Natural Kinds Problem for Genetics

Mamula, Mateo

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(DIPLOMSKI RAD)

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Diplomski studij: Filozofija i Anglistika

Mentor: Prof. dr. sc. Predrag Šustar

Komentor: Dr. sc. Zdenka Brzović

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Abstract and key words

This paper presents the idea that biological species are natural kinds. Natural kinds represent a sort of a privileged way of grouping entities into classes based on some objective properties. Different views give different insights into what those objective properties are, but all recognize that they must be objective in some sense. Views that vary in their strictness of requirements for natural kinds permit different groups to be natural kinds. Chemical elements are the paradigm examples of natural kinds that follow the strictest requirements, meaning that they have a certain property that is enough to explain their membership of the kind. The property in question is their atomic number. However, finding such a property for biological species is not an easy task. We do not know what the 'atomic number' for biological species is, if it even exists, but regardless, we may assume that it does exist. It seems intuitive that the solution for this should be found in genes, however, it is generally accepted by philosophers of biology that genes cannot be the property that explains biological species membership in the sense in which the atomic number can explain the membership of chemical elements. Nonetheless, attempts are still being made to undermine this consensus and show that genes are an essential property of biological species.

Key words: *natural kinds, biological species, genes, essence*

1. Introduction

This paper looks into the idea of biological species being natural kinds and how it interacts with the knowledge genetics provides us with. The discussion within the philosophy of science can introduce us to different views of what natural kinds are and what can therefore be a natural kind. My main goal is to show that biological species are natural kinds, and that genes are the reason for this

In the first section I will introduce the idea of natural kinds and talk about features of natural kinds which are important for our better understanding of them. The section is meant to provide general knowledge of natural kinds, after which I will introduce the three most prominent views on natural kinds and provide them with examples in order to make them as clear as I can. The three views are called *essentialism, cluster kinds* and *promiscuous realism*, all of which are important for the idea of biological species being natural kinds and will serve us as a great introduction into this philosophical discussion. After I present these three views I will briefly introduce an idea in which species can be ontologically conceptualized in an unintuitive and non-common-sense manner. The so called *species as individuals* conceptualization can be applied at any point in this discussion because when we discuss natural kinds it will not matter which conceptualization we have in mind. However, it will be mentioned because it offers view of species which might better explain the species relation to natural kinds.

Following this, I am going to discuss genes and what we know about them thanks to the scientific field of genetics. As genetics studies genes it shows us how genes affect organisms' traits, and I take the 'affect' to mean 'cause', which is why I will describe the genocentric view which holds that genes have the most important role in defining organisms and evolution. This is not a universally accepted view, so in the final section I will show the problem that arises when one tries to claim that genes should be the basis for biological species being natural kinds. Finally, I will attempt to provide a solution to the problem by discussing a theory by the philosopher Michael Devitt.

At least some understanding of genes is known to every person that has no connection to the scientific fields of biology or genetics. It is because of this that it is commonly believed that genes make us what we are, at least to a significant degree. Philosophers and biologist, however, do not generally agree with this opinion because they deny that genes have this much explanatory power over organisms. We will see why this is so before we attempt to refute them.

2. Natural kinds

Let us begin by introducing the idea of natural kinds. I find it necessary for the reader to understand this concept before delving deeper into this paper’s main focus, so this section will be a more general introduction into natural kinds.

To best explain the meaning of natural kinds in philosophy and its relevance in science, we should ask ourselves the following question; how do we group things together? When we talk about objects that we perceive to be sufficiently similar, we tend to see them as members of the same group, or rather we classify them as belonging to the same class or category, or to be of the same kind. For example, if we see a golden retriever and a Siberian husky, even if we do not know what breed they are, we group them together and call them dogs. They are similar enough for us to see them as members of the same class, but they are different enough so that we know that they belong to separate kinds of dogs. Based on this example we can see three different groups: dogs, golden retrievers and Siberian huskies. This is one way we group objects together and it helps us to make sense of the world since it tells us something about the entities we grouped together. This way of grouping also works for other entities whether living or inanimate (for example different breeds of cats, or objects that we call tables no matter what material they are made from). We also classify dogs as mammals, a group whose members include other species, such as cats and even us, who seem to be quite different from one another, but due to some shared characteristics this kind of grouping makes sense.

These are just a few types of classifications I have mentioned, but being that there is an infinite number of possible ways to classify objects in this world we can ask ourselves whether there are special categories or kinds that are privileged among the rest. For a classification to be privileged it would have to have certain elements that make it stand out from the rest. If we have two different classifications one of which is subjective and has a noticeable element of arbitrariness, and the other that is objective and non-arbitrary, it stands to reason that the latter would be privileged when compared to the former. For example, classifications such as dogs and spiders seem objective and they can give a lot of information about the entities that comprise them, however, on the other hand, we could group both dogs and spiders (and many other species) together and classify them as “animals we can keep as pets”. The “animals we can keep as pets” classification clearly reflects our interests, making it seem subjective, and the only piece of information this classification yields is that these animals can be kept as pets. If there truly are objective classifications in our world they should not be in relation to us, meaning they should not reflect our interests, and they should be discovered scientifically. We may assume that in our world there exist these special privileged classifications, and that we have to find them instead of creating them ourselves. In philosophy, these special privileged categories are called natural kinds (Brzović 2018, 1).

If natural kinds are indeed privileged, then there has to be a reason for them being privileged. As we attempt to discover and demystify our world, we do not randomly group objects together hoping that at some point we will learn something. As I have stated, we tend to group together objects that seem sufficiently similar to us, and based on this kind of grouping we increase our chances of finding proper knowledge of the world, or at least knowledge about the objects belonging to the group that we might find useful. The way we classify these objects has to come from our observation of the world, where we should find natural divisions, which will allow us to make claims of natural kinds. This can perhaps best be explained by Plato’s words when in Phaedrus he writes that one should be able to: “divide into forms, following the objective articulation; we are not to attempt to hack off parts like a clumsy butcher” (Plato 1952, 265e). What is meant by this is that both a bad and a competent butcher might find themselves in a situation where they have to cut meat into pieces, but the way they cut the meat will not be the same. A bad butcher will cut the meat as best he can, but the competent butcher, who knows his trade, will know where the meat should be cut due to its natural divisions, regardless of any other way he might want to cut it. A competent butcher knows where the muscle of a hind leg of a pig is and will cut along its edges to get a perfect piece, whereas someone like me would most certainly cut through the muscle because they would not know where the division between the muscles is. This is exactly how we have to treat our world in order to find natural kinds, like the competent butcher cutting meat according to the divisions that are presented to him rather than the divisions that he might want to impose himself. The world should show these objective natural divisions that we can discover, and once they are discovered we will be closer to knowing what is or is not a natural kind.

However, it is not so easy to say how we can identify these natural divisions with certainty, and what we can therefore say is a natural kind. One possible solution to this problem of finding natural divisions in nature is posed as follows:

> One good place to look for them would be in the discipline of particle physics because it appears that, if there are some objective divisions in nature, they will surely be found at the level of fundamental entities that comprise all existing things: protons, neutrons, electrons, or even smaller particles like quarks. (Brzović 2018, 2)

Surely this seems like valid reasoning, and yes, we should be able to find natural divisions at the level of fundamental entities, but that does not mean that this is the only place where we could find them. Some might argue that we should only look for natural divisions at the level of fundamental entities, but others will argue that this view is too restrictive, and would therefore dismiss any candidate for a natural kind that is above the level of fundamental entities. This view would also greatly discredit scientific fields other than particle physics because of the lack of validity in their categorizations, as they do not focus on the fundamental entities in their research. Take for example, geology, which Samir Okasha uses when explaining the importance of classifying of the objects under study into distinct kinds, or types, where he says the following:

> Geologists classify rocks as igneous, sedimentary, or metamorphic depending on how they were formed. Part of the point of classification is to convey information. If you find a rock and a geologist tells you it is igneous, this tells you a lot about its likely behavior. So a good classification scheme should group together objects that are alike in important respects, and which are thus expected to behave similarly. (Okasha 2019, 63)

Clearly there is merit to the classification of rocks in this way, because by knowing what kind of rock we have, we have access to the knowledge about the rock. Even if these rocks are not fundamental entities, it seems that the divisions between them are natural. It seems then that not only fundamental entities must be natural kinds.

Even if we restrict natural kinds to the fundamental entities, we may still have problems in defining the proper classification, because, as Okasha says: “For example, fundamental particles can be classified by their spin instead of their mass, which yields division into two types: bosons and fermions” (Okasha 2019, 63). How should we decide on which way is the proper way of classification when there can be more than one that has seemingly valid reasons to be natural? Should there only be one way? In the next subsection I will deal with these questions by introducing the views of natural kinds *monism* and *pluralism*, monism claiming that there can be only one proper way of classification whereas pluralism supports the idea of there being more than one proper way of classifying entities into natural kinds.

2.1. Natural kinds monism and pluralism

We see in Okasha’s last example that fundamental particles can be classified by their spin, or by their mass, which means that we have at least two ways of classifying them. If we are a natural kinds monist, then we believe that there is only one valid way to classify objects into natural kinds, meaning that at least one of the ways of classification in this example must be invalid (if any of them is truly valid). If we suppose that classification according to mass gives us a natural kind, then the classification according to spin is not a natural kind. However, if different kinds happen to overlap, then a natural kind monist can assume that one kind is a sub-kind of the other, thereby forming a hierarchy. For example: “The isotopes of hydrogen, for instance – protium, deuterium and tritium – can be said to constitute a sub-kind of the kind hydrogen” (Brzović 2018, 3). Protium, deuterium and tritium vary in the amount of neutrons they have, but this only makes them isotopes of the kind hydrogen, rather than separate kinds on their own. A particularly illustrative example for this kind of hierarchical structure of classification is the Linnaean system in biology, which Okasha describes as follows:

> First, each individual organism is assigned to a *species*. Next, each species is assigned to a *genus*, each genus to a *family*, each family to an *order*, each order to a *class*, each class to a *phylum*, and each phylum to a *kingdom*. The species is thus the base taxonomic unit; while genera, families, orders, etc. are known as 'higher taxa'. To take an example, my pet cat belongs to the species *Felis catus*, which along with a handful of other small cat species makes up the *Felis* genus. This genus itself belongs to the family Felidae, the order Carnivora, the class Mammalia, the phylum Chordata, and the kingdom Animalia. (Okasha 2019, 64)

A natural kind monist believes that there is only one natural categorization of objects which must apply to the lowest possible level of classification, and in the Linnaean system example the *Felis catus* or the "pet cat" represents that lowest level. All the "pet cats" and other entities such as lions, leopards and tigers represent the smallest units in nature that we further categorize as "cats", referring to the family Felidae, and they are therefore considered candidates for the natural kind "cat". However, cats are also categorized as mammals, which Okasha explains is a "higher taxon" that is comprised of a lot of other beings that differ greatly from cats, which means that a pet cat belongs to at least three groups. If "mammal" is indeed a natural kind, then because it is a higher level taxon (it is comprised of a lot more entities than cats) a hierarchy must form in such a way that "cats" and "mammals" are sub-kind and kind, but they absolutely cannot both be natural kinds on equal grounds. If higher-level natural kinds exist, a hierarchy must form and the hierarchy must bottom out at the lowest level (Brzović 2018, 3).

On the other hand, a natural kind pluralist allows for various possible classifications to be natural kinds. For example, a species and a genus from the Linnaean system can be viewed as equal in validity for being natural kinds, rather than one being a sub-kind of the other. In the same way, classifications of a cat being a carnivore and a mammal can be considered to be separate natural kinds, without one being more valid than the other. Allowing for more natural kinds also means that different kinds overlapping is not an issue for the natural kind pluralists, as it is for the monists. Also, pluralists could form hierarchical structures with natural kinds, but unlike the monists, they need not do so (a species and a genus need not be viewed as subordinate and superordinate, meaning a species does not need to be a sub-kind of the kind genus). A classification is valid if it is useful in our scientific investigation, or in other words, if I want to know what a cat eats, it being a carnivore is much more informative to me than it being a mammal is because the category "carnivore" carries information about the animal's preference for eating meat, whereas the category "mammal" does not directly imply this, because there are mammals that are not carnivores. Based on this we can see how different classifications serve different purposes, which is why pluralists allow that there can be more than just one natural categorization. In the next subsection I will present what is thought to be needed for natural kinds membership, which will be helpful for understanding the natural kinds relation to biological species that is going to be discussed in later sections.

2.2. Requirements for natural kinds

It should not come as a surprise that there exist differing views on natural kinds, being that it is a philosophical concept. However, even though they may greatly differ from one another, they all begin with the same idea of what should be a minimal requirement for natural kinds. To be classified as a natural kind, all the entities comprising this kind must share a certain set of common properties. The entities are grouped together based on these common properties, and the groupings should not be accidental. These shared common properties of a natural kind do not have to be directly observable.

To clarify this I will present some examples that show groupings that are based on common properties which are directly observable and those which are not directly observable. If we look at a golden retriever, we will notice a medium sized dog with golden fur, a wide head with a black nose, and an overall gentle appearance. After seeing more golden retrievers we notice that they share these properties so we assume that they form a discrete group and we assume there is a cause for this. We see that if a golden retriever mates with another golden retriever their offspring will show properties of their parents, after which we assume that they belong to the same species. Once we believe that these golden retrievers belong to the same species we observe their behavioral and mating habits, and if our beliefs are correct we can form predictions based on what we observed in the past and expect that future golden retrievers will show properties of their parents. Knowing that golden retrievers show these properties when they produce offspring with other members of their own species we may conclude that the cause of these common properties is golden retrievers having a shared ancestry. This example shows grouping that is based on directly observable properties since it is based on the physical and behavioral properties of the entities that we can notice.

On the other hand, chemical elements can be used as an example for grouping entities based on common properties that are not directly observable. This is because chemical elements are grouped together based on their atomic structure. The atomic structure is what causes elements to be classified into separate kinds. Take carbon, for example, which comprises both graphite and diamonds. Directly observing graphite and diamonds would have us believe they are completely different objects, but in fact, they are made up of the same material, namely carbon atoms, which is something that is not directly observable. Even though directly observed they show very different properties, they actually have an important shared property, which is their microstructure (Brzović 2018, 4). Only after we discover the microstructures of graphite and diamonds can we conclude that carbon is the essence of the two vastly different products. The essence refers to what is commonly considered an intrinsic property or structure that is necessary for an entity to be the kind of entity that it is. Thus carbon needs to possess the specific atomic number in order to be of the kind "carbon".

These two examples can show us the merit of having such categorizations in our exploration of the world. The more we encounter members of a certain species the more we learn about them, and therefore, the more we can predict about them if we encounter them in the future. Such knowledge is important in science because categorizing things into natural kinds can eventually lead to discovery of scientific or natural laws, or it can just give us plain explanations and inductive inferences regarding certain information. A great example of this is provided by Zdenka Brzović:

> Our previous encounters with sunflowers, for instance, allow us to infer some properties and behaviors related to this species, such as that they grow best when exposed to plenty of sun, in fertile, moist and well-drained soil; that they can be used to extract some toxic ingredients from the soil, such as arsenic or lead, and so on. Establishing the existence of stable, clustered properties associated with sunflowers thus underpins the inductive inference that future observed instances of this kind will also share some or all of those properties. (Brzović 2018, 4-5)

Such knowledge is important and very useful, and it makes it easier to cultivate our own sunflowers were we ever to attempt it. In the same way, if we are looking for a good pet or a good guide dog, our previous encounters with golden retrievers would lead us to believe that they would be a good fit due to their temperament, gentle nature and their ability to learn quickly. That they are still being trained as guide dogs shows that they still share the properties that we know they had in the past, and we expect they will have in the future. Thus we see how natural kinds not only group together entities that appear to be similar enough because they share certain common properties, but also carry information about the entities which can explain certain phenomena in the world. Furthermore, natural kinds allow us to make inductive inferences based on the information they carry, which is the reason why we can expect sunflowers and golden retrievers to behave the way they do, knowing what we know about them from our past observation of them.

We can see now why natural kinds could easily be associated with science with all this talk of explanations, inductive inferences and predictions, but based on what was just discussed, another type of kinds needs to be mentioned. If natural kinds are so important in science because their explanatory power and the scientific inferences that they produce validate them, then, maybe *functional kinds* can also be natural kinds, and this is the idea that I will discuss in the following subsection.

2.3. Functional kinds

So far we have established that to be a natural kind, the entities comprising the kind need to share some common properties. To be a functional kind, the entities comprising the kind need to share, as the name suggests, common functions. Functional kinds can therefore be comprised of vastly different entities, so long as they have the same function. Showing examples of functional kinds are predator and prey. The predator is a category that is comprised of all sorts of species, which includes lions, sharks, alligators and even humans to mention just a few. All of the mentioned species can also comprise the prey category, but even though they are different species and they do not appear to be similar, it is due to what they do (their function) that we group them together in the same functional kind.

In the example above we see that biological kinds can be functional kinds, and in the following example we will see how artifact kinds can be functional kinds as well. To represent an artifact kind we can use a knife, and as Brzović writes: "…very different kinds of things can be used as a knife, from a piece of a sharp stone or glass to steel blades specifically manufactured for cutting food" (Brzović 2018, 6). It is not due to a common underlying property that we name all these objects knives, because we can easily find the differences that make them dissimilar enough to be considered different things. But it is their common function that unites all these objects into the same kind. Okasha provides an example with a desk that can further clarify this:

> The desk in my office has a glass top and steel legs. So the two parts of my desk – the top and the legs – are intrinsically unalike. But that does not prevent them from being parts of a single thing. Moreover, even if they *were* intrinsically alike, for example if both were made of steel, it would not be in virtue of this that they constitute parts of the same table. (Okasha 2019, 74)

The intrinsic properties of the table are not important so long as the object functions as a table. Thus we see that no matter what an object is made from, as long as it functions as a table it is a table according to the functional kinds idea. Not only can different tables be made up of intrinsically different materials, a single table can also be made of intrinsically different constituents (steel and glass) and still function as a table. I should mention that Okasha did not use this example to talk about functional kinds, rather he uses it to discuss the *species-as-individuals* idea, which I will talk about later in this paper. Nonetheless, the example is useful for this discussion as well.

One more example of functional kinds that should be mentioned is the mental kind pain. We may assume that all animals, as well as humans, can feel pain. In this case pain is something we all have in common, however, if we try to reduce pain to the paradigmatic physical kinds, we will encounter a problem. The problem arises from the fact that humans and animals have different neuropsychological structures, meaning that pain can appear from different origins. Brzović describes this as follows:

> If pain can be realized by different physical states, however, then it seems that pain could only be a "widely disjunctive" and disunified kind, in the sense that in humans it is realized by one set of neuropsychological states, in squids by another, in snakes by still another set, and so on and so forth for different species. (Brzović 2018, 6)

Thus if pain can be realized through various neuropsychological states depending on the species that present them, it seems that it would be incredibly difficult (if at all possible) to reduce pain to the paradigmatic physical kinds. This example, as well as the ones before, shows a feature that functional kinds possess, which is called the multiple realizability of functional kinds. Roughly explained, it means that a functional kind has the ability to be realized through different types of things, so as I have said, both lions and sharks can be predators even though they are different enough to be considered different species. In this case, when we talk about pain as a kind, we talk about something that functions as pain rather than something that has the essence of pain, which makes pain a functional kind.

Some argue that functional kinds are not natural kinds, for we can see how disunified this kind would be if we were to attempt to reduce it to paradigmatic physical kinds, if that is even possible. However, others argue that because functional kinds can have an important role in scientific explanations in certain scientific fields that they should not be disregarded as natural kinds so easily. However disunified pain as a kind may seem, it has an important explanatory role in the scientific field of psychology. As the igneous, sedimentary and metamorphic rocks play an important role in geology, so does pain play an important role in psychology, and therefore we might consider pain to be a natural kind. Thus some argue that functional kinds might be viewed as natural kinds due to their use in scientific explanations.

With functional kinds having been discussed I want to conclude this general introduction into natural kinds. With the understanding of the basic ideas about natural kinds we can enter a deeper philosophical discussion about natural kinds in the following section, in which we will be introduced to the idea that biological species are natural kinds. The discussion will no longer be focused on general ideas of natural kinds, rather it will be aimed at some of the most well known views and how natural kinds are perceived by them. Each view will help us to understand how biological species are viewed in relation to natural kinds.

3. Different natural kinds views

I am going to continue the discussion about natural kinds by presenting the following three views, which are called *essentialism, cluster kinds* and *promiscuous realism*. I mean to present them in the order written above because the essentialist view has the strictest and the clearest requirements for what a natural kind is, after which we will discuss the more lenient views starting with the cluster kinds and ending with the promiscuous realism, promiscuous realism being the most lenient of the three views. As I go through the views I will accompany each with examples to make their ideas clearer for the reader. Essentialism will thus be accompanied with the examples from chemistry, while cluster kinds and promiscuous realism will be accompanied with examples from biology, which is how we will get introduced to the idea that biological species are natural kinds. After I describe the views I mean to present a conceptualization of species that is different from the intuitive which goes by the name *species as individuals*. This conceptualization is not a natural kinds view, but a way in which species might be viewed, which can be put into the discussion of species being natural kinds. So without further ado, let us begin the discussion on essentialism.

3.1. Essentialism

As the name suggests, according to essentialists, to be a natural kind the entities being grouped must share a common essence. An essence is typically thought to be an intrinsic property or structure of the entity in question, which is shared only by other entities of the same kind. The essence being an intrinsic property means that the entity possesses the essence in virtue of itself, or rather, that it is not in relation to anything else. For example, if a snake is intrinsically venomous, then it is not venomous because it is venomous to us, it is venomous because its essence causes it to be venomous. It would be venomous even if we did not exist. Such essences can only be discovered empirically, through scientific research, as Brian Ellis tells us that;

"Specifically we have to discover what sets of intrinsic properties or structures are required to constitute things of these kinds" (Ellis 2008, 139).

It needs to be stressed that the common essence is possessed only by the members of the same kind, meaning that an essence belonging to the kind X will not be found in the kind Y, nor any other kind that is not kind X. Possessing the essence belonging to the kind X makes the entity a member of the kind X, and it prevents it from being a member of any other kind. Ellis has a straightforward clarification of what I have written so far:

> To explain the existence of these natural kinds, essentialists postulate that the sources of the relevant similarities and differences are intrinsic, i.e. independent of circumstances, and independent of human knowledge or understanding. Things of the same natural kind are supposed to have certain intrinsic properties or structures that together explain their manifest similarities, whereas things of different natural kinds are supposed to be intrinsically different in ways that adequately account for their manifest differences. (Ellis 2008, 139)

As I have already said, the intrinsic properties or structures are the essences of natural kinds, and in what Ellis has written we can also infer that essences hold the explanatory power, because, in the essentialist view, ultimately the essence; "causes and explains all other observable shared properties of the members of a kind and allows us to draw inductive inferences and formulate scientific laws about them" (Brzović 2018, 9). Thus, if we discover that a certain entity possesses a certain essence we can learn what natural kind the entity belongs to and what properties the entity is going to show. This kind of essence will be important in later sections when we start to discuss the idea that biological species have intrinsic essences.

The most commonly used examples to explain natural kinds by the essentialists are chemical elements. This is because they are the seemingly perfect entities to capture the strict requirements of essentialism, and is the reason why I will also use them to illustrate the points of essentialism. To begin with, I am going to quote Ellis in saying that:

> Every distinct type of chemical substance would appear to be an example of a natural kind, since the known kinds of chemical substances all exist independently of human knowledge and understanding, and the distinctions between them are all real and absolute. (Ellis 2008, 140)

That the chemical elements are distinct means that there are clear divisions between one chemical element and another. This makes chemical elements discrete natural kinds, because we can tell precisely where one element ends and another begins. There are no smooth transitions from one chemical element to another so we do not have to decide where the borders should be drawn. Rather it is the elements themselves that show those borders to us. These divisions between the chemical elements were discovered due to scientific research and are realized in the fundamental structures of the elements which the elements possess regardless of our intentions and awareness of their existence. Thus, the order in which the chemical elements are sorted comes from nature, not from our interests, and because of this we do not need to regulate the order by imposing artificial distinctions between them. The chemical world, as Ellis says; ”gives every appearance of being a world made up of substances of chemically discrete kinds, each with its own distinctive chemical properties” (Ellis 2008, 140).

The distinctions between chemical elements are found in their atomic structure. This is something that is not directly observable to us, but thanks to scientific discoveries we now know that the hydrogen atoms are composed of one proton in the nucleus and one electron in the atomic shell. Thus, because there is only one proton in the nucleus the atomic number of hydrogen is 1. Were we to find two protons in the nucleus of an atom we would know that the atom belongs to helium, whose atomic number is therefore 2. There are no two chemical elements that share the same atomic number so based on the atomic structure we can precisely differentiate between the elements of the periodic table. Therefore, if an atom has the atomic number 1, which is the essence of the kind hydrogen, then it belongs to the kind hydrogen and only to the kind hydrogen. It cannot be anything other than hydrogen, and any other atom that has an atomic number that is not 1 cannot be hydrogen but has to be something else.

According to essentialism, now that we know that the essence of a chemical element is its atomic structure, we know what it is that causes and explains the observable properties of the kind (element) it belongs to. Therefore we can make claims such as:

> The structure of hydrogen atoms determines the bonds it can form with other entities and compounds, such as the molecular structure of the chemical compound H_2. These molecular forms then determine other properties of hydrogen, such as its colorlessness, odorlessness, tastelessness, and high combustibility at normal temperatures. They also account for its prevalence in molecular forms, such as water and organic compounds, because it has a disposition to form covalent bonds with nonmetallic elements. (Brzović 2018, 10)

In the same way that the atomic structure of hydrogen explains all of these properties, the atomic structures of other chemical elements explain their properties. Thus, the atomic structure of carbon will explain why carbon can form both graphite and diamonds even though these two substances seem vastly different.

Since we have established that possessing an essence means that an entity belongs to only one kind according to essentialism, then we can predict that typically essentialists will support a monistic view on natural kinds. Even if essentialists claim that there is only one valid way to classify the world, if there happen to be overlaps in categorizations, as long as they can be ordered into kinds and sub-kinds, they can accept hierarchically structured natural kinds. I have already mentioned an example with the isotopes of hydrogen, which are different due to the number of neutrons they possess, to show that they can be classified as sub-kinds of the kind hydrogen. There are clear divisions between these isotopes so one might claim that they all represent separate natural kinds, but if the atomic number of hydrogen is the essence of hydrogen, then it explains how all of the isotopes actually are instances of a single natural kind (hydrogen) because they all possess a single proton in their nuclei. However, there could be another way to classify chemical elements that seems plausible since it also appears to follow some essential properties. This other classification would create a different system of elements that form natural kinds because:

> If we focus on patterns of radioactive decay and the stability of elements undergoing decay, then chemical elements can be classified in a way that crosscuts standard classification as captured by the periodic table. (Brzović 2018, 11)

Such a classification can be used in nuclear physics and would certainly be different to the standard at least because of the fact that different isotopes of hydrogen vary from stable to unstable, meaning that hydrogen isotopes become natural kinds rather than sub-kinds of hydrogen. If an essentialist claims a monistic view on natural kinds, then he must either decide which classification is valid or state which one is a sub-kind to a kind.

Here we begin to see where the problems start to appear for essentialists. If we are presented with several ways of classification, each of which seems equally valid, how do we decide which of the classifications is truly valid? We could claim that natural kinds are pluralistic which allows for more classifications to be valid, but this means that essentialism loses the strictness and preciseness which are considered to be its greatest aspects. Let us suppose that both the classification of chemical elements according to their atomic mass and the classification according to patterns of radioactive decay give valid natural kinds. This implies that chemical elements can have more than one essence. If different essences determine different kinds then they also carry different information. In this case knowing the essence of an entity does not grant us complete information about the entity being observed. The essence would only give partial information about the entity. It could then be possible that the colorlessness of hydrogen is caused by its atomic number, while its stability is caused by the number of protons and neutrons it possesses. Both essences carry only specific information. Which essence is important is determined by the observer's interests.

But let us suppose that the periodic table is the only valid classification of the world into natural kinds as many essentialists claim. The periodic table is a classification on the fundamental level of entities, but what can that tell us about more complex phenomena? We know that water is comprised of hydrogen and oxygen. If the atomic structures of these two elements cause and explain water's properties, then water seems to have two essences. In this case essentialists can claim that water is not a natural kind so there is no point in talking about its essence. Essentialists tend to support the idea that only the entities at the fundamental level can be classified into natural kinds, thus water cannot be a natural kind in this sense since it is not a fundamental-level entity. However, let us say that higher-level entities can be natural kinds that have their own essences. We could then say that the essence of water is H_2O molecular structure, having discovered the molecule of water. Now we are faced with the problem of describing how the essence of a higher-level entity explains and causes all the observable properties of the entity. Technically, we cannot say that molecular structure of H_2O causes and explains water because: "Water is more accurately described as containing H_2O, OH^-, H_3O^+ and some other less common ions" (Brzović 2018, 11). Water still appears to have its properties because of hydrogen and oxygen, but it is not as simple as saying that H_2O is its ultimate cause. On the other hand, if we look at a piece of graphite which is composed entirely of carbon atoms, we can point to the carbon atom as its ultimate cause, and no matter how much we try to divide the piece of graphite we will get only carbon atoms. Considering H_2O is not the only structure found in water, this cannot be expected of water. This is not to say that water should not be a natural kind, but to show the shortcomings of essentialism when it comes to classifying higher-level entities. We know a lot about water, we just cannot easily pinpoint its essence.

Essentialism thus seems to only be compatible with fundamental sciences like chemistry and physics which study the fundamental entities. I have mentioned that water is problematic for essentialism because it seems like a rather simple specimen of the higher-level entities. What I mean by that is that it is comprised of only two chemical elements that are accepted to be natural kinds. One can only imagine how much more problematic more complex entities are for essentialists, especially living entities that are subject to change. For example, biological species are standard examples of natural kinds in philosophy of biology, but according to essentialism there is currently no way for us to say what an entity needs to have in order to be a dog or a cat. Higher sciences like biology that deal with higher-level entities provide us with vast knowledge about our world, so they warrant a different view on natural kinds to explain the existence of higher-level natural kinds. Either essentialism needs to loosen up its strict rules, or a different idea needs to take its place. One such idea is called *cluster kinds* and will be the focus of the next subsection in which we will be introduced to the idea of biological species being natural kinds.

3.2. Cluster kinds

Natural kinds imagined as cluster kinds allow for a lot more classifications to be considered natural. This is due to the fact that members of the same kind do not have to share an essence. What is needed for a natural kind is that the entities that comprise it; “Share some subset of properties that tend to cluster together due to some underlying common causes” (Brzović 2018, 13). Therefore, even though we do not know what the essence of a golden retriever is, it is enough that entities called golden retrievers share certain observed properties that are repeated continuously due to shared ancestry that we can consider this classification natural. However, the importance of the common causes of the clustering properties needs to be stressed. If we only look at common properties we might end up with some odd classifications that even non-philosophers and non-scientists would think are not natural. For example, certain biological species are incredibly adept at mimicry, one of them being the hummingbird hawk-moth which is a moth that behaves and looks surprisingly similar to the hummingbird that it mimics. These two animals could be mistaken for being the same species, but upon closer inspection we can discover differences which ultimately sort them into separate species, one being a bird, the other a moth. Even though they seem to share some properties, they either do not share enough properties to be the same kind, or the properties they share are not the product of the same underlying causes and therefore are not of the same kind. Thus, the clustering properties need to be explained by common causes.

Another characteristic of the cluster kind approach is that it does not require the strict divisions between natural kinds that essentialism requires. Biological species are commonly used as representatives of natural kinds as bearers of clustered properties, so it is not by chance that I also decided to mention biological species in the discussion of cluster kinds. Because there is no known essence of any species, they cannot be differentiated to the degree of preciseness that chemical elements can be. This might sound odd since the average person normally can tell species apart, but the fact is that the term species does not have a simple explanation that biologists universally agree upon, so defining a biological species is not as simple as defining a chemical element. You will remember that the atomic number 1, which refers to the structure of the atom that has only one proton in its nucleus, is the essence of hydrogen, meaning that this is what is necessary and sufficient for belonging to the kind hydrogen. Okasha explains why this is not the case with biological species;

> In every species, we find considerable variation among its constituent organisms. Mutation continually throws up new genetic variants, and sexual reproduction continually 'shuffles' genes around, resulting in extensive genetic differences between organisms within a single species. (Okasha 2019, 67)

Wherever in the universe we find instances of hydrogen, we can point to their atomic number and be sure that they are of the kind hydrogen, but we cannot point to a property and say that it is a necessary and sufficient condition for belonging to a certain biological species. Members of a single biological species show differences that members of a single chemical element do not. This problem of variation is not restricted to the classification of members within a single species, but can also be problematic for establishing divisions between separate species. Mutation, evolution and sexual reproduction are some of the reasons why biological species tend to have smooth transitions from one species to another rather than the clear ones of the chemical elements. Essentialism requires natural kinds to be discrete, but discreteness is not a requirement for cluster kinds. Thus, even if we do not exactly know where the real division between say a mouse and a rat is, both are perfectly viable candidates for natural kinds.

Even though biological species are not discrete, this does not mean that they are arbitrarily classified. In order to prove this we need to address the problem of which and how many properties are relevant or necessary to be a requirement for a natural kind. To answer, recall the Linnaean system which orders biological species into a hierarchical structure. I should mention that the Linnaean system is perhaps not the best nor currently the most agreed upon classification in the philosophy of biology. This is because the system was crafted before the theory of evolution through natural selection was worked out, so it predates many discoveries and much knowledge about the biological world. Although it is an old system it is in fact still sometimes used today even by biologists, but this is not important for the point I am about to make. To give you an example, think of a dog. Chances are that you and I thought of a different representation of a dog because there are many breeds to choose from that comprise the species *Canis familiaris*, or as I already said, dog. We know that golden retrievers share common properties with other golden retrievers, and that they share common properties with other breeds such as German shepherds, but even though they are both considered dogs they show properties that make them quite different as breeds. The fact that they are recognized as separate breeds tells us that there are somewhat significant differences between them. Notice that they are different breeds but not different species. They are subspecies of *Canis familiaris*. Remember that in the Linnaean system the base taxonomic unit is the species, so if we can name separate subgroups of *Canis familiaris*, why are they not recognized as separate species instead? Well, the answer to this is rather simple. It is because these breeds of the same species can interbreed and produce fertile offspring. The potential to interbreed is not something that is relative to us, but an occurrence that is objectively found in nature. So considering golden retrievers and German shepherds a single species does not seem like an arbitrary decision. The idea that species are comprised of entities that can interbreed with and only with the members of the same species to produce fertile offspring is the central tenet of the biological species concept (BSC), which is among the best-known attempts to explain what a species is (Okasha 2019, 68). Thus, as Okasha illustrates:

> Consider, for example, the European and American golden eagles. The BSC counts these as two varieties of a single species, not separate species, since they can in principle interbreed and produce viable offspring (even if they do so rarely). By contrast the spotted eagle and the golden eagle count as separate species, since their members cannot interbreed. (Okasha 2019, 69)

This idea also explains without question why a hummingbird and a hummingbird hawk-moth are considered separate species. Even if the hummingbird hawk-moth could mimic the hummingbird's appearance and behavior perfectly, they would still not be able to interbreed, and thus be considered separate species. So among all the possible shared properties, according to BSC, we may consider the ability to interbreed as a relevant property in distinction between separate natural kinds.

However, while the BSC gives an appealing solution to the manner of classification of biological species, unfortunately it does not work for all living organisms. The first problem that arises is the existence of ring species. The ring species is a species; ”Composed of a number of populations arranged geographically in a ring, where each population can interbreed with its immediate neighbor, but the populations at either end of the ring cannot” (Okasha 2019, 70). Imagine that on an island there are four populations of dogs. Population A is positioned in the north, population B in the west, population C in the south and the population D in the east. Since dog A and dog B are neighbors, they can interbreed, which means they are the same species. Dog B and dog C are neighbors so they can interbreed and are thus same species. If A and B are same species and B and C are same species, then we can deduce that A and C are same species. However, dog A and dog C cannot interbreed which means that they are not same species. Thus we see the fallacy that the BSC leads us to in the case of the ring species. It should be mentioned however that ring species are rather uncommon in nature and that they are seen as being a part of a speciation event, so they are not as problematic for the BSC as one might think.

The second problem that becomes fairly obvious is the fact that the possibility of interbreeding tells us nothing about the organisms that reproduce asexually. BSC thus cannot be applied to many species of plants, animals and fungi that reproduce asexually. Furthermore, it is not uncommon for organisms of clearly separate plant species to produce fertile offspring which again shows the shortcomings of the BSC (Okasha 2019, 69-70).Despite its shortcomings, BSC does seem to give a reasonably good way to classify sexually reproductive organisms while presenting biological species as real units of nature rather than arbitrarily or artificially constructed groups, but the problem is that it cannot encompass all existing organisms within its classification system. As is the case with chemical elements, a classification system that encompasses all existing organisms is needed for a universally accepted concept of biological species as natural kinds. Various species concepts exist because philosophers and biologists attempted to form this classification. Each classification offers something that another lacks, but none has yet achieved universal acceptance.

With that I want to conclude the discussion about cluster kinds and move on to the most lenient approach to natural kinds which is called *promiscuous realism*. While cluster kinds have the problem of deciding whether or not certain clustered properties give rise to natural kinds, promiscuous realism deals with this rather easily as I will explain in the following subsection. Promiscuous realism offers a rather interesting and alternative view of natural kinds which is why I find it important to be represented here.

3.3. Promiscuous realism

Let me begin by explaining the first claim I have made about promiscuous realism, that it is the most lenient approach to natural kinds, when compared to the ones discussed in this section. This is because the core tenet of promiscuous realism is that there are multiple valid ways of classifying entities into natural kinds. Furthermore, our aims and interests play an important role in the classification process. Due to this, we can correctly assume that promiscuous realism allows for the existence of many more natural kinds than the previous two approaches. However, one should not be under the impression that anything can qualify for a natural kind under this approach due to the possibly misleading nature of its name. Why this approach was given the name “promiscuous realism” is best explained by the philosopher who introduced it, John Dupré:

> The realism derives from the fact that there are many sameness relations that serve to distinguish classes of organisms in ways that are relevant to various concerns; the promiscuity derives from the fact that none of these relations is privileged. (Dupré 1981, 82)

The sameness relations Dupré speaks of must be objective occurrences found in nature in order to satisfy the term realism that this approach claims. Thus, two German shepherds that share some sameness relations that can be observed directly or indirectly can be considered members of the same kind (German shepherd). A German shepherd and a grizzly bear can also be considered members of the same kind because their shared properties regarding the feeding of their offspring form the kind "mammal". However, we cannot group a German shepherd and a hamster into a group called "pets I would like to own" and consider them members of the same kind. While they do possess a sameness relation, which is that I would like to own them, this property is in relation to me, meaning it is not an objective property these entities possess. Therefore, such groupings that are not based at least minimally on some objective shared properties fail to meet the requirements for natural kind membership.

Dupré also claims that none of the possible sameness relations are privileged, which means that ultimately no natural kind category is privileged. According to this it is perfectly reasonable that a single entity can be a member of various natural kinds. Just because it is a member of one kind does not exclude it from possibly being a member of another. The entity's membership of any of the possible kinds is equally valid. Therefore, a German shepherd can at the same time belong to the kind "*Canis familiaris*" and the kind "mammal". These two different kinds need not be in any relation to one another in the sense of a hierarchy or one being more informative than the other. The two kinds are equally valid because they are both based on an objective property, but we choose which kind matters to us because of our interests. Robert A. Wilson elegantly clarifies these two core tenets of promiscuous realism described by Dupré by putting them in negative form:

(a) There is no *one* criterion for membership in a given natural kind, i.e. that provided by the essence of the kind.

(b) There is no *one* way of ordering the natural kinds that there are in the world so that they constitute a unity. (Wilson 1996, 305)

Thus, we see that promiscuous realism is a pluralistic approach as it permits the existence of multiple natural kinds which do not require further ordering. Furthermore, because all objective classifications form natural kinds according to promiscuous realism and none of them are privileged, scientific classifications are considered natural kinds in the same sense as the nonscientific classifications are. This might not make sense initially, but actually nonscientific or folk classifications can sometimes be much more useful than scientific ones. Dupré gives us illustrative examples of this, one of which includes lilies where he explains that; "Species which are commonly referred to as lilies occur in numerous genera of the lily family (Liliaceae)" (Dupré 1981, 74). The folk classification of lilies includes various flowers that belong to the lily family but excludes onions and garlics which are also members of the lily family according to the science of biology. If we are looking to plant a garden in order to grow pretty flowers, the folk classification gives us better information for what we need because onions and garlics will not serve the purpose we desire. If we are looking for cooking ingredients, the fact that onions and garlics belong to the lily family does not carry information that is in any way meaningful to us. Even within biology scientific classifications can end up being awfully uninformative about the members of a given kind. An illustrative example of such a classification can be found in cladistics. Cladictics deals with organizing biological species into higher taxa, and it does so by observing the species' evolutionary history. According to cladistics, all higher taxa must be monophyletic groups of entities. Put simply by Okasha; "A monophyletic group, or clade, is one which contains *all and only the descendants of a single ancestral species*" (Okasha 2019, 76). Therefore, if dogs are descendants of wolves, then all dog breeds form a monophyletic group. However, if we exclude from that group any particular breed, let's say a pug, the group is no longer monophyletic as it does not include all the descendants of the common ancestor. The ancestor also may not have any other descendants, for if it did, they would also have to be included within the group. According to cladistics, this kind of grouping is the only way of classification that should be recognized as valid biological classification, whereas all other classifications are artificial. This classification system seems to make perfect sense scientifically, however, the higher the level of the taxon the more complex it will be, meaning it will consist of a multitude of very different species. And if we assume that life on Earth evolved from a single species at only one point in time, then all the species that have ever existed form a single monophyletic group (Okasha 2019, 76). What useful information can be extracted from such a group that could be applied to all the members it consists of? Lower level taxa in cladistics tend to make sense because the species that descend from a single ancestor usually share common traits, so a group like the great ape family (which includes humans, chimpanzees, bonobos, orangutans and gorillas) provides us with much information about all its members. The most obvious information that can be attributed to them is that they are larger than other primates and that they do not have a tail. At this level, monophyletic groups can be rather informative and thus useful. However, if we trace the great ape family's ancestry far enough, we will arrive at an ancestor species that gave rise to other primate species, making the information I have mentioned about the great ape family inaccessible from the point of view of the higher taxon, because this group consists of primates of various sizes that either do or do not have a tail. This is not to say that cladistics should only be applied up until a certain level of taxa, but just to show that sometimes a nonscientific classification can be more informative or even sensible in certain situations. Non-biologists and biologists alike recognize reptiles and birds as two separate classes, but according to cladistics birds share an ancestor with lizards and crocodiles which means that birds must be members of the class reptile if reptiles are to be considered a valid kind. But the distinction between birds and reptiles is based on their morphology and thus these two being classified separately happens to be rather sensible and more useful based on how informative they are as separate classes.

The monophyletic grouping seems like a valid candidate for natural classification in the more strict approaches to natural kinds because it follows a scientific process of grouping species together by observing their natural relation regardless of how well we might perceive it or what use we have from such groups, but for promiscuous realists there is no doubt that it would produce natural kinds as the relation between the species is not invented by us but found in nature. The difference is that it need not be the only system that produces natural kinds. According to promiscuous realism there isn't only one way to group entities into natural kinds, and all the ways are valid as long as they are based on objective facts about nature. Some classifications can however be seen as superior to others and therefore privileged, but their being scientific does not inherently grant them this special status. Which natural kinds we consider to be privileged, if we consider any privileged at all, is based on how they serve our purposes. Remember also that cluster kinds need to have defined which and how many properties are necessary for belonging to a kind. This is not a problem with which promiscuous realism is faced, because as I have already mentioned, as long as the classification is at least minimally based on objective properties in nature, the classification will be considered natural. As long as two entities share some objective properties, we need not concern ourselves with their amount, nor what caused them.

Promiscuous realism grants the status of natural kind to many classifications, whether they are scientific or not. Whereas essentialism allows only fundamental sciences to classify the objects of their study into natural kinds, promiscuous realism, like the cluster kinds approach, holds that higher level sciences can also do this. Unlike the cluster kinds approach, the natural kind category is a lot more permissive in promiscuous realism because even folk classifications can be equal in status to the scientific classifications, and in some instances they can even be privileged. However, the term privileged in this sense is different to the term privileged in the original sense in which natural kinds are privileged groups. It just means that the group that is privileged is better suited for our needs than other groups are. In the original sense privileged means that if a group is classified as a natural kind, other classifications cannot produce natural kinds, so a German shepherd for example cannot be classified as a German shepherd and a dog simultaneously so that both classifications are natural kinds. If one of these classifications is natural, the other is either not or is a sub-kind of the other. Even though promiscuous realism permits higher level sciences to study natural kinds, it does so in a way which lowers the importance of what it means to be a natural kind because the original sense of privilege is lost. It does seem rather odd that so many classifications can be natural kinds when a natural kind is a classification we would normally consider privileged. But if they can all be privileged, or if none of them really are privileged, what is the point in calling them natural kinds at all?

Species being natural kinds is an important part of this paper. But so far I have discussed species as if the species category is a class made up of organisms that are its members. This ontological conceptualization of species seems rather intuitive, and it is not questioned by regular folk. However, another conceptualization of species exits that is truly interesting on its own and for its philosophical implications regarding natural kinds, which is why I will present it in its own subsection. I am referring to the *species as individuals* idea, and I want to stress that this is not another competing view of natural kinds, but a competing ontological view of species that can be applied in our discussion of natural kinds.

3.4. Species as individuals

Species as individuals, as advocated by Michael Ghiselin and David L. Hull, is a brilliant concept that simply claims that species are complex individuals rather than classes of individuals. To better understand the implications of this concept we need to be aware of three different levels of classification of an entity within biology that are directly affected by this idea. At the bottom level we have a single organism (my pet dog for example), at the next level there is the biological species that an organism belongs to (*Cannis familiaris*), and finally there is the species category which is comprised of all biological species. Traditional species concepts as well as the common-sense view would tell us that the single organism is an individual, the individual is then a member of the biological species class that it belongs to, and then the biological species class is a member of the class category which is a class containing all biological species. Thus, my pet dog is a member of the *Canis familiaris* class. However, according to the species as individuals concept this is not the case. While the single organism is still seen as an individual, the next level (the biological species) is also seen as an individual, which then makes the species class a class of individuals rather than a class of classes. This means that my pet dog is an individual, but that *Canis familiaris*is now an individual as well. David L. Hull explains why this is the case:

> Organisms remain individuals, but they are no longer members of their species. Instead an organism is part of a more inclusive individual, its species, and the names of both particular organisms (like Gargantua) and particular species (like *Gorilla gorilla*) become proper names. The species category itself is no longer a class of classes but merely a class. (Hull 1976, 174-175)

Based on this we see how the three levels of classification are affected. While a single organism remains an individual, it is no longer a member of its species but its part. The biological species (*Canis familiaris*) is no longer a class but an individual. And the species category is no longer comprised of classes but of individuals. I want to address only briefly what Hull means when he mentions proper names because it is a sizable part of his paper, however I do not consider it quite so important for mine. Let's say my dog's name is Richie. Richie is a proper name that denotes my dog when I say it so that you know exactly which dog I am talking about. However, the only information that "Richie" carries is that it is my dog. Nothing else can be inferred about my dog based on the proper name "Richie". The proper name is not descriptive, it is only denotative. In the same way the proper name "*Canis familiaris"* is given to the species in order to denote it as an individual.

It might not make sense to you that my pet dog is a part of *Canis familiaris* rather than its member, so let me clarify that statement. Every cell in my body is a living entity that is considered a part of me (they are not considered members of me). Even though these cells might be similar, it is not in virtue of their similarity that they are considered a part of me. The cells within my body will group up in order to form organs that are rather different from one another, yet there is no doubt about them being a part of me. You will recall that I have already mentioned an example by Okasha in which a table is made up of two intrinsically different parts (glass and steel) but that the difference between those parts neither causes nor prevents the entity from being a table. The same is true for a living organism. My heart and my kidney are quite different, but they are both a part of me in the same way the steel legs and the glass top are a part of Okasha's office desk. And as the cells in my body form organs that are a part of me, so does Hull claim that; "The relation an organ has to an organism is the same as the relation which an organism has to its species" (Hull 1976, 181). Thus, we see the reasoning for my pet dog being a part of *Canis familiaris* rather than its member.

At first glance, one might think that this species concept would be problematic for biology considering how much data is based on the view that biological species are classes, but that is not the case. On the contrary, it actually fits in quite well with some of the things I already mentioned. Remember that due to mutation, sexual reproduction and evolution members of the same biological species show enough variation that it is hard to find properties that are uniquely shared by all of them and that could with absolute certainty set them apart from other species. For chemical elements this is easy, but determining something like an atomic number for species is problematic because they may not possess the same kind of unchanging property. However, if we look at individual organisms as parts of a whole complex individual, then the problem of variation becomes irrelevant. If the atoms of hydrogen presented as much variation amongst themselves as do all the different breeds of dogs (for example a pug and a doberman), we could assume that chemical elements would no longer be the paradigm examples of essentialist natural kinds, but would also have to be classified in some manner of cluster kinds. Such variation amongst the constituent organisms of a species is one of the reasons why Hull claims that;

> The fact that any specimen, no matter how atypical, can function as the type-specimen makes no sense on the class interpretation; it makes admirably good sense if species are interpreted as individuals. (Hull 1976, 175)

Therefore, no matter how different a pug is from a doberman, the clustered properties they share allow them as individuals to cluster into a kind *Canis familiaris*.

Even though the species as individuals concept might seem like an appealing solution to the species problem, it carries with it an unfavorable implication regarding the natural kinds it would form. Because there is significant variation amongst the organisms of a single species; "we should not expect to discover scientific laws that apply to all and only the organisms in a given species" (Okasha 2019, 75). Remember that the idea of natural kinds is that knowing what kind an entity belongs to should give us information about the entity in question. The natural kind hydrogen carries a lot of information about its representatives, so if we find something that we know belongs to this kind we can expect that it will exhibit certain behavior. We cannot expect this to be the case for species because their constituent organisms show such variation that claims about all and only the organisms of the same species cannot easily be made, if they can be at all. This can also be inferred from Hull's statement that the name of a species is a proper name in the same sense that an individual organism's name is a proper name which does denote it but does not describe it.

This concludes the discussion on the natural kinds approaches and the ontological conceptualizations of species that I wanted to present to the reader. With the knowledge of natural kinds and the ideas of different approaches to the concept as well as the different species concepts, we can move on to the next section in which I mean to introduce genes. My reasoning for biological species being natural kinds is based on the idea that genes are an essential property of species. But before I present this theory in the final section, I have to provide a description of genes because they have such a significant role in said theory. By talking about genes in the following section we will begin to understand why a problem arises when genes are intertwined with the idea of biological species being natural kinds.

4. Genes

A great deal is known about genes today, and a great deal is still unknown about them. Children learn about them I schools and most people have at least some kind of awareness about them. People with no experience in genetics have no problem claiming that someone has strong or good genes just because of their outward appearance. The focus of this section is to describe genes so that we may understand genes enough to realize why they entered the everyday lexicon of an average person. I believe this is necessary before we can understand the implications of genes being intrinsic essences of biological species. This will be the last section before we can move on to the main topic so let us begin our discussion of genes which will help us understand the problem of biological species and natural kinds in the final section.

4.1. What are genes?

The first question we need to answer is what genes are. While it might seem like there is a straightforward answer to what genes are, unfortunately this isn't so. As is the case with species, genes do not have one perfect definition that is universally accepted among scientists. Thus, when we talk about genes we cannot talk about them with the accuracy that we might have were we to talk about, for example, chemical elements. However, we do know a lot about genes today thanks to biology and genetics, and for the purposes of this discussion a completely accurate definition of genes is not absolutely necessary. For this discussion the following description of genes will serve well enough; "Genes find themselves packaged together in "teams" on chromosomes, producing gene products that together make phenotypes, which in turn interact with the environment more or less directly" (Rosenberg, McShea 2008, 162). This definition might not be overly informative to one that does not have at least a little bit of background knowledge of biology, so I believe it is necessary to further describe what is known about genes in order to get a better understanding of the given definition. Therefore, the role of genes in the production of phenotypes (the observable traits of organisms) needs to be cleared up before we can make such claims. In order to give the best description of genes I believe that one should start from the inception of genetics, by which I am referring to the work of Gregor Mendel which is considered to be the starting point of genetics as a new branch of science. Even though Mendel was not aware of genes in the way we are today, his contribution to genetics is unmistakably significant and will therefore be mentioned in this paper as well.

Mendel's pea plant experiment represents the inception of genetics and shows us in a rather interesting manner what the role of genes in an organism is, which is why I believe it to be wise to describe the experiment. The experiment was designed so as to discover the mechanisms of the transmission of phenotypic traits from one generation to another. The chosen objects for the experiment were two pure lines of pea plants, one of which produced round peas, while the other produced wrinkled peas. Mendel then cross-bred the two pure lines in order to get a hybrid plant generation. The result of this cross-breeding was a hybrid plant generation that possessed only the round peas, which would make us assume that the wrinkled pea trait was lost in this generation. However, Mendel then bred plants only from the hybrid generation which resulted in the second generation of hybrid plants in which one fourth of the population produced wrinkled peas, while the rest of the population produced round peas. This was not only the case for pea plants as other plants showed this kind of behavior as well. Remember that during the time of the experiment Mendel did not know about genes, so the occurrence of wrinkled peas in the second hybrid generation makes it appear as if the trait materialized out of thin air. This is what led Mendel to the one of the most important early discoveries for genetics:

> He suggested that a plant's pea shape is determined by a pair of 'factors'. A plant inherits one factor from each of its parents. The factors are of two types: **R** (for round) and **W** (for wrinkled). So there are three possible types of plant: **RR**, **RW**, and **WW**. Now an **RR** plant will have round peas, while a **WW** plant will have wrinkled peas. What about an **RW** plant? Mendel suggested that it will have round peas, since the **R** factor is 'dominant' and the **W** factor is 'recessive'. (Okasha 2019, 84)

If we apply this logic to the generations from the example, then the trait distribution starts to make sense. The plants of the pure line generation have the **RR** factors for the round peas and **WW** for the wrinkled peas. Since only one factor is inherited from each parent that means that the first hybrid generation must inherit one **R** factor from the **RR** parent and one **W** from the **WW** parent, making all the plants in the first hybrid generation **RW** type. Because the **R** factor is dominant all the plants produce round peas. The second hybrid generation is bred from plants that are of the type **RW** meaning that there are three possible types; **RR**, **RW** (**WR**) and **WW**. According to Mendel, after the factors of one plant segregate, only one of the factors is transmitted to the offspring, and this factor is chosen randomly. Therefore it should be expected that all types will be found in the second hybrid generation, and it makes sense that about one fourth of the population is of the type **WW**.

This is how Mendel discovered that genes (which he calls factors) come in pairs (as was said in the definition of genes I stated earlier). Moreover, he discovered that genes can be dominant and recessive, and that genes are the cause of phenotypic traits of organisms. Even though Mendel spoke of factors rather than genes, he provided us with the theoretical description of what will later become known as genes, which helped scientists to actually discover the structure of the gene so that we may better understand how genes behave. Thanks to the technological progress of the past century we now know a lot about the genetic material. We know that genes are located in the DNA, and we owe this knowledge to James Watson and Francis Crick.

Before the structure of the genes was discovered, scientists were looking for genetic material thinking that it should be located within a cell because every organism is developed from a single cell. For a long time it was believed that DNA is not what they were looking for, but in 1953 Watson and Crick finally determined that their double helix model of the DNA perfectly represented the structure of the genetic material. The description of DNA that we know today is the one given to us by Watson and Crick, but a simplified version of it in the words of Richard Dawkins will serve this paper well enough:

> A DNA molecule is a long chain of building blocks, small molecules called nucleotides. It consists of a pair of nucleotide chains twisted together in an elegant spiral; the 'double helix'; the 'immortal coil'. The nucleotide building blocks come in only four different kinds, whose names may be shortened to *A, T, C* and *G*. These are the same in all animals and plants. (Dawkins 1976, 27)

These two chains of a single DNA molecule are joined together by bonds between their nucleotide bases. Base is the name given to the nitrogen-containing compounds which refer to adenine, thymine, cytosine and guanine which we shortened to A, T, C and G. The bases are joined in such a way that A is always paired with T and G is always paired with C. This is the structure that is found in every existing organism, and the way it differs from organism to organism is in the way the nucleotides are ordered within the chain.

With the double helix joined at the bases we now have the picture of genetic material, and when we now talk about genes we no longer talk about entities that are only theoretical but real material entities that we can observe. However, we still need to explain what goes on in the DNA macromolecule so that we can claim that genes are in fact located in the DNA. If genetic material can be found in every cell of an organism and the organism developed from a single cell, then we could assume that somehow this genetic material needs to be copied in order to be found in every cell. Watson and Crick discovered the mechanism for copying genetic material based on the shape of DNA which now might seem rather obvious; "The two strands uncoil, and each is used as a template for synthesizing a new strand" (Okasha 2019, 89). Due to the fact that base A is always paired with base T, as are the bases C and G, we can conclude that the two separated strands, or chains, will give rise to two identical double helixes. This is in fact how genes get accurately copied from cell to cell and from generation to generation. So now that we know that genes are in fact located in the DNA, we need to understand what it is that genes actually do.

With the DNA described we can expand on the description of genes by adding that genes are particular segments of DNA and that each gene is responsible for the production of a specific protein, which is how they affect organisms' phenotypic traits. The way that a gene determines which protein will be produced is based on the order of its nucleotide bases. However, it is not simple locating specific genes in the DNA because they are not divided discretely in an obvious manner as one might expect. Although, Dawkins describes how we can consider a particular segment of DNA to be a specific gene:

> To be sure, there are special symbols for END OF PROTEIN CHAIN MESSAGE and START OF PROTEIN CHAIN MESSAGE written in the same four-letter alphabet as the protein messages themselves. In between these two punctuation marks are the coded instructions for making one protein. If we wish, we can define a single gene as a sequence of nucleotide letters lying between a START and an END symbol, and coding for one protein chain. (Dawkins 1976, 35)

Now we have a much clearer picture of what genes are, knowing that they are segments of the DNA located on the chromosomes and that they are responsible for the production of specific proteins within cells, thereby creating organisms' phenotypic traits. Protein production is an important feature of genes because proteins are necessary building blocks of organisms. Their roles are crucial for proper function and structure of cells, tissues and organs. A protein is built from a long chain of amino acids, and the linear sequence of the amino acids determines the protein's shape and behavior. Okasha informs us just how the linear sequence of amino acids in a protein is determined by explaining that the genes that we are describing have; "A direct correspondence between the linear sequence of nucleotide bases in a gene, and the linear sequence of amino acids in the protein that the gene produces" (Okasha 2019, 90). Here we see the importance of the order of nucleotide bases for the production of proteins and how genes carry information that affects protein production which is ultimately responsible for phenotypic traits of an organism. This means that if for some reason the sequence of gene's nucleotides changes, which can be caused for example by a mutation, then the sequence of the protein's amino acids also changes accordingly. In order to get the complete picture of how genes produce proteins I believe that the processes of DNA transcription and translation need to be mentioned. Okasha provides us with simple explanations of both:

> In transcription, a segment of DNA is copied to RNA, which is single-stranded. The resulting RNA strand is identical in sequence to one of the two DNA strands, except that thymine (T) is replaced with uracil (U). In eukaryotic organisms (which includes all plants and animals), the initial RNA strand undergoes processing to yield the mature messenger RNA (mRNA), which then leaves the cell's nucleus. In translation, the mRNA strand is decoded in a cellular 'factory' called a ribosome, where a growing polypeptide chain is formed by the addition of amino acids, one at a time. (Okasha 2019, 90)

During translation the mRNA's nucleotide sequence determines the order in which specific amino acids are added to the protein chain. With this we finally have the understanding of the role nucleotide bases play in protein production and what genes are and how they behave.

Genetics has made substantial progress since its inception when Gregor Mendel performed the experiment with the pea plants. Recall that Mendel did not know about genes and that his theoretical 'factors' were at the time the best explanation for trait inheritance. Thanks to the technological progress of the past century it is now possible to sequence genes, which means that we can actually identify the order of the nucleotides within a gene, and therefore the order of amino acids within a protein. In 2003 the sequence of all human genes were published as a result of the Human Genome Project. All of this has led to something remarkable. By sequencing genetic material it was discovered that the 'book of life' can be read through the A, T, C and Gs. Not only can it be read, but it can also be written in, which can be done through genetic engineering. Such knowledge is utilized in medicine and so far it is showing promising results. With this we may conclude the description of genes and move on the next subsection whose focus will be on *genocentrism.* Genocentrism is important for this paper because it provides us with the background for the idea that genes are essential properties of biological species.

4.2. Genocentrism

Genocentrism can best be explained in the words of Rosenberg and McShea: "Genocentrism is the thesis that the genes have a special role in the explanation of both individual development and biological evolution" (Rosenberg, McShea 2008, 173-174). This means that if we are talking about evolution, we are focused on genes. It is important that this be mentioned because when evolution or natural selection are being discussed, we can either focus on genes, organisms, populations or even whole species. Thus, because this paper is largely concerned with genes, genocentric point of view needs to be discussed. The main goal of this paper is to present theidea that grouping of biological species into natural kinds should be based on genes and the problem therein, therefore I need to explain the beliefs of genocetrists such as that genes are more important for the discussion of evolution than organisms or species are. This belief is based on the idea that organisms are gene creations, or as Dawkins calls them, vehicles that carry their genes. The reason why genes are considered the units of evolution can be expressed in the following way:

> A replicator is a thing whose structure is copied in the next generation. Thus DNA sequences are paradigmatic replicators. An interactor, or in Dawkins's term, a vehicle, is a thing that interacts with the environment, well or poorly, for better or worse. A replicator may well be its own interactor, or the interactor may be the vehicle that "carries around" the replicator (hence Dawkins's term, vehicle). Evolution by natural selection can be economically expressed as the differential perpetuation of replicators owing to fitness differences among interactors. (Rosenberg, McShea 2008, 161)

Based on this, a replicator is an entity which we trace through generations (a gene). An intractor, or vehicle as Dawkins calls it, is a gene product which carries genes within itself as it interacts with the environment. We are then the vehicles of our genes. Therefore evolution refers to genes because they are the replicators that pass from generation to generation. One of the reasons this theory seems so appealing is because it is far more likely that faithful copies of genes will be found in different generations, rather than copies of phenotypic traits, or vehicles. Furthermore, since genes are responsible for creating organisms, an organism can be considered an extension of the genes. Therefore, when we talk about evolution, we are not talking about organisms, we are talking about genes. This is not to say that genocentrists deny the existence of higher level entities, like the organisms for example, but that they are not necessary for any evolutionary explanations. So if we were talking about evolutionary traits such as gills, we should consider them not on the level of fish, but on the level of genes.

Genocentrism, however, is not a universally accepted theory. One of the reasons for this is due to its implication of genetic determinism which biologists and philosophers tend to deny. It would seem rather odd that certain social traits of humans are genetic products, but this would be the case if we are completely determined by our genes. For example, depression is a product only of our genes rather than the possible external factors which may affect it. In this view neither our intelligence nor cautiousness could be affected by the environment with which we interact. It appears that some traits really need to be explained by some additional factors. This is the idea that the opponents of genocentrism support. They want to deny genetic determinism because it is not their belief that there is a gene for every imaginable trait, be it social or biological, and they believe that;

> One way to do this is to show that for any biologically or socially important trait, the causal role of the genes in determining that trait is no different from the causal role of any of a number of environmental factors. (Rosenberg, McShea 2008, 174)

Take building muscles for example. In order to build muscle, one needs to exercise, eat a lot of protein based food and sleep properly. Without doing these things, we cannot expect to get any results. But imagine a person who has achieved this by properly exercising, eating and sleeping. We may say that the person has genes for building muscles, but it appears that the big muscles are not a product only of said genes, but of the genes interacting with other mentioned factors. If the big muscles were a product only of muscle building genes, then we could expect that the children of bodybuilders will have big muscles simply because these genes were passed on to them from their parents, but this is not the case. We can even say that a person without big muscles has muscle building genes, but they do not have big muscles because they have not exercised, ate or slept properly. It needs to be known, however, that opponents of genocentrism do not deny that genes are important for explaining traits of an organism, they do in fact believe that genes are important, but their role is not more important than the role that the environment may have on the same traits. Even if we are against genocentrism, we can still focus on genes when we talk about evolution, however we need not be focused only on genes.

In order to expand on the importance of genes, I want to address one more aspect attributed to genes that was hinted at in Dawkins's description of DNA, which is that genes are immortal. This aspect of genes will be an important factor for my claim that genes are intrinsic essences of biological species in the final section. Now what exactly do we mean when we say that genes are immortal? If we already know that genes are segments of DNA, does this mean that the life expectancy of the DNA lasts unimaginably longer than the life expectancy of the vehicles carrying the DNA? No, it does not. DNA does not survive the death of its vehicle. The idea of immortality of genes is brilliantly explained by Dawkins: "But a DNA molecule could theoretically live on in the form of *copies* of itself for a hundred million years" (Dawkins 1976, 44). It is based on this that we might consider genes immortal. So it is not that a gene lives for such a long time that we consider it immortal, but because it can potentially survive for an eternity through copies of itself. Dawkins illustrates this point like this:

> The genes are the immortals, or rather, they are defined as genetic entities that come close to deserving the title. We, the individual survival machines in the world, can expect to live a few more decades. But the genes in the world have an expectation of life that must be measured not in decades but in thousands and millions of years. (Dawkins 1976, 43)

This means that the genes that we are talking about could be unbelievably old. It also means that they have the potential to live on for another eternity still. Dawkins and other genocentrists believe that genes are the basic unit of natural selection, unlike those who oppose genocentrism and believe that the basic units are organisms, populations or species. This is because genes possess a special property which is considered necessary for natural selection to actually have an impact on the world, and this is that property:

> Each entity must exist in the form of lots of copies, and at least some of the entities must be *potentially* capable of surviving – in the form of copies – for a significant period of evolutionary time. (Dawkins 1976, 42)

Unlike the organisms, populations and species, genes actually possess this property. This makes it clearer why some choose to defend the genocentric view of evolution so eagerly. And as Rosenberg and McShea concur, when compared to genes, organisms just seem ephemeral; "But genes are forever, or at least their DNA sequences are almost perfectly copied over and over again, and they persist for very long periods" (Rosenberg, McShea 2008, 161). However, we might question the claim that genes are so faithfully copied because we know that during sexual reproduction the DNA does not pass intact from parent to offspring. This is not a problem for organisms that reproduce asexually, by replication for example, but in sexual reproduction the DNA splits and randomly chosen chunks of it are transmitted to the offspring. We also know that the offspring possess only half of the genes of each parent. Dawkins explains the answer to this problem with an illustrative example:

> Individuals are not stable things, they are fleeting. Chromosomes too are shuffled into oblivion, like hands of cards soon after they are dealt. But the cards themselves survive the shuffling. The cards are the genes. The genes are not destroyed by the crossing-over, they merely march on. (Dawkins 1976, 44)

Parents and their offspring do not share the same genome, which corresponds to the odds of getting the same hand dealt after the cards have been shuffled. But, it was never said that the whole genome was successfully copied through generations. Genes are entities that are small enough that they can in fact stay intact even as the DNA splits so that they can form new DNA in the same way that the cards can be reshuffled on and on and still remain unchanged. In the same way that the same cards can create different hands, the same genes can form different genomes. So, presumably the same genes might be shuffled for an incredibly long time without ever being changed so long as the splitting of the DNA does not directly affect those genes. Just to show that genes can be affected by the splitting of DNA, imagine that while you are shuffling the cards you tear a card. The splitting of the DNA molecule can in the same way 'tear up' a gene. But the possibility of the genes staying intact for long periods of time is the reason why we may attribute immortality to them.

I believe that I have provided a satisfactory description of genes so that we need not expand on them any further in this section. From this point we can move on to the final section of this paper because now we have the knowledge required for the main topic, which is to show how genes can be at the basis of the idea that biological species are natural kinds which have intrinsic essences and why this idea faces a problem.

5. Genes are the essence of biological species

The knowledge we have about genes today is quite big, and it is still growing. One thing we know for sure is that genes are the building blocks of all living beings. We have seen how genocentrists have made an attempt at reducing an organism down to genes which are seen as the creators of said organism, therefore giving genes the explanatory power for describing organisms. My goal is to attempt to show that genes have this explanatory power, at least to a certain extent, and that they ought to be seen as essential properties of species, thereby making biological species real natural kinds that have essences.

The idea that organisms can be reduced to genes the same way graphite can be reduced to carbon seems rather intuitive and appealing. I strongly believe that this is what most people would agree with before they see this belief put into context of a philosophical discussion regarding the species' status of natural kinds. However, most philosophers and biologists will agree on the notion that species as natural kinds are at best relational kinds. By this I mean that if we can say that an organism is of a certain species because it possesses a certain structure or a property, that property or structure needs to be viewed in comparison to other organisms of the same species. We cannot say that the organism is of the certain species only in virtue of possessing the property or structure like we can for chemical elements. Thus, most biologists and philosophers will deny that species have essences of the essentialist sort that we already described because we have yet to show that species have intrinsic essential properties which make them natural kinds. However, I believe that species must have intrinsic essences that explain them, and I believe genes to be the intrinsic essential property of species. I am not alone in this belief which I will prove by providing the reasoning for it by basing this idea on Michael Devitt's theory of species having partly intrinsic essences.First I mean to explain the problem that prevents us from claiming that species are natural kinds based on their genes, and after that I will present a possible solution to the problem through the theory provided by Michael Devitt.

5.1. The problem

Cluster kinds and promiscuous realism approaches can allow that genes be the basis for species being natural kinds. Genes are already an important part of the biological species concept which was already described as the idea that organisms are of the same species if they can produce fertile offspring. This idea can be reduced in terms of genes, whereas restricted gene flow determines species membership. So the idea of reducing species to genes is not really a new one. However, claiming that genes are intrinsic essences of species needs to be discussed.

Recall what we said about essences in our discussion on essentialism. Pointing to an entity's essence is enough to claim that the entity belongs to a certain kind. Thus, pointing to certain genetic material should allow us to claim that an organism belongs to a certain species. Attempts are being made at defining species membership in this way, one such being the attempt to show which genes make us humans rather than chimps or Neanderthals by comparing the DNA of each species. However, currently we cannot point out certain genetic material and make such claims. There is no genetic material we know of that is found only in dogs so that if we find such material we could claim that it belongs to a dog without having to examine it alongside other dog genomes. DNA sequencing works rather well in determining to which species an organism belongs, however, it is based on the similarities that are shown between the DNA sequences of other members of the same species. This means that the DNA sequence cannot tell us to what species an organism belongs all on its own, but that it needs to be compared to something.

Furthermore, if we trace our ancestry far enough, we will arrive at a species that is not *Homo sapiens*. DNA sequencing can show us the relatedness between us and the certain organism that belongs to this ancestor species, but it cannot perfectly explain why we belong to one species while our ancestor belongs to the other. This is because there is not a simple transition between these two species so that at a certain point the ancestor species started producing the new species while they ceased to exist. Because the transition from species to species is gradual and rather long, the further we trace our ancestors that belong to the *Homo sapiens* species, the more they are going to resemble the ancestor species that they evolved from. And because the division between the two species is not clear and discrete, we can correctly deduce that the divisions are not found in nature, but are imposed by us. Still, these divisions are not purely arbitrary and they point to a property that species have which some philosophers and biologists tend to agree are actually essential for the species because they carry explanatory power and are necessary to describe them. Thus, many believe that species are defined by their evolutionary history and that in fact; "No intrinsic genotypic or phenotypic property is essential to being a member of a species" (Sterelny, Griffiths 1999, 186). During a speciation event, it would be difficult to determine to which species an organism belongs, as some of our ancestors will show more resemblance to the ancestor species than to us if they are located closely to the imaginary division between us, but if we put the organism in a certain historical context, then we can decide to what species the organism belongs. This is why species are said to have historical essences. Although, it needs to be stressed that a historical essence is a relational essence, it is not an intrinsic essence, meaning it still fails to show that species have intrinsic essences of the sort that essentialism requires for natural kinds.

It also appears that the historical property tends to better explain species membership in some cases than morphologic and genetic similarities can. To prove this point, suppose that the genetic structure of humans is their intrinsic essential property that explains them. The genetic structure is ordered into 46 chromosomes that come in pairs of two, and is responsible for creating a human being that has two eyes, two legs, two arms, ten fingers and so on. If this is the intrinsic essence of humans, then this same essence will be found in other humans as well, the same way every instance of hydrogen will have one proton in its nucleus. However, we need to be extremely precise when we say which genetic structure is essential because the one I described just now is too broad and will certainly fail, and the reason for that is simple:

> People born with the wrong number of chromosomes, eyes, or arms are still human beings. So the essential properties that make a particular organism a platypus, for example, are historical or relational. An animal is a platypus by virtue of its place in a pattern of ancestry and descent. (Sterelny, Griffiths 1999, 186)

The historical property without a doubt explains why a human with the wrong number of chromosomes is a human, but if we focus on the genetic structure we would find a difference between the members of the same species which should not exist according to the essentialist beliefs. We will never find a hydrogen atom that has two protons in its nucleus. Therefore, if we want to claim that genes are the intrinsic essential property that defines species, we need to find what it is that makes it so that different gene structures can produce the same species. But so far we can see that historical essences have the advantage in explaining species membership.

Another reason why historical essences have an advantage over intrinsic essences is when we look at certain species whose members, while sharing similar genetic structures, show such variations so that they can resemble members of other species more than the members of their own. The essence should point to a similarity between the members of the same species, but as Sterelny and Griffiths tell us, the members of the same species are not always similar, and in some cases of butterflies, they are actually rather different from one another because some individuals mimic one species while others mimic a different species; "So different individuals of the same species can resemble members of another species more than other members of their own" (Sterelny, Griffiths 1999, 184). The members of such species have to be defined on the basis of genetic similarity since they are too different morphologically, but as we have already seen this can best be done by referring to the historical evolutionary property which is the reason why these members are parts of the same genealogical nexus, meaning that they are in the same gene pool as the result of ancestor-descendant pattern and place.

One might assume that the discoveries that genetics has made up until now would have already resulted in proof about genes' status as intrinsic essences based on which organisms are classified into species. However, any attempt at claiming that species have intrinsic essences, be they genetic or otherwise, has been countered to the point that the idea is considered naïve by many philosophers and biologists. Perhaps living, constantly changing objects cannot have the same kind of essentialist definitions that inanimate, unchanging objects can. Even species having historical essences is not accepted by all. But despite all the disagreements that abound in this discussion, there is one thing that most of the philosophers and biologists agree on, and that is as Okasha tells us; "that *essentialism* about species is incompatible with both Darwinian theory and modern taxonomic practice" (Okasha 2002, 191). In fact, many believe that this is the end to the discussion about species having intrinsic essences. We still have not discovered an intrinsic structure that is found in all and only the members of the same species. We still cannot equate the status of biological species to the status that chemical elements have in the essentialist view. However, this does not dissuade some from keeping the discussion of species having intrinsic essences going. Michael Devitt shares my belief that species do in fact have intrinsic essences despite the overwhelmingly anti-essentialist consensus. Therefore the next subsection is dedicated to his theory.

5.2. Species have partly intrinsic essences

Despite being aware of the consensus against species having intrinsic essences Devitt stands firm in the belief that he claims he shares with children, which he calls *intrinsic biological essentialism*. Devitt claims rather boldly that it is the children who are in fact right on this matter, not the philosophers or the biologists. His theory claims that; “Linnaean taxa have essences that are, at least partly, intrinsic underlying properties” (Devitt 2010, 650).This marks Devitt’s theory as a significant departure from the conventional views represented in the philosophy of biology. Normally essentialism would posit that species have intrinsic essences which ultimately determine their properties, but Devitt introduces a new element into this discussion. He argues that species have partly intrinsic essences, which means that some features are essential while others need not be, and probably are not since Devitt does not deny that species are partly historical entities.

Devitt’s partly intrinsic essences are based on a description that is somewhat different to the essences we were introduced to earlier in this paper. He describes essential properties as follows:

> A property *P* is *an essential property* of being an *F* if and only if (iff) anything is an *F* partly in virtue of having *P*. A property *P* is *the essence* of being an *F*iff

> anything is an *F* in virtue of having *P*. The essence of being *F* is the sum of its essential properties. (Devitt 2010, 649)

In the traditional sense an essence is the necessary intrinsic property that ultimately causes and explains all observable features about the entity that possess it, and that will be found in all the members of the kind it represents. Devitt’s intrinsic essences do not hold the ultimate explanatory power about the entities that possess them, because while they are necessary, they are only a part of what explains and causes the entity. Unlike the traditional essences, Devitt’s partly intrinsic essences recognize that some properties are intrinsic while others are extrinsic.

While Devitt admits that essences can be completely intrinsic or completely extrinsic, it is the essence that is partly intrinsic and partly relational that is of the most importance for this discussion. To see how an essence can be both intrinsic and relational Devitt provides us with the following illustrative example:

> The essence of being a pencil is partly being an instrument for writing, which an object has in virtue of its relation to human intentions, and partly having the sort of physical constitution that distinguishes it from a pen, which an object has intrinsically. (Devitt 2010, 649)

In our discussion of genes and genocentrism we have attempted to reduce an organism to its genes and saw the problem that arises from it. If an organism could be reduced to genes, then logically, species (which is a higher level ‘entity’ than an organism) cannot be reduced to genes either. It seemed as though genes were not enough to explain the organism they had created. It appeared that an extrinsic factor was needed to completely explain the organism. In much the same way, an extrinsic factor might be needed to explain species membership. According to this theory, genes can assume the role of the intrinsic essence required for species membership as long as they are the partly intrinsic properties. But the species cannot be completely caused and explained without the partly extrinsic properties that are also necessary to define it. Thus, the unity of the relational properties (be they environmental or historical) and the intrinsic properties is needed to cause and explain all the observable similarities between the members of the same species.

Devitt applies the idea of partly intrinsic essences to species in order to explain the generalizations made by the average folk as well as biologists about the organisms that are grouped together into the same species. This refers to all sorts of generalizations such as the members' morphology, the way they behave, where they live, their social habits and so on, but to give a clear example of these we can generalize that African rhinoceri have two horns while the Indian rhinoceri have only one. Devitt argues that an explanation for this generalization can be given by the rhinoceri's evolutionary history which shows how it came to be that this generalization about the number of horns is true. However, evolutionary history does not explain why this is true. Something needs to explain the 'mechanisms' that make this kind of generalization true. Devitt argues that the explanation for this cannot come solely from extrinsic factors, but that;

> There has to be something about the very nature of the group – a group that appears to be a species or taxon of some other sort – that, given its environment, determines the truth of the generalization. That something is an intrinsic underlying, probably largely genetic, property that is part of the essence of the group. Indeed, what else could it be? (Devitt 2010, 655)

Here we see why species have intrinsic essences according to Devitt. It seems intuitive that these generalizations need to be explained through some intrinsic factors, and since genes are responsible for the production of the organisms that carry them, they appear to be the best candidate for the intrinsic essence. I would argue that the example in which a person born with a wrong number of chromosomes is still a human works in favor of proving that genes are the intrinsic factor. Even though a mistake was made in the transmission of genes from parents to child, the similarity of the genes does not allow for something outside of the parental species to be born, no matter how different the genetic structure of the child might turn out. What I mean by this is that due to the child's historical property, the fact that it was conceived by two humans, it is also a human. But what explains the 'mechanisms' that make this true is the genes which were passed on from the parents. As we have already said, these genes could be ancient, and for a long time they have been creating human phenotypes. Even in the event of a mistake, they will create another human, not something non-human, which we can claim because we know that speciation takes a long time and does not happen at once. So it is the 'human genes' that prevent the child from being anything other than human. Were it not for the intrinsic property (genes), what would keep the extrinsic factors from affecting this organism in such a way so as to create something that is non-human? To prove my point, it might be easier to imagine a deck of cards again, where as it is being shuffled a card falls out of it. The deck we are left with is still the same kind of deck, it does not become a new kind of deck meant for a new kind of game. It stays the same deck minus the one card. Different subspecies of dogs should also point to the idea that species have intrinsic essences. We know that certain dog breeds have certain features that allow them to thrive in cold weather while other breeds have features that allow them to thrive in hot weather. It makes sense that the environment played an important role for this to be true. But, without something intrinsic that also caused this, what prevents the external factors from affecting the dogs in such a way that they turn into separate species, rather than just different breeds of the same species? Perhaps they are actually going through the process of speciation, but if they are they are in the very early stages of it. Therefore, they have to share an intrinsic property that keeps them members of the same species. These different dog breeds can exhibit such vast morphological differences that it would be easy to confuse them for not being members of the same species, so the intrinsic property that keeps them con-specific should point to something genetic. Since the genes they carry could be old beyond belief, it stands to reason that these same surviving genes allow for the dogs to be a part of the same restricted gene pool.

Variations between the members of a same species have always been problematic for their classification into the species. The species as individuals idea offers a solution to this problem, but it does not show that the different parts (organisms) of the individual (species) are grouped according to intrinsic essences. Devitt's intrinsic biological essentialism can be applied whether we hold that species are classes or individuals. Since species as individuals theory allows for the members of the same kind to be vastly different, then genes should be able to show the same variation. This would further aid the grouping of members into same species even though they show differences in genetic structure. But to see how variations between the members (or parts) of the same species are acceptable for the theory we need to further clarify the difference of the essence that Devitt describes and the traditional essence. The traditional essence is completely intrinsic, fixed and the same for every member of its kind. Devitt's essence is the sum of intrinsic and extrinsic factors. It is possible that the intrinsic factor (or the partly intrinsic essence) is the same for all members of the same kind, but the extrinsic factors can be different from member to member. And since a species' essence is the sum of the intrinsic and the extrinsic, we can deduce that the essence of a species will show variation between its members because the external factors ought not be the same for every member, and unless the members are identical, neither should the intrinsic since there will be genetic variation. Thus, unlike the traditional essence, the partly intrinsic essence can vary from member to member. This is needed to explain why Devitt claims, against the consensus on essentialism, that; "Variation within a species can be seen to be compatible with Essentialism once one realizes that an intrinsic essence does not have to be "neat and tidy"" (Devitt 2010, 659). So the essences of the members of same species need not be the same in order to be compatible with essentialism. It seems that the essences actually should show such variation because in this way they show compatibility with evolution. But, for essentialism to be compatible with species we need to abandon the traditional concept of essences.

I have already talked about the fact that knowing to which species an organism belongs tells us a lot about the organism. So far the names of species, and higher taxa, could have been seen as carriers of information about their members. But if you recall, a property of an essence is that it is enough to explain the member of its kind, not to just give partial information about it. Devitt thus claims that knowing to which species, or taxon, an organism belongs is not only informative, it is explanatory. So something being an African rhinoceros explains why it has two horns, or in other words, it has two horns because it is an African rhinoceros. The essence of the rhinoceros is the reason why this is true. Based on this Devitt makes another seemingly intuitive claim:

> For when biologists group organisms together under some name on the basis of observed similarities, they do so partly *on the assumption that those similarities*

are to be explained by some intrinsic underlying nature of the group. (Devitt 2010, 655)

Explanations of this kind abound in biology, and we take them for granted without contemplating whether species carry explanatory or just partly informative power. However, it is important to show that the intrinsic underlying nature belongs only to the certain group if it is to be essential, otherwise it cannot be essential. Whether or not biologists actually base their work on the given assumption does not matter because even if it is not the case, it appears as if they do, and it appears that our knowledge of species is compatible with actual species in the world.

I believe that the key points of Devitt's theory have been explained well enough to understand his ideas. Through his theory we have seen how species can have intrinsic essential properties and we established that they are not the only factor needed for the explanation of species, but that external factors are necessary as well. We have finally explained the importance of genes when we ascribed them the status of being the intrinsic essences. We also see why it appears that species' membership carries explanatory power rather than it just being partly informative about organisms that belong to the certain species. After his intrinsic biological essentialism has been described, it begins to appear as though it is completely in sync with our intuitive views on biological species and genes. So it could be said that Devitt provided the theoretical background for the intuitive beliefs of many a folk, including children as well. The theory also shows why essentialism can be compatible with evolution and biological species. However, in order for this to be true, traditional essentialism needs to be reformed because traditional essentialism does not permit the existence of the kind of essences that Devitt is advocating for.

I want to offer one final objection to intrinsic biological essentialism. While it is an appealing theory, the fact of the matter is that it changes the way essentialism is conceptualized, and with that the essence itself becomes different from its traditional counterpart. Devitt himself explained this difference. But if we do not allow for traditional essentialism to be changed, than his theory does not succeed in showing that species have intrinsic essences. Not only can variations between the essences of the same species be allowed to exist, but the addition of something relational is definitely forbidden. Thus, because we cannot determine a non-relational completely intrinsic essence for each species, species cannot form natural kinds according to essentialism. At best, intrinsic biological essentialism forms natural kinds of the cluster kind type. It appears to pick some properties which members of the same species share, but it also picks some extrinsic properties and relates them to other members. It seems quite a lot like these properties form a cluster which is not influenced by our intentions. It should be mentioned, however, that this objection is based on the idea that traditional essentialism should not be changed. But traditional essentialism is not compatible with modern sciences like biology and genetics which provide us with substantial knowledge of the world. So perhaps we ought to consider that a change in the way we conceptualize essentialism is necessary.

6. Conclusion

The desire to show that genes are the basis for biological species being natural kinds is destined to run into certain problems. One such problem is caused by those who believe that only essentialist natural kinds are real, while other theories point to groups that are not privileged. This belief seriously undermines a great body of work by non-fundamental sciences such as biology, genetics, geology and others which provide us with substantial knowledge about our world. The explanations derived from these higher-level sciences appear as though they are referring to natural kinds and this is why many claim that essentialism is too restrictive. Other views of natural kinds attempt to reason that essentialist requirements need not be the only way to classify entities into natural kinds. But perhaps we need to rethink essentialism so that it can comply with modern higher-level sciences. Even if they are not dealing with natural kinds, it appears as though they are based on the kind of knowledge we receive from them. This might imply that it is essentialism that was not properly imagined.

Genes as entities are probably older than we can even imagine, and this is based on the fact that genes existed long before any current species did. For something to exist for such a long time while every other living entity seems to disappear, it would be reasonable to think that genes possess a quality that causes their dominance over other living entities, since they still thrive in this world while organisms and species come and go. This is why it does not seem farfetched that genes have a special role in explaining species and that they are in fact essential properties of species. Discoveries from genetics more and more provide us with explanations of how genes and mutated genes affect organisms. It appears that the more progress genetics achieves the more we are going to understand why species are the way they are.

Such beliefs are why I am of the opinion that species have intrinsic essences that cause them to be natural kinds, and that genes are these intrinsic essences. Like Michael Devitt, I am not intimidated by the consensus on species not having intrinsic essences. I see the consensus only as a challenge to overcome in order to prove the theory that coincides with my intuitive beliefs.

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