Explanatory essentialism and cryptic species

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Abstract: Explanatory Essentialism (EE) is the view that a property is the essence of a kind because it causally explains the many properties that instances of that kind exhibit. This paper examines an application of EE to biological species, which I call Biological Explanatory Essentialism (BEE). BEE states that a particular biological origin is the essence of a species on the grounds that it causes certain organisms to display the group of properties the species is associated with. Evaluating BEE is important, as it offers a novel argument for biological essentialism—the contentious claim that biological species have essences. This paper critically assesses the empirical foundations of BEE, focusing on the presupposition that a single biological origin causes the many properties associated with the species in question. By discussing a case of cryptic species among five-toed jerboas within the *Scarturus elater* species complex, I challenge that presupposition, thereby arguing that cryptic species present a serious obstacle to BEE. I conclude that BEE fails to support biological essentialism and suggest that essentialist philosophers reconsider the role of causal-explanatory factors in accounting for the purported essences of biological species. These philosophers may need to explore alternatives beyond such factors, one of which I briefly outline.

Keywords: natural kinds, biological species, explanatory essentialism, biological explanatory essentialism, cryptic species, biological origins.

1 Introduction

Kripke (1971, 1980) and Putnam (1970, 1975) played a pivotal role in reviving the notion of essence (Benardete, 1993; Okasha, 2002), shaping the modern understanding of what is now known as Natural Kind Essentialism (Tahko, 2024). A central tenet of this view is that the essences of natural kinds are expressed through propositions that are both a posteriori and necessary—commonly referred to as "theoretical identifications."

Natural Kind Essentialism faces significant difficulties. Salmon's (1981) influential analysis suggests that the necessity of theoretical identifications depends on non-trivial essentialist premises. For example, the necessity of "Water is H_2O" relies on the assumption that being a sample of a particular substance is determined by possessing a specific chemical structure. The problem is that this assumption appears to rest on a mere a priori intuition, which lacks clear justification (Oderberg, 2007;

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Lowe, 2011; Tahko, 2015). Philosophers of science have observed that no compelling argument has been offered for that intuition, raising doubts about its support from scientific theory (e.g., Van Brakel, 1986; Needham, 2011).

In response to these and other difficulties, some philosophers have recently looked for alternative ways to support Natural Kind Essentialism. One of these attempts is what I refer to as Explanatory Essentialism (EE), the view that a property is the essence of a kind because it causally explains why certain items exhibit the group of properties associated with that kind.[2] Philosophers such as Hawley and Bird (2011), Bird (2018), Mallozzi (2021a, 2021b), Godman et al. (2020), Godman and Papineau (2021), and Papineau (2022) can be said to be proponents of EE. For instance, Hawley and Bird (2011) argue that the essence of a natural kind is the universal (natural property) that is causally responsible for the existence of the combination of universals with which that kind is identified. Similarly, Godman et al. (2020) contend that the essence of a natural kind is the super-explanatory property that causally explains the many properties that instances of that kind exhibit. In this vein, EE supplies a principled basis for Natural Kind Essentialism. The essences of natural kinds and the modal status of theoretical identifications are accounted for by the causal-explanatory role of certain properties, rather than by contentious a priori intuitions (Mallozzi, 2021a).

This paper critically examines the prospects of EE in relation to biological species. This task is particularly relevant, as EE may support biological essentialism, the contentious claim that biological species have essences (e.g., Mayr, 1959; Ghiselin, 1974; Hull, 1976; Dupré, 1999; Slater, 2016). Evolutionary theory indicates that members of the same species need not share a specific set of intrinsic properties, which contradicts the thesis that this type of properties are the essences of biological species (Okasha, 2002). Some authors argue that evolutionary theory is still compatible with the idea that the essences of biological species are extrinsic-relational properties, such as specific biological origins (Griffiths, 1999; Okasha, 2002). However, one may still question why a specific biological origin constitutes the essence of a species rather than some other property. EE offers a straightforward response, which I call Biological Explanatory Essentialism (BEE): such an origin is essential because it causally explains why certain organisms exhibit the many properties associated with the species (e.g., Hawley and Bird, 2011; Godman et al., 2020). For example, the essence of tigers (*Panthera tigris*) is the relational property of being a descendant of original tiger populations, as this origin explains the many properties that tigers display (*ibid.*). Thus, biological origins are the essences of biological species in virtue of their causal-explanatory power.

[2] Proponents of EE not only argue for the weaker claim that a property F has explanatory power but also for the stronger claim that this explanatory power is the reason why F is the essence of a kind K. Thus, EE can be understood as addressing what might be called "the reason question": why is F the essence of K? According to EE, F is the essence of K in virtue of its explanatory power. It follows that rejecting EE does not require denying the weaker claim that F is causally responsible for the various properties exhibited by samples of K; rather, it involves rejecting the claim that F is the essence of K as a consequence of its causal-explanatory role.

To assess whether BEE supports biological essentialism, this paper scrutinizes the empirical foundations on which the view rests. BEE presupposes that only one biological origin is capable of causing the various properties associated with the species in question. If two or more origins could fulfill this role, causal-explanatory considerations would fail to justify why one of these origins, rather than the others, constitutes the essence of the species. This paper examines that empirical presupposition by delving into the phenomenon of cryptic species—taxa that are morphologically indistinguishable yet follow distinct evolutionary paths (Bickford et al., 2007; Struck and Feder et al., 2018). I argue that cryptic species suggest that more than one biological origin could cause organisms to exhibit the properties associated with a given species. If this is the case, this biological phenomenon has the potential to undermine BEE, thereby challenging the support that this view offers for the thesis that biological species have essences. The upshot of this discussion is not that biological essentialism is false, but rather that causal-explanatory considerations may be insufficient to justify it.

The remainder of this paper is organized as follows: Section 2 introduces EE and outlines the arguments presented by Hawley and Bird, as well as Godman et al., highlighting the auxiliary premise on which these arguments depend. Section 3 presents BEE in a similar manner. Section 4 evaluates the auxiliary premise required to underpin BEE, focusing on a case of cryptic species among five-toed jerboas of the *Scarturus elater* species complex. It explains why cryptic species pose a challenge for BEE and counters a potential solution to this issue. Section 5 discusses Devitt's (2008, 2010, 2023) case for what I term "Intrinsic Biological Explanatory Essentialism" (IBEE) and his appeal to cryptic species. Finally, the conclusion raises doubts about the feasibility of accounting for the purported essences of biological species through causal-explanatory considerations and proposes an alternative avenue for further exploration.

2 Explanatory Essentialism and its empirical grounds

2.1 Explanatory Essentialism

Advocates of EE emphasize that there are numerous generalizations about members of a given natural kind. For example, horses have manes, uncloven hooves, eat grass, and share a wide range of other morphological, physiological, and behavioral traits. These observations resonate with Mill's (1840) view that a Kind is a class of items sharing numerous attributes, potentially inexhaustible in number. From this perspective, each natural kind is associated with several properties, and identifying a kind involves recognizing the various properties that consistently correlate in certain items.

Hawley and Bird (2011) and Bird (2018) translate this Millian perspective into a specific ontological framework. Since members of the same kind share multiple attributes, various properties of unobserved members of the kind can be inferred, implying that each kind is a rich source of induction. To account for these inductions on an ontological level, Hawley and Bird argue that natural kinds are complex universals: "Natural kinds have this inductive power by managing to encapsulate many natural properties in one. A plausible way that natural kinds could achieve this is by themselves being compounds of the relevant universals" (Hawley and Bird, 2011, p. 208). A complex universal is simply a combination of several simple universals that co-occur in certain items. For instance, the kind gold can be identified with a combination of universals (natural properties) such as yellow, shiny appearance, a density of 19.283 g/cm^3, a melting point of 1,064.18 °C, and a boiling point of 2,970 °C.

Godman et al. (2020) define natural kinds in line with Mill without offering an ontological interpretation. They state, "Following John Stuart Mill, we call this sort of category ['horse'] a Kind (and retain his capitalization for this and related terms). The defining characteristic of Kinds is that any Kind K will enter into a plurality of informative synthetic generalizations of the form: All K are G" (p, 317). These generalizations describe the multiple commonalities among members of the kind. Natural kinds, in this way, are categories whose members share a wide range of properties rather than just one or a few.

Both Hawley and Bird (2011) and Godman et al. (2020) argue that, for any kind, there exists a property that is causally responsible for certain items exhibiting the corresponding group of associated properties. On this basis, the authors maintain that such a property is a condition without which the kind cannot exist, from which they suggest that it is the kind's essence. This reasoning is especially clear in Hawley and Bird's (2011) account. They state, "suppose that a kind-universal K is composed of universals A, B, C, D, and E, but E plays a privileged role in explaining why these universals are frequently co-instantiated (…) when X is a kind, E is a part of X without which X could not exist (…) Given that E plays this central role in explaining the existence and nature of K, it is a prime candidate for being or contributing to the essence of K" (p. 219).[3] E is causally responsible for the existence of the combination of properties K is identified with, so that E is necessary for K to exist. For example, "being constituted of atoms with atomic number 79 explains why this complex [the one gold is identified with] exists, and so will be part of the complex wherever it exists. Hence, it will be a necessary and plausibly essential feature of the kind [gold]" (Bird, 2018, p. 1418).

Godman et al. (2020) present a similar argument, noting that a single property often causes the multiple properties associated with a kind—a property they call "super-explanatory." In their words, "So for us, Kinds are any categories whose instances display multiple commonalities. A super-explanatory property for such a Kind is then a single property that causes all the other shared

[3] Hawley and Bird are committed to the view that an explanatory universal forms part of the essence of a kind, so they do not claim that this property constitutes the kind's full essence.

properties" (Ibid., p. 320). From this, Godman et al. infer that a super-explanatory property is a necessary condition for supposing the existence of the kind in question, a thesis that they present as a counterfactual argument.

> But when counterfactually suppose that some Kind lacks a super-explanatory property, we are prevented from holding most of its other properties fixed, given that counterfactually supposing away a cause typically requires us to suppose away its effects, too. So when we suppose away the super-explanatory core of some Kind, all bets are off. We are hypothesizing away all the many correlated properties that distinguish that Kind from others. The natural reaction is that we have thereby taken away the Kind altogether (p. 327–328).

By invoking the causal-explanatory role of a super-explanatory property, the authors argue that, without this property, no items would exhibit the distinguishing properties of the kind at issue. On these grounds, they contend that the kind cannot be supposed to exist without its corresponding super-explanatory property. A super-explanatory property thus serves as a necessary condition for supposing the existence of the kind, suggesting that it constitutes the kind's essence.

According to the observations above, a natural kind K is identified with a group of many properties (GMP)—based on a Millian perspective on Kinds—, and a property (or universal) F is posited to cause that GMP. This suggests that F is a necessary condition for the existence (or supposition) of GMP, which implies that K cannot exist without F. In this vein, F is a strong candidate for constituting the essence of K. By means of this argument, the authors support EE: a property is the essence of a kind because it causally explains the group of many properties associated with that kind.

Based on the remarks above, and to facilitate the discussion, the argument in question can be outlined as follows:

Argument for EE (Argument 1)

P1.1 A natural kind K is identified with a group of many properties GMP.
P2.1 A property F causes some items to exhibit GMP.
P3.1 F is a property without which GMP cannot exist nor be supposed to exist.
C1.1 F is a property without which K cannot exist nor be supposed to exist.
C2.1 F is (at least part of) the essence of K.[4]

[4] The inference from C1.1 to C2.1 appears to rely on a modal conception of essence, according to which the necessity of a property to a thing is sufficient to establish that it constitutes (at least part of) the essence of that thing (Wildman, 2013). The modal view of essence faces several challenges, particularly in light of Fine's (1994) critique. Nevertheless, for the sake of argument, I will assume that this modal view is viable.

2.2 Explanatory essentialism's auxiliary premise

I will now focus on premise P3.1 (applied to biological species). Notice that while P2.1 provides support for P3.1, it does not entail this premise. Although we often regard causes as difference-makers—factors whose absence would likely prevent certain effects (Lewis, 1973)—we also recognize that some effects can arise from different causes (Mackie, 1965). This issue is known as the problem of redundant causation, which underscores that an alternative cause could, in principle, bring about a certain effect (Paul and Hall, 2013). Accordingly, the fact that a property F causes a certain GMP (P2) does not entail that the GMP exists only if F does (P3.1). Another property, F*, may produce the same GMP even in the absence of F, implying that the GMP would exist even if F did not. With this in mind, it follows that for P3.1 to hold, an auxiliary premise (AP) is required, stating that F is the only property capable of causing the relevant GMP.

Kim (2023), a critic of Godman et al., underlines that the truth of a premise like P2.1 does not imply P3.1, which indicates that P3.1 depends on AP.

> For an explanatory relation, whether causal or non-causal, holds by virtue of a set of background conditions and some general laws, which we may call the explanatory basis. Unless the explanatory basis is shown to be metaphysically necessary, that X is explanatory of Y does not imply that Y is impossible without X. (…) Hence, any account that tries to explicate the notion of essence in terms of an explanatory relation faces the challenge of showing the necessity of the explanatory basis itself (p. 11-12).

These remarks suggest that even if P2.1 is true, P3.1 would be false if AP were disconfirmed in the actual world or in some possible world. A consequence of this is that Putnam's (1975) Twin Earth scenarios pose a problem for P3.1, as they illustrate cases in which two distinct (microstructural) properties (e.g., being composed of H_2O and being composed of XYZ) can give rise to the same group of many properties (e.g., those associated with water).

This point can be illustrated by appealing to Tahko's (2015) proposal for supporting Natural Kind Essentialism. He argues that a crucial principle for that position is IDENT: "Necessarily, a sample of chemical substance A is of the same chemical substance as B if and only if A and B have the same microstructural composition" (p. 804). IDENT is required for the thesis that a proposition like "Water is H_2O" is a posteriori yet metaphysically necessary (Salmon, 1981). Tahko indicates that IDENT is not justified by a mere priori intuition but on a principle like INST: "Necessarily, there is a 1:1 correlation between (all of) the chemical properties of a chemical substance and the microstructure of that substance" (Ibid.). This 1:1 correlation indicates that identical microstructures cause the same chemical properties, whereas different microstructures cause different chemical properties. The truth of INST implies that microstructures determine the properties of chemical substances, which supports the thesis that microstructures determine those substances' identities (IDENT).

Building on this reasoning, Tahko (2015) argues that Twin Earth scenarios pose a significant challenge to Natural Kind Essentialism. If Twin Earth was possible (a planet, identical to Earth in every respect except that the colorless, odorless, and tasteless liquid filling its lakes and oceans is composed not of H_2O molecules but of a different chemical compound, XYZ), two microstructures, H_2O and XYZ, could produce the group of properties associated with water.[5] On this basis, INST is false, as there is no 1:1 correlation between microstructures and chemical properties. Tahko (2015) underlines that, in these circumstances, it would be unclear why microstructures determine the identities of chemical substances (IDENT). "If two distinct microstructures [H_2O and XYZ] could cause some items to exhibit the same chemical properties [so that INST is false], then what reason would we have to think that IDENT is true?" (p. 807). Since both H_2O and XYZ can cause the chemical properties of water, the assertion that one of these microstructures, as opposed to the other, is the identity (or essence) of water lacks justification.

Tahko's remarks are pertinent for the present discussion since they highlight the empirical foundation of EE.[6] One can accept that H_2O causes the many properties associated with water (P2.1); however, if another property (being composed of XYZ molecules) could fulfill a similar causal role in the actual world or in another metaphysically possible world (¬AP), there would be no justification—other than an a priori intuition— for considering H_2O, rather than XYZ, as necessary and essential to water. Given that both properties serve analogous causal roles, causal-explanatory considerations alone cannot justify why one should be regarded as the essence of water instead of the other. Along these lines, it is possible to see that an argument like that advanced by EE, as well as Tahko's defense of Natural Kind Essentialism, relies on an auxiliary premise (AP). If a property, F*, can reproduce GMP even in the absence of F, then there would be no reason—aside from an a priori intuition—to believe that F is necessary and essential to the kind in question.

Provided the importance of this auxiliary premise, further clarification is necessary. One pressing issue is the meaning of the expression "group of many properties." This clarification will allow us to assess whether AP can withstand close examination in the context of biological species.

Hawley and Bird (2011) provide hints as to what could be that meaning. The authors distinguish between precise conjunctive kinds and vague indeterminate kinds. The former are kinds defined in terms of conjunctions of properties (universals), where possession of every property is necessary for an item to be an instance of the kind in question. For example, the kind electron is defined as a conjunction of properties: a charge of $-1.602176 \times 10^{-19}$ C, a mass of 9.109382×10^{-31} kg,

[5] Based on the assumption that microstructural properties like being composed of H2O are causal-explanatory.

[6] In my view, what Tahko terms Natural Kind Essentialism aligns with what I have defined as EE. Due to space constraints, I will not explore the issues that arise from this alignment here.

and a spin of 1/2. Accordingly, an item is an electron only if it possesses all the properties in the conjunction. In contrast, a kind is vague and indeterminate insofar as not every property that co-occurs partakes in the kind's definition, which implies that not every property is necessary for an item to be a member of the kind. For example, members of the species red squirrel (*Sciurus vulgaris*) share several properties, such as a specific weight range, a coat that may be black, red, or gray, bushy tails, ear tufts, curved claws, a diet of seeds, and classification as rodents. However, "possessing all these [associated] properties is not a necessary condition for kind membership: outlying individuals may lack one or more of the 'core' properties, without it being determinate that they are non-members of the kind" (Hawley and Bird, 2011, p. 211).[7]

Hawley and Bird argue that higher-level kinds, such as chemical and biological kinds, are indeterminate. In this regard, they align with Boyd's (1991, 1993, 1999) thesis that, for some kinds—particularly biological ones—, there are neither necessary nor sufficient conditions for kind membership. This implies that sometimes it would not be possible to determine whether an item is a member of a kind or not.

In order to account for membership in higher-level kinds, the authors embrace indeterminacy.[8] As a result, the group of many properties (GMP) associated with a kind is understood as a vague combination, where no single property is necessary to maintain the kind's identity or to determine kind membership—only a majority of them are.[9] Understanding the notion of the "many group of properties" associated with the kind in this fashion, P3.1 can be redescribed as stating that F is a property without which the vague combination of properties associated with K cannot exist. Similarly, the corresponding auxiliary (AP) premise can be redescribed as follows:

> AP: F is the only property capable of causing a vague combination of the properties associated with K.

[7] Hawley and Bird (2011, p. 212) illustrate their stance through the following example: they ask us to consider a kind K whose associated properties are P, Q, R and S. An individual, *a*, that possesses all these properties is a member of the kind. On the other hand, an individual, *b*, which instantiates P, Q and R but lacks S, cannot be merely excluded from K. Whether or not *b* is a member of the K is indeterminate.

[8] The indeterminacy in question is metaphysical rather than epistemic; it arises from what a natural kind is, rather than from our ability to know a certain state of affairs.

[9] My assumption is that Godman et al. should also embrace indeterminacy in order to avoid the unpalatable thesis that possession of all the associated properties is necessary for kind membership in chemical and biological kinds.

3 Biological Explanatory Essentialism

Proponents of EE, following Kripke and Putnam, argue that chemical constitutions are the essences of chemical kinds. They justify this essentialist claim based on the explanatory role that those constitutions play. In this context, Godman et al. (2020) observe: "the atomic constitution of gold explains why all samples of solid gold have the same density, electrical and thermal conductivity, melting and boiling point, and so on" (p. 319). Given its explanatory role, that atomic constitution is plausibly a necessary and essential property of gold.

With regard to biological species, proponents of EE deviate from Kripke and Putnam's—alleged— view. Kripke (1980) stated that the essence of tigers is a certain internal structure, while Putnam (1970, 1975) claimed that the essence of lemons consists of a specific genetic code. In both cases, the essences of biological species are said to be intrinsic properties. However, this thesis appears to conflict with evolutionary theory, to the extent that it is rejected by most biologists and philosophers of biology (Okasha, 2002). A more appealing alternative for those sympathetic to biological essentialism seems to be the idea that the essences of biological species are extrinsic properties, corresponding to specific biological origins (Griffiths, 1999; Okasha, 2022).

Proponents of EE provide a principled explanation for this view, thereby supporting biological essentialism. Bird (2018), for example, maintains, "It is the fact of sharing a common ancestor that (in large part) explains why members of a clade tend to share genetic and phenotypic characteristics. I suggest that what explains the existence and nature of something has a good claim to fix its identity" (p. 1422). A biological ancestry is necessary for the existence of a species (thereby determining its nature) because it causes some items to exhibit certain properties. Godman et al. (2020), for their part, argue, "(...) it seems natural enough to take origins to be essential to taxa: you cannot possibly be a tiger unless you are part of the lineage that starts with the original tigers, and necessarily anything that is part of that lineage (without too many modifications) is a tiger (...) we attach more importance to the fact that our proposal also suggests a principled explanation for these intuitions" (p. 327). This principled explanation is what I call BEE: biological origins constitute the essences of biological species because they cause certain organisms to exhibit the many properties a species is associated with.

BEE can be understood as an application of EE to the issue of the essences of biological species. Thus, an argument analogous to Argument for EE can be constructed. From this perspective, a kind K is a biological species (BS), and the property F that causes the group of many properties (GMP)—a vague combination of properties—associated with BS is a specific biological origin (BO).

Argument for BEE (Argument 2)

P1.2 A BS is identified with some GMP.

P2.2 A BO causes some organisms to exhibit that GMP.
P3.2 That BO is a property without which the GMP cannot exist nor be supposed to exist.
C1.2 That BO is a property without which the BS at hand cannot exist nor be supposed to exist.
C2.2 That BO is (at least part of) the essence of BS.

P1.2 depends on a specific perspective on natural kinds, aligned with Mill. P2.2 is an empirical observation, suggesting that a particular biological origin reproduces a combination of properties associated with a biological species. P3.2 is a necessity claim, asserting that that specific biological origin is necessary for the corresponding vague combination of properties to exist. Considering the points made in subsection 2.2, P3.2 relies on an auxiliary premise saying that the biological origin in question is the only one capable of reproducing a combination of the properties associated with the species at hand. If two or more biological origins possessed this causal power, none would be necessary for the existence of the species' associated properties, as one origin could fulfill this role in circumstances where the other does not exist. Consequently, no specific biological origin could be necessary for the existence of the species, thereby weakening the argument that one origin, as opposed to another, is (at least partially) the species' essence. Adapted to Argument for BEE, the aforementioned auxiliary premise can be expressed as follows:

APB: a specific biological origin is the only property capable of causing a vague combination of properties associated with a biological species.

As can be seen, the argument supporting BEE relies on two empirical observations: P2.2 and P3.2. For the sake of argument, I will assume that P2.2 is true—that is, that a given biological origin can cause many of the properties associated with a particular biological species.[10] The premise to be evaluated, then, is P3.2, which, in turn, depends on APB. Accordingly, I will examine whether there are sufficient reasons to trust APB, especially in light of biological theory and the phenomenon of cryptic species.

[10] P2.2 is particularly problematic. Avise (2000) observes that the origin of a species is not a singular event but rather the outcome of multiple processes and mechanisms. Some of these processes indicate that certain properties associated with a species can be traced back to a time well before the lineage became distinct, while others may result from more recent, post-origin events, such as hybridization. Consequently, the complexity of biological origins challenges their singularization, contrary to the presupposition that BEE requires.

4 Assessing BEE

4.1 Biological theory and cryptic species

Prima facie, biological theory aligns with APB making the prospects of BEE appear promising. This is due to the purported correlation between speciation events and morphological change (Rabosky, Santini et al., 2013). Advocates of the Theory of Punctuated Equilibrium (Gould and Eldredge, 1976), for instance, appeal to this correlation to argue against gradual evolution. After a speciation event occurs, the groups involved differentiate morphologically at a faster rate than previously assumed. For example, the original population of tigers (*Panthera tigris*) gave rise to organisms with distinct morphological traits, differentiating them from closely related species, thus establishing a group of properties characteristic of the organisms called "tiger." Based on the assumption that speciation is closely tied to morphological change, it is unlikely that more than one biological origin could make some creatures exhibit the morphological traits associated with a particular species.

Nevertheless, the notion that speciation invariably leads to morphological change is nowadays discredited (Bickford et al., 2007). Phenomena such as morphologically static cladogenesis—the diversification of new species without the expected morphological changes—have been increasingly documented, largely driven by the discovery of cryptic species. Struck and Feder et al. (2018) define cryptic species as "taxa that cannot readily be distinguished morphologically, yet evidence shows they are on different evolutionary trajectories" (p. 153). Cryptic species have been identified in the last decades due to sequencing techniques and improved methods for extracting DNA from biological collections (Monro, 2022). Employing these techniques, taxonomists have been able to reassess the boundaries between morphologically similar or indistinguishable taxa (Avise, 2000; Olson et al., 2004). Organisms once classified within the same species have been revealed to form non-monophyletic groups, lending credence to the hypothesis that they constitute at least two distinct species rather than one.

Cryptic species have been found across a broad spectrum of animal phyla and plant groups (Pérez-Ponce de León & Poulin, 2016; Monro, 2022). Notably, this phenomenon is not limited to closely related organisms; phylogenetically distant species can also exhibit cryptic speciation. Cryptic species may emerge from the independent evolution of morphologically dissimilar ancestors, rather than exclusively from sister taxa or recent speciation events (Vrijenhoek, 2009). Well-documented cases of convergent evolution leading to cryptic species have been observed in diverse taxa, including singing insects (Henry et al., 1999), bonefish, and copepods (Vrijenhoek, 2009). On this basis, biologists invoke the concept of cryptic species to highlight biological processes once considered rare, such as parallelism and convergent evolution (Struck and Feder et al., 2018).[11]

Taking these observations into account, the phenomenon of cryptic species suggests that some organisms may exhibit the properties typically associated with a particular biological species despite having distinct biological origins. Assuming that a biological origin explains the commonalities among members of a species, this phenomenon raises the concern that most properties associated with a species can be reproduced by at least two distinct biological origins, which contradicts APB. In this vein, cryptic species indicate that no specific biological origin is necessary for a given combination of properties to exist, thereby casting doubt on P3.2 and, consequently, on BEE.

Before embracing this conclusion, it is necessary to examine a concrete case that illustrates the threat cryptic species pose.

4.2 Jerboas of the *Scarturus elater* species complex

Jerboas are mouse-like rodents inhabiting the deserts and steppes of Eastern Europe, Africa, and Northern Asia. The most distinctive feature of these animals is their elongated hindlegs, reminiscent of those of kangaroos, which enable jerboas to move swiftly by saltation. Within the jerboa subfamily Alactaginae, the smallest members belong to the *Scarturus elater* species complex (Bannikova et al., 2018). These diminutive jerboas have a body mass ranging from 40 to 70 grams, possess four digits on their hindlimbs, exhibit large rabbit-like ears, and sport tails that exceed their body length.

The *Scarturus* species complex comprises two species: *S. elater* and *S. vinogradovi* (Ibid.,). Biologists have identified three morphotypes (*elater*, *indica*, and *vinogradovi* groups) based on cranial and dental measurements, as well as the morphology of the glans penis. A study by Moshtaghi et al. (2016) subdivided the *S. elater* morphotype into four genetic forms, suggesting the presence of four monophyletic groups. This research concluded that four species are associated with only one morphotype, supporting the hypothesis that S. elater may represent a case of cryptic speciation. Nonetheless, the data gathered by Moshtaghi et al. were insufficient to draw definitive taxonomic conclusions, as they lacked comprehensive genetic markers and extensive morphological analysis.

Bannikova et al. (2018) sought to fill this gap. The investigation analyzed 115 specimens collected from the geographic range of *S. elater*, encompassing European Russia, Armenia, Georgia, and Turkey in the west; West China and Mongolia in the east; Kazakhstan and southern Russia in the north; and Iran, Afghanistan, and Pakistan in the south. Bannikova et al. compared the specimens' mitochondrial cytochrome b (cytb) gene, as well as BRCA1 and IRBP nuclear gene fragments. They

[11] It is important to note that the exact degree of similarity required for two groups of organisms to be considered cryptic species remains unclear. In this regard, the notion is not as straightforward as it might initially seem. An anonymous reviewer has helpfully highlighted this point.

performed a morphological analysis that involved 13 cranial measurements, molar proportions, and examination of the glans penis, including its length, width, height, pattern of spine distribution, and number of spines.

The morphological analysis distinguished only two morphotypes: one corresponding to clades North (N) and South (S), and another corresponding to clade South West (SW). Clades N and S were morphologically indistinguishable. No statistically significant differences were observed in the morphology of the glans penis, cranial measurements, dental characteristics, glans penis, etc.,. Thus, Bannikova et al.'s data revealed no significant differences in the morphological and physiological properties of members of clades N and S.

On the other hand, the mitochondrial analysis confirmed the existence of three highly divergent genetic clades: N, S, and SW. This genetic divergence was substantial (10-11.3%), which led the authors to conclude that clade N and S represent distinct species, despite their striking morphological similarity. Based on these findings, Bannikova et al. (2019) concluded: "(...) our comparison demonstrated that the level of morphometric variability of the samples from the areas of co-occurrence of the two clades [N and S] was the same as that of the samples from the areas where only one of the clades was recorded. Therefore, these two clades within the *Scarturus elater* species complex evidently represent true cryptic species" (p. 36). In short, Clade N and Clade S are two biological species, despite the striking similarities between the properties of members of both clades.

4.3 A problem for BEE

The case described above highlights a problem for BEE. It appears that the auxiliary premise APB can be false for certain species, suggesting that the empirical grounds upon which BEE relies are shaky. I will now examine this point in detail.

As stated in Section 3, the argument for BEE requires an auxiliary premise stating that only one biological origin is capable of reproducing the combination of properties associated with the species in question (APB). The case described by Bannikova et al. appears to present a situation in which this premise is disconfirmed. Members of clades N and S share a broad range of biological properties to such an extent that individuals from each clade cannot be distinguished either by visual observation or through statistical analysis of the traits by which jerboa species normally differ (e.g., glans penis morphology, cranial measurements, and dental characteristics). This similarity contrasts with the genetic differences between members of both clades, which suggest that these groups have distinct biological origins. Clade N and clade S follow separate evolutionary trajectories, with the former descending from biological population N and the latter from biological population S.

Given the premise that biological origins are causally relevant, Bannikova et al.'s research supports the concern that two distinct biological origins can cause most of the properties associated with a given biological species. Two biological origins can account for the combination of properties associated with clade N (and, similarly, with clade S): being a descendant of original population N and being a descendant of biological population S. Hence, APB is false.

The falsity of APB undermines the rationale for BEE. According to this view, being a descendant of original population N would constitute the essence of clade N because it is causally responsible for the properties associated with that clade. As shown in the Argument for BEE, this thesis depends on premise P3.2, which indicates that being a descendant of original populations N is necessary for the group of properties associated with clade N to exist (or be assumed to exist). Nonetheless, if being a descendant of original population S can also cause an organism to exhibit the group of properties associated with clade N, then this combination of properties can exist even without being a descendant of original populations N. Consequently, this biological origin cannot be necessary for the existence of these properties (P3.2), nor for the clade associated with them (C1.2), rendering the thesis that being a descendant of original populations N constitutes the essence of clade N (C2.2) unjustified. In short, if the causal-explanatory role of being a descendant of original population N is equivalent to that of being a descendant of original population S, then the former cannot be the reason why that biological origin constitutes the essence of clade N.[12] Thus, BEE fails as an account of the alleged essence of clade N.

Before embracing that conclusion, it is important to recall that the two biological origins in question do not produce exactly the same properties. While members of clades N and S may share morphological, physiological, and possibly behavioral traits, they differ in certain genetic properties. Thus, it would be a mistake to assume that being a descendant of clade S is capable of producing the same genetic properties associated with clade N. On these premises, one might argue that the case in question is not one where two biological origins possess equivalent causal-explanatory power, which suggests that only one of these origins—namely, being a descendant of original populations N—is capable of causing the group of many properties associated with clade N. Therefore, APB appears unchallenged.

This line of reasoning fails to adequately defend BEE. The reason is that APB does not mean that only one biological origin can reproduce every single one of the properties associated with a kind

[12] The fact that two biological origins can reproduce the combination of properties associated with a species is not the only empirical challenge faced by Biological Explanatory Essentialism (BEE). Another significant problem concerns the role of deeper ancestry in explaining species-specific properties. For example, given the numerous traits shared by members of clades N and S, it seems plausible to argue that the property responsible for these shared traits is not simply being a descendant of the closest ancestor of each group's members (e.g., being a descendant of original populations N). Rather, it may be being a descendant of a deeper common ancestor from which both clades originated (e.g., being a descendant of the original populations that gave rise to clades N, S, and SW as offshoots). This observation complicates the claim that the relevant explanatory property is a specific biological origin—namely, the one corresponding to the most recent speciation event, as proponents of EE presuppose. I am grateful to an anonymous reviewer for raising this issue.

but only that one biological origin can reproduce a vague combination of those many properties. As such, that premise gets falsified if two or more biological origins are capable of producing most of the properties associated with the species, even if they are not capable of producing all of them. As stated in subsection 2.2, the content of APB is tied to the commitment of proponents of EE to indeterminacy, stemming from their goal of accounting for kind membership in higher-level kinds, such as biological ones. In view of that commitment, proponents of BEE should accept the thesis that some items can be members of a kind even if they do not exhibit all the properties associated with it.

Let us clarify this point further. Given the causal power of being a descendant of the original populations S, a scenario could arise in which no organisms are descendants of the original populations N, yet some organisms exhibit most of the properties typically associated with clade N. Consistent with their commitment to indeterminacy, proponents of BEE would describe this scenario as one in which it is indeterminate whether clade N exists. Since some organisms exhibit most of the properties associated with clade N, it would be indeterminate whether these organisms are members of clade N. The point is that this observation does not adequately support the claim that being a descendant of the original populations N is both necessary and essential to clade N. If that claim were correct, it would not merely be indeterminate but outright impossible for clade N to exist without the corresponding biological origin. Thus, BEE fails to support the thesis that a particular biological origin is both necessary and essential to a given biological species.[13]

To illustrate the threat that cryptic species pose to BEE, it may be useful to refer to chemical kinds.[14] Several scholars, including Kuhn (1990), Lowe (2011), and Hoefer and Martí (2018), have expressed skepticism regarding the plausibility of Putnam's (1975) Twin Earth. The concern is that "the Twin Earth thought experiment is founded upon a supposition that turns out to be incompatible with the physical and chemical laws of our universe" (Lowe, 2011, p. 15). According to these laws, H_2O is necessary for the manifestation of the superficial properties associated with water, implying that

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[13] An alternative line of reasoning might provide an objection to my criticism of BEE. In the discussed case, different biological origins correlate with distinct genetic properties. However, each of these origins may also correlate with other properties that define species boundaries, depending on the species concept employed. Properties related to mate recognition (e.g., visual or olfactory receptors) or those tied to sexual reproduction could be argued to play this role and, as such, to be distinctive of a species. Proponents of BEE might argue that no evidence has been provided to suggest that two biological origins (super) explain the properties that characterize a species, particularly those crucial for setting species boundaries. I am grateful to one of the reviewers for raising this potential objection to my criticism. Nevertheless, in my view, this reasoning may conflict with one of the main motivations behind BEE. The idea that properties related to mate recognition, reproductive compatibility, and genetic differences may carry more weight than others in characterizing certain species challenges BEE's understanding of a kind as merely a combination of properties (each given equal weight). This understanding is central to BEE's attempt to defer the determination of species boundaries to nature itself, relying solely on the observation of several co-occurring properties rather than on theoretical considerations, such as species concepts, to distinguish between species.

[14] The following remarks are intended solely to illustrate the problems that BEE presents and are not supposed to defend a specific thesis regarding chemical kinds. Similarly, no assumption is made regarding the essence of water.

no other chemical composition (e.g., XYZ) could replicate these properties. Based on these considerations and other observations, Tahko (2015) suggests that empirical evidence may support a necessary 1:1 correlation between microstructure and chemical properties (INST) for several chemical substances. This means that only one microstructure may be capable of producing the group of properties associated with a given substance, thereby supporting the thesis that this microstructure is necessary (and essential) to the kind.

In the case of biological species, no biological laws substantiate the principle asserting a necessary one-to-one correlation between biological origins and the properties associated with a given species. The existence of cryptic species reinforces this point. Cryptic species demonstrate that a single biological origin is not the only factor capable of producing the group of properties associated with a species—assuming that biological origins have causal-explanatory relevance. The key takeaway is that there is no need to invoke hypothetical possible worlds (e.g., Twin Earth scenarios) to challenge the empirical foundations of BEE. These foundations are disconfirmed by a phenomenon occurring in the actual world—one that taxonomists are increasingly documenting across all animal phyla.

4.4 A potential solution: the origin of the cluster

Bird (2018) provides theoretical resources that may help address the problem cryptic species pose for BEE. He acknowledges that the commitment to indeterminacy has a significant drawback. It suggests that any two similar combinations of properties might count as instances of the same kind. Consequently, modal reasoning about the kind—in particular, the issue of kind identification in different possible worlds—becomes particularly difficult. Bird addresses this issue by invoking Kripke's (1980) principle that origin is essential.[15] He argues that the property responsible for causing the many properties associated with a kind is the origin of the kind and, therefore, the kind's essence.

This approach appears effective in addressing the problem posed by cryptic species. The possibility that two or more biological origins could make some organisms exhibit many properties associated with a species would no longer be problematic for BEE, as the presence of these properties alone is insufficient to establish the presence of the species. A necessary condition for two combinations of properties to be instances of the same kind is that they share the same causal-explanatory origin. Applied to the case discussed, Bird's approach suggests that even if many of the biological properties associated with clade N are present, clade N itself is not present unless those properties are caused by the property of being a descendant of original populations N, the explanatory origin of the species in question. Consequently, the fact that being a descendant of original

[15] The principle is commonly interpreted as stating that "objects have their origins necessarily" (Hermida, 2024, p. 1). Being necessary, origins are therefore essential, according to a modal view of essence. Applied to species, the principle suggests that organisms have their biological ancestors necessarily, implying that biological ancestry is essential.

populations S can reproduce several properties associated with clade N does not justify the suspicion that clade N might exist independently of the property of being a descendant of original populations N.

Nevertheless, Bird's appeal to Kripke's principle does not seem to resolve the problem at hand. Such an appeal is effective only if the combination of biological properties associated with a species has a single explanatory origin—a claim that cryptic species call into question. In the case under discussion, one might ask: what is the property that corresponds to the origin of the vague combination of properties with which clade N is identified? The answer is that more than one property could fulfill this role—both being a descendant of original populations N and being a descendant of original populations S. Given that clade N and clade S are cryptic species, there may be no single origin for the combination of properties associated with both species.

Godman et al. (2020) adopt a strategy similar to Bird's. They maintain that there may be possible worlds where the properties associated with a kind are produced by a super-explanatory property other than the one fulfilling that role in the actual world (e.g., being composed of XYZ, which produces the many properties associated with water). This observation suggests that no single super-explanatory property is necessary for the kind to exist, which implies that no single super-explanatory property can serve as the kind's essence. To address this problems, the authors argue that the super-explanatory property causally responsible for the properties associated with the kind constitutes the kind's essence because it fulfills that explanatory role in the actual world. "But that liquid [with the properties of water but being XYZ] would not be water, nor that species [with the properties of tigers but from a different origin] tigers, precisely because their correlated properties do not stem from the same super-explanatory source as in the actual world" (p. 328).

Godman et al.'s suggestion encounters the same difficulty as Bird's. The authors presuppose that most of the properties associated with a kind in the actual world stem from a single super-explanatory source. However, the phenomenon of cryptic species challenges this assumption. This phenomenon demonstrates that, in the case of biological species, the combination of properties associated with a kind can arise from more than one super-explanatory property. As a result, it becomes difficult to argue that any one of these properties is the origin of the species in the actual world and, therefore, constitutes the essence of the species in question.

5. Intrinsic Biological Explanatory Essentialism

Before concluding, I will address Devitt's (2008, 2010, 2023) thesis that intrinsic, primarily genetic properties constitute part of the essences of biological species. This thesis is supported by the claim that genetic properties play a causal-explanatory role in causing certain items to exhibit the many properties associated with a species, which is why I refer to it as "Intrinsic Biological Explanatory Essentialism" (IBEE).[16] Engaging with this approach is important because Devitt argues that the existence of cryptic species confirms IBEE, implying that this phenomenon supports some form of explanatory essentialism.

Devitt distinguishes between two issues: the taxon problem, which asks in virtue of what an organism is a member of a certain species, and the category problem, which asks in virtue of what a group of organisms constitutes a species rather than a subspecies, genus, or other taxonomic rank. He argues that relational-extrinsic properties are insufficient to address the taxon problem. To illustrate this, he emphasizes the existence of numerous true generalizations about members of each species, stating, "We group organisms together under what seem, at least, to be the names of species or other taxa and make generalizations about the morphology, physiology, and behavior of the members of these groups (...)" (Devitt, 2023, p. 7). Based on this picture, Devitt asserts that "being a member of a certain taxon is more than informative; it is explanatory" (Ibid., p. 8). Genetic mostly intrinsic properties are the cause of many of the attributes reflected in these generalizations, thereby making kind membership explanatory. He points out that, by doing so, these intrinsic properties serve as the basis in virtue of which an organism is a member of a particular species, thus responding to the taxon problem. As a consequence, intrinsic properties are at least part of the essences of biological species.

Devitt (2008) himself acknowledges that his line of reasoning encounters an important objection, which he expresses as an observation raised by Godfrey-Smith: "it is, of course, the case that the truth of any such generalization must be explained by an intrinsic, probably largely genetic, property, but why does that property have to be an essential property of the kind in question?" (p. 364). Devitt proposes different solutions to tackle the problem, one of which appeals to cryptic species.[17] He states that the idea that intrinsic genetic properties are essential is implicit in the practice of taxonomists, which cryptic species illustrate. "What we see [in cases of cryptic species] is a pattern of tying a taxon to an underlying genetic structure, a structure that causes its phenotypic properties, and of reclassifying whenever it is discovered that there is significant genetic difference among two populations within a taxon. And this is just what we should expect because the underlying structure makes the taxon explanatory" (Devitt, 2023, 43). Since genetic properties are used to identify cryptic species, Devitt maintains that this phenomenon confirms IBE.

[16] The remarks presented here, rather than constituting a comprehensive critique of IBEE—which would require a separate paper—, should be understood as a criticism of Devitt's appeal to cryptic species.

[17] Devitt's(2008, 2010) initial response to this problem is that intrinsic properties explain the many generalizations about members of a species in a non-accidental, law-like, way, which indicates that these properties are essential. This move was called into question by Slater (2013):"(...) there is a significant difference between there being laws about biological taxa and those taxa having essences—properties (or sets thereof) which a thing must have if it is to be of a certain kind. Laws give us only the converse: that if something is of a certain kind, then it must have this or that property" (p. 53). In a later response to the "added metaphysical claim objection" Devitt resorts directly to the Aristotelian scholarship (Devitt, 2023).

The role of genetic properties in taxonomic practices is insufficient to support Devitt's conclusion. In this respect, it is important to point out that genetic properties may serve roles other than being causal-explanatory. One of those roles is precisely illustrated by the phenomenon of cryptic species. Genetic properties provide evidence of reproductive compatibility, suggesting that organisms with differing genetic properties are on distinct evolutionary trajectories. Indeed, this latter observation underpins the reclassification proposed by Bannikova et al. Their conclusion that clades N and S represent different species is grounded in the phylogenetic species concept (Cracraft, 1983; Mishler & Brandon, 1987), which classifies organisms based on their position in the "tree of life" (De Queiroz, 2007). Members of clades N and S are considered different species because their genetic differences indicate that they occupy separate branches in the evolutionary process. Thus, it is not the genetic differences *per se* that ground the discovery of cryptic species, but rather what those differences signify (evolutionary trajectories, reproductive compatibility).

Along these lines, the relevance of genetic properties in identifying cryptic species can be understood as serving an epistemic role. Genetic properties are particularly significant for taxonomy because they provide evidence of reproductive incompatibilities and divergent evolutionary trajectories. Therefore, the fact that genetic properties play a crucial role in scientific classification, as seen in the taxonomy of cryptic species, does not establish that they constitute the essence of biological species or that they possess such a metaphysical status in virtue of their causal-explanatory power.[18]

Conclusion

This paper presented Explanatory Essentialism (EE) and analyzed the argument supporting it, as developed by Hawley and Bird (2011) and Godman et al. (2020). In examining this argument, emphasis was placed on its reliance on a specific auxiliary premise (AP). The paper then introduced the authors' application of this framework to biological species—a perspective referred to as Biological Explanatory Essentialism (BEE)—and broke down the corresponding argument (Argument for BEE). It was highlighted that this argument depends on an auxiliary premise (APB): that a particular biological origin is the only property capable of reproducing most of the traits associated with a given species.

[18] An important observation in this regard is that certain genetic markers, while used as evidence for taxonomic classification, may not even have causal or explanatory relevance, contrary to Devitt's assumption. Specifically, these markers may not be phenotypically expressed. This issue is particularly pertinent in bacterial classification, with the 16S rRNA gene serving as a prominent example (Woese et al., 1990). I am grateful to one of the anonymous reviewers for this valuable observation.

APB was evaluated through an appeal to evolutionary theory, with a focus on the phenomenon of cryptic species. By resorting to a case of jerboas of the *Scarturus elater* species complex I showed how cryptic species disconfirm APB. This case suggests that at least two distinct biological origins can exert equivalent causal-explanatory power in making certain organisms exhibit a specific combination of properties. The properties associated with a species may not depend on any single biological origin for their existence, suggesting that the existence of the species itself does not require a specific biological origin. Consequently, the empirical basis supporting the thesis that a biological origin constitutes the essence of a species by virtue of its causal-explanatory role appears weak, thereby undermining BEE.

The paper briefly discussed IBEE. Given the varied roles that genetic properties fulfill, it is unwarranted to conclude that these properties are essential and that they hold such a metaphysical status because they are causal-explanatory. Genetic properties serve epistemic functions—as indicators of other traits—which may account for their significance in classification practices.

It is important to note that the observations in this paper are compatible with the thesis that biological species possess essences, with these essences taking the form of extrinsic properties tied to biological origins. Rather than challenging biological essentialism itself, those observations question the applicability of Explanatory Essentialism (EE) to biological species, as in the cases of BEE and IBEE. The upshot is that, if biological origins do constitute the essences of species, it is not due to their causal-explanatory role. The purported causal-explanatory role of a biological origin does not sufficiently support the thesis that it is necessary for a species (given that an alternative origin can fulfill an equivalent causal-explanatory role), nor does it substantiate the associated essentialist claim. In this regard, philosophers of biology may need to seriously consider the possibility that causal-explanatory considerations are inadequate to justify biological essentialism.

Yet if causal-explanatory power does not justify a property's metaphysical status as essential, what does? Answering this question is a topic for further exploration. For now, a promising avenue may involve analyzing the scientific aims behind scientific classificatory frameworks (Beebe and Sabbarton-Leary, 2010). A scientific classificatory framework is a theory that clarifies what distinguishes one kind from closely related ones (e.g., one chemical substance from another, or one biological species from another) within a specific scientific discipline. For example, in evolutionary biology, a species is defined by its position in the evolutionary tree, which implies that no two species are identical if they occupy different positions in the tree. Following Okasha (2002), one could argue that biological classifications, at least within evolutionary biology, aim to capture units within evolutionary processes. From this perspective, biological origins might be considered essential because they signify an organism's position within those processes, marking organisms that share a particular biological origin as members of a distinct evolutionary unit.

A key question is how an account of essential properties that does not rely on causal-explanatory considerations can still be said to capture real essences. One advantage of

Explanatory Essentialism (EE) is that, by grounding a property's essential character in its causal-explanatory role, it anchors essences in objective causal connections. In contrast, if essences are justified primarily through classificatory frameworks, they become theory-dependent, raising doubts about their status as real. Consequently, a crucial task for proponents of biological essentialism, in light of EE's shortcomings, is to develop a realist version of Natural Kind Essentialism that avoids reliance on causal-explanatory considerations.

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