# Species, Variability, and Integration

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## 1. Introduction

Different from the visible spectrum, the variation among living organisms does not form a continuum. Because of evolution, life comes discretely organized in clusters called **species**. We refer to these clusters via **species names** such as "*Homo sapiens*" or "*Drosophila pseudoobscura*".

One can pick a particular species name and ask what it refers to. A different kind of question is to wonder what is common between the referents of every species name. That is, one may ask what every single species has in common. This paper is about the latter question. In particular, the main aim of this paper is to assess the answer provided by Boyd (1991; 1999).

Clearly, a satisfactory account of the referent of species names has to capture what is characteristic about species. So before presenting Boyd's view, I discuss two important features of biological species. Firstly, I discuss the extent to which the individual traits within a single species can vary (Section 2). In Section 3 I discuss how this variability is balanced with some integration. Based on those two sections, I derive two desiderata that a satisfactory conception of species should satisfy. Section 4 motivates Boyd's position in face of these desiderata. The last section offers some objections against Boyd's view.

## 2. Biological species and variability

According to **essentialism** concerning species, all and only members of a species necessarily share an intrinsic property.[1] That is, an organism cannot be a member of a species without sharing a certain intrinsic property. This property is commonly known as an **essence**. So, for the essentialist picture, the living world comes in "packages" because (1) every member of a certain species necessarily shares an essence; and (2) different species have different essences. However, despite its explanatory power, essentialism appears to be incompatible with contemporary biology.

As Okasha (2002) points out, the incompatibility between essentialism and biology has empirical and conceptual grounds. On the empirical side, we find examples of species that exhibit intra-specific variability which rules out the possibility of species essences. On the conceptual side, even if all and only the members of a certain species share some intrinsic property, this property does not count as necessary for membership to the species. I now turn to these criticisms.

The essence of a species can be either phenotypic or genotypic features of its members. Let us first consider the case in which essences are taken to be phenotypic.

As mentioned earlier, essentialism can be understood as comprising two assumptions: (1) every member of a species shares the same essence; and (2) different species have different essences. Assuming that essences are phenotypic, there are two sorts of examples of species in biology that go against both (1) and (2). As to (1), there are examples of polytypic species that are immensely diverse in terms of phenotypic traits. One example is the butterfly species *Heliconius erato*. Concerning (2) there are sibling species that are phenotypically alike but are considered as different species because they cannot interbreed among themselves. The fruit flies species *Drosophila pseudoobscura* and *Drosophila persimilis* form such a case.

Now consider the case in which essences are genetic. As before:

> Intra-specific genetic variation is extremely wide – meiosis, genetic recombination and random mutation together ensure an almost unlimited variety in the range of possible genotypes that the members of a sexually reproducing species can exemplify (Okasha 2002, p. 196).

Furthermore, we can have distinct species sharing a considerable array of genes. Thereby, the assumption that essences are genetic is empirically problematic because it fails to single out individual species.

The argument presented above against essentialism is strictly empirical. In face of this, one may argue on behalf of essentialism that the empirical arguments presented above are not sufficient to show that it is *impossible* to find a common intrinsic property among the members of a species. Maybe the failure in finding species essences is just an empirical limitation. Okasha's conceptual argument aims to rule out this possibility. The argument runs as follows. Suppose that every member of a species shares some intrinsic property. In Okasha's view, this shared property still does count as an essence

> For if a member of the species produced an offspring which lacked one of the characteristics, say because of mutation, it would very likely be classed as con-specific with its parents. So even if intra-specific phenotypic and genetic variation were not the norm, this would not automatically vindicate the essentialist (Okasha 2002: p. 197).

To sum up, the argument against essentialism has the following format. First, if we look at species studied in biology, essentialism has no empirical support. It is not the case that, for any species, we can find some trait – be it phenetic or genotypic – that is shared by all and only the members of the species in question. In addition, even if we find a trait shared by all and only members of a species, it does not follow that this trait is an essence because it is not necessary for the species to instantiate it. That is, we may have a circumstance in which a member of the species does not possess the trait in question.

## 3. Biological species and integration

As argued in the previous section, to appeal to intrinsic properties of organisms is not sufficient to demarcate biological species. Hence the individuation of species has to be based on the relational properties of its members and the environment. Contemporary biology provides an array

1 From now on, I will use the word "essentialism" as short for "essentialism concerning species".

of species definitions in terms of relational properties. Such definitions are known as **species concepts**. In what follows, I consider two examples of species concepts: the *Biological Species Concept* and the *Ecological Species Concept*.

According to the Biological Species Concept (henceforth, BSC), species are groups of natural populations that are reproductively isolated from other such groups.[2] An important feature of BSC is its connection with population genetics, because a "reproductively isolated" population forms a gene pool in which gene frequencies vary through gene transfer within the population. Thereby, according to BSC, the stability of a species depends on **isolating barriers** "that would favor breeding with conspecific individuals and that would inhibit mating with nonconspecific individuals" (Mayr 2004, p. 178). Examples of such barriers include habitat isolation or reduced viability of hybrid zygotes.

For the Ecological Species Concept (henceforth, ESC), species are understood as a set of organisms adapted to a particular set of resources – or, a niche.[3] So, according to ESC, species are formed because of how resources are made available in face of selective pressures. The parasite-host relations illustrate this fact (Ridley 2004: 353). Suppose a parasite exploits two host species that have different characteristics such as morphology. In such a situation, the parasites will have different ecological resources and, consequently, they will tend to develop different adaptations that will in turn cause them to form different species.

ESC and BSC are related because gene flow within a reproductively isolated population may develop shared adaptations to a certain niche (Ridley 2004: 353-54). However, there are situations in which these two species concepts conflict. The North American oaks form distinct species despite gene flow among these different species (Van Valen 1976). Furthermore, there are cases of single species that do not exhibit gene flow among its members (Ehrlich & Raven 1969). Another point of conflict is that, in contrast to BSC, ESC permits species with asexual organisms as members.

The point of this section is not to solve the conflicts between BSC and ESC but rather to illustrate what makes species concepts distinct from essentialism. In particular, species concepts do not invoke any intrinsic property to define what a species is. Rather they show how a species is integrated via relational properties of its members like *interbreed with* or *occupy the same niche as*. Unlike essentialism, species concepts are both compatible with widespread variability of both phenotypic as well as genotypic characteristics of the members of a species.

## 4. Boyd's proposal

The goal of this section is to present Boyd's view about species known as *Homeostatic Property Cluster* theory. Based on the two previous sections, I describe two desiderata for a satisfactory account of species. After this, I describe how Boyd's view accommodates these two desiderata.

The incompatibility between essentialism and contemporary biology (Section 2) makes room for the following desideratum:

> *Desideratum I*: It is not necessary that members of a biological species share any intrinsic property.

The species concepts (Section 3) grounds in turn the additional desideratum:

> *Desideratum II*: Every biological species is somehow integrated (e.g., it forms a gene pool, it shares the same niche, etc).

In face of these desiderata, a satisfactory conception of what a species is has to ensure a big range of variability within a species (Desideratum I) despite the fact that species are interconnected via relational properties (Desideratum II). In what follows, I present Boyd's view in face of these two desiderata.

According to Boyd, biological species are natural kinds. Boyd's conception of natural kinds is called Homeostatic Property Cluster (henceforth, HPC) theory. HPC theory comprises, *inter alia*, the following two claims:

> **($C_1$)** There is a family (F) of properties that are contingently clustered in nature in the sense that they co-occur in an important number of cases.
>
> **($C_2$)** Their co-occurrence is, at least typically, the result of what may be metaphorically (sometimes literally) described as a sort of *homeostasis*. Either the presence of some of the properties in F tends (under appropriate conditions) to favor the presence of others, or there are underlying mechanisms or processes that tend to maintain the presence of the properties in F, or both (Boyd 1999: 143).

Different from essentialism, HPC theory does not assume that there is a property that is both necessary and sufficient for membership in a species. For HPC theory allows the existence of species with members that do not share the same single property. Because of this, HPC theory seems to permit enough variability within a species to satisfy the first desideratum.

HPC theory also ensures that species have some integration (Desideratum II) because species are coupled with some homeostasis. A species forms a unit because there is a certain set of properties that tend to co-occur among the species' members.

## 5. Assessing Boyd's position

As stated by ($C_2$), homeostasis may occur in two forms:

> *Homeostasis-I*: some properties of the cluster F induce the instantiation of other properties in F.
>
> *Homeostasis-II*: mechanisms are present that induce the instantiation of properties in F.

In the case of species individuated by BSC, we seem to have these two sorts of homeostasis. The fact that organisms within a species interbreed may cause the species to share some phenotypic trait. Thus the property of *interbreeding with conspecific organisms* would induce the instantiation of the property *to share some phenotypic trait* (Homeostasis-I). As an instance of Homeostasis-II, one

2 See Mayr (1970).
3 For a more detailed definition of the ecological species concept see Van Valen (1975).

could mention the many sorts of isolating barriers (Section 3) that prevent gene flow between distinct species (Wilson *et al.* forthcoming). Despite its apparent plausibility, the goal of this section is to present an objection against HPC theory.

The properties in the cluster F can be either intrinsic or relational. According to the conceptual argument against essentialism (Section 2), no intrinsic property may count as necessary for membership in a species. But the same argument is also effective against Boyd's finite disjunction of intrinsic properties.[4] For if Okasha is right, there is no boundary on the variation of individual traits among the members of a species. Thus, if the cluster F contains intrinsic properties, then given the rejection of essentialism F could not exclude any phenotypic or genotypic trait. If it did exclude such a trait, F would entail that not having a certain property is necessary for membership in a species. But this consequence cannot be right because F would then not single out individual species. To make this clear, consider an example. Suppose an unbounded disjunction of intrinsic properties $P_1 \vee P_2 \vee \ldots$ and objects *a* and *b* both containing $P_1$ and $P_2$. Are they both members of the same species? As the disjunction is unbounded, the disjunction by itself cannot decide this question. Therefore, if we accept the conceptual argument against essentialism, F cannot contain intrinsic properties and so *F can only contain relational properties.*

Now let us move to the second kind of homeostasis (Homeostasis-II). As mentioned earlier, isolating barriers between species seem to count as Homeostasis-II. An important feature about isolating barriers is that they are evolved characters between two species – e.g., courtship. Since isolating barriers are evolved characters, they are analogous to phenotypic/genotypic traits: they not only can vary through time, but also there is no boundary to such variation. In contrast, non-interbreeding caused by geographic separation is not considered as an isolating barrier because it is not an evolved character (Ridley 2004: 355).

But if the previous paragraph is correct, we can extend the argument used above against Homeostasis-II. A finite disjunction of isolating barriers cannot single out a species. Otherwise, we would have to accept that there is some a priori impediment to how isolating barriers between two species can evolve. Hence, *species cannot be distinguished via Homeostasis-II*.

I have drawn two conclusions so far: (i) F can only contain relational properties; and (ii) species cannot be distinguished via Homeostasis-II. Because of (i) and (ii) it follows that, if species are HPC kinds, then they are a cluster of relational properties where some of these properties induce the presence of others (thereby, intrinsic properties and Homeostasis-II are both excluded). If I am right about this, when applied to species, HPC theory collapses into a theory that is no more explanatory than the species concepts themselves. Boyd's theory can only state that some relational property such as *interbreeding with con-specifics* induces other relational property like *belonging to the same gene pool as*. So, although the notions of homeostatic mechanisms or cluster of co-occurring properties seem to carry some additional explanatory power, I tried to show above that these notions are irrelevant to comprehending what a species is.*

## Literature


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4 See Ereshefsky and Matthen (2005), p. 9.

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