GRANT, V., (1971), *Plant Speciation*, Columbia Univ. Press, New York.

HENNIG, W., (1966), *Phylogenetic systematics*, University of Illinois Press, Urbana, Ill.

HIRSCH, I., (1982), *The Concept of Identity*, Oxford University Press, New York.

HULL, D., (1976), "Are species really individuals ?" *Syst. Zool.*, *25*, 174)191.

HULL, D., (1978), "A matter of individuality." *Phil. Sci.*, *45*, 33—60.

KITCHER, P., (1984), "Species". *Phil. Sci. 51*, 308—33.

MAYR, E., (1957), "The Species Problem", *Amer. Assoc. Adv. Sci. Publication* no. 50.

MAYR, E., (1963), *Animal Species and Evolution*, Harvard Univ. Press, Cambridge, Ma.

MAYR, E., (1970), *Populations, Species and Evolution*, Harvard Univ. Press, Cambridge, Ma.

MULLER, H., (1949), "Redintegration of the symposium on genetics, paleontology, and evolution", In Jepsen, G., Mayr, E., and Simpson, G., (eds.) (1949), *Genetics, Paleontology and Evolution*, Princeton Univ. Press, Princeton.

PUTNAM, H., (1975), "The meaning of meaning", In Putnam, *Mind language and reality*, *Philosphical Papers*, vol. 2. Cambridge University Press, New York.

RENSCH, B., (1959), *Evolution above the Species Level*, Columbia, Univ. Press, New York.

ROSENBERG, A., (1985), *The Structure of Biological Science.* Cambridge University Press, New York.

SHOEMAKER, S., (1979), "Identity properties and causality". *Midwest studies in philosophy*, no. 4. 321—42.

SIMPSON, G., (1944), *Tempo and Mode in Evolution*, Columbia, Univ. Press, New York.

SIMPSON, G., (1961), *Principles of Animal Taxonomy*, Columbia, Univ. Press, New York.

WIGGENS, D., (1980), *Sameness and Substance*, Oxford Univ. Press, New York.

WILSON, E., and BROWN, W., (1953), "The subspecies concept", *Syst. Zool.*, *2*, 97—111.