3D/4D Metaphysical Equivalence:
Lessons from the species debate for the metaphysics of change and persistence

Abstract

In this paper, we address the question whether the persistence of biological species raises some difficulty for the thesis of the metaphysical equivalence between three-dimensionalism (3D) and four-dimensionalism (4D). We argue that even if one assumes that 'species' is a homonymous term that refers to two entities (*evolverons* or synchronic species and *phylons* or diachronic ones), 3D/4D metaphysical equivalence still holds. In doing so, we challenge Reydon's strong association between a synchronic view of species and a 3D theory of persistence, and between the diachronic view of species and a 4D theory of persistence (2008). Finally, we show how this debate on persistence of species helps to illustrate some misunderstandings behind contemporary analytic metaphysics of change and persistence.

In a previous paper, we assessed the consequences that the *species-as-individuals thesis* together with the *species concept problem* have for metaphysical theories of persistence (Triviño and Cerezo 2015). In particular, we addressed the question whether the *species-as-individuals thesis* together with the *species concept problem* compromise the thesis of metaphysical equivalence between three-dimensionalism (3D) and four-dimensionalism (4D) (henceforth 3D/4D ME). Reydon (2008) had given a positive answer to this question, claiming that 3D/4D ME finds a counterexample in the species debate. However, we offered a negative answer. We challenged Reydon's crucial assumption, i.e., that the term 'species' is homonymous and, therefore, it refers to two different entities in different biological disciplines *(evolverons* in evolutionary biology and *phylons* in systematic biology). On this occasion, we intend to show that even if we accept his assumption that 'species' is homonymous, 3D/4D ME still holds.

The structure of the paper is as follows: Firstly, we introduce Reydon's view and some preliminary conceptual distinctions (Section 1). Then, we establish four conditions *evolverons* must satisfy in order to play the role they do in evolutionary biology, and offer two arguments for the third condition, *Extended Temporality Condition*, which is crucial for understanding the dynamic nature of species. By means of those two arguments, we show that *evolverons*

exist at time intervals (Section 2). Section 3 introduces a new notion of *evolverons* as *synchronic species* where coexistence and extension in time are its crucial features. In Section 4, we show that classical intertranslation procedures offered by defenders of 3D/4D ME can be employed in the case of species. Finally, in Section 5, we explore the consequences that our proposal might entail for contemporary metaphysics of change and persistence.[1] We close with some concluding remarks.

1. Reydon's proposal and preliminary conceptual distinctions

According to Ghiselin and Hull's metaphysical characterization of species-as-individuals (Ghiselin 1974; Hull 1976, 1978), species are dynamic, evolving entities: spatio-temporally restricted units, which occupy a geographical space, are extended in time, and have an origin and become extinct. These units are wholes whose parts are organisms. This dynamic consideration of *species-as-individuals* raises an issue that is crucial for our purposes: the *temporal dynamics issue of species*. This issue refers to whether species must be considered *synchronically*, that is, composed by the organisms that are part of such species at a particular time *t;* or *diachronically*, that is, composed by the organisms that are part of such species during the whole period of life of such species, from its origin to its extinction.[2]

According to Reydon (2005), the term 'species' refers, at least, to two biological entities, namely: *evolverons* and *phylons.*[3] *Evolverons* are dynamic entities that participate in the evolutionary process and interact with their environment and with other species as cohesive units. These are the entities referred to by the term 'species' in evolutionary biology, since this discipline aims at explaining the evolutionary causal mechanisms. *Phylons* are static entities that result from the evolutionary process. They are what biologists in

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[1] This paper can thus be considered as an example of the interaction between Metaphysics and Biology as described in Triviño 2022. In particular, we think that this is a paradigmatic sample of Metaphysics *in Biology.*

[2] For an introduction to this distinction, and other implicit or explicit defences of it, see Simpson 1961; Mayr 1988; Endler 1989; Sluys 1991; Ridley 1993; Baum 1998; De Queiroz 1998; Stamos 1998, 2002; Hey 2001; Lee and Wolsan 2002; Reydon 2008; Triviño and Cerezo 2015. Stamos 2002 uses the terms 'horizontal' and 'vertical' to refer to something analogous to what we refer here as 'synchronic species'/ '*evolverons'* and 'diachronic species'/ '*phylons'*. Yet, his purpose is to show that the horizontal dimension is primary in evolutionary biology and for species reality.

[3] Actually, Reydon defends the view that 'species' has four meanings, two of them class-like, and the other two individual-like. For our purposes, only the latter meanings (species-as-individuals) are relevant. Classes, in principle, are abstract and static, and considerations regarding their constitution and persistence as objects are not relevant in the context of this paper.

systematic biology call 'species', since they are used to classify the biodiversity of the organic world due to their stability through time and their mutual exclusion. *Phylons* refer to phylogenetic lineages constituted by relations of common descent.

In his approach, Reydon conceives of *evolverons* as synchronic entities and *phylons* as diachronic ones.[4] On the one hand, since evolutionary biology deals with causal mechanisms in the evolutionary process, the organisms constituting *evolverons* must exist at the same time for them to interact with each other. On the other hand, since systematic biology deals with the classification of *all* organisms of all times, the organisms constituting *phylons* exist at times very distant in the history of life. Furthermore, since *evolverons* are interacting entities, they are constituted by living organisms only; whereas *phylons*, due to their classificatory role, include living and dead organisms (Reydon 2008, see also Reydon 2021 for how these individuals of different kinds have different kinds of part-whole relations).[5]

Reydon associates *evolverons* with a 3D-endurance theory of persistence, and *phylons* with a 4D-perdurance theory.[6] According to the standard conception of endurantism, entities persist by being 'wholly present'. They are given in the three spatial dimensions and have all of their parts present at each point in time at which they exist. In this account, change consists of having different spatial parts and/or properties at different times (Lowe 1987; Simons 2000), and persistence is conceived as identity through time, that is, it is the same entity that has different spatial parts/properties at different times. Perdurantism, however, claims that change means having different temporal parts (with different properties and/or composition) at different times (Quine 1950; Armstrong 1980; Sider 1997), and that an entity persists by having different temporal parts that exist at different times at which the entity exists,

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[4] We will use *evolverons* and *synchronic species* as synonymous in this paper. The same applies to *phylons* and *diachronic species*.

[5] Rieppel (2009) offers an interesting argument against this classic view of species as diachronic historical entities: their eternalist flavour does not seem to allow for the contingent character of evolution and the importance of emergence and novelty in evolutionary processes, especially, when species applies to non-extinct species. This is the reason why a concept of species as *open-ended processual systems* seems to be a more accurate notion for him. In this paper, we will remain close to Reydon's classic interpretation of *phylons*. Yet, our arguments could be easily adjusted if *phylons* are considered open to the future: we would just require leaving open the end-point of the diachronic extended class of constituents of such *phylons*.

[6] We are aware of the difference between the issue of persistence (perdurance and endurance) and the one of the nature/composition/dimensional status of objects (3D and 4D). Yet, for the purposes of this paper this difference is not relevant. We will treat 3D and endurance, on the one hand, and 4D and perdurance, on the other, as equivalent positions.

that is, by means of those temporal parts being *its* parts. The entity, therefore, is given in the three dimensions of space, as well as in the temporal dimension.

While in the case of endurantism, the name of an object (or the corresponding sortal predicate[7]) refers to (or is satisfied by) the entity that is wholly present at the time of utterance (or to the one that is wholly present at some time in the past or in the future when the verb of the statement is in past or future tense), in the case of perdurantism the name rather refers to (or the sortal is satisfied by) the whole time-extended entity, i.e., to the sum of its temporal parts, even if the truth-conditions of particular utterances appeal only to the temporal parts involved in such assertions.[8]

Perdurantism thus relies on a twofold perspective from which to speak about an object, namely a temporal and an atemporal one. Regarding the temporal perspective, perdurantism involves a *temporal time-indexed* talk about changing things. Thus, if we say of an object x that it has a particular property P at a time t, such statement is temporal and is true iff there is a temporal part of x, *x-at-t*, that is P. If x changes and there is a later time t' in which x is not P, then there is another temporal part *x-at-t'* that does not have the property P, which accounts for the truth-conditions of the corresponding statement about this later state of x. With respect to the atemporal perspective, on the other hand, we can say of x that it extends in time, has so and so temporal parts, and it is P and not-P (all these verbs 'extends', 'has' and 'is' are atemporal).[9]

Despite the discrepancies between these theories of persistence, different authors have considered that 3D and 4D are, in fact, metaphysically equivalent. McCall and Lowe (2003, 2006), for instance, argue for this idea on the basis that the different descriptions of the world that 3D and 4D offer are intertranslatable without any loss of information. They conceive of endurant objects as composed of particles at each time at which they exist. Thus, each endurant object given at a time t can be identified with the *sum-of-its-particles-at-t*. This allows the authors to intertranslate 3D to 4D, and vice versa, by correlating the

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[7] *Evolverons* and *phylons* are sortals, and entities satisfying those sortals are particular species, considered as individuals, as it is assumed in all the paper, such as *Mus musculus* and *Homo sapiens sapiens.*

[8] In addition to these two theories, many contemporary metaphysicians advocate for a different version of four-dimensionalism, namely, stage theory (Hawley 2001, Sider 2001). According to stage theory, real objects are instantaneous temporal parts (or stages) that stand in suitable relations to other stages to form four-dimensional objects extended in time. Names, therefore, refer to stages, and predicates are satisfied by stages.

[9] See Hawley 2001 for more details about the temporal/atemporal perspectives in four-dimensionalism.

sum-of-particles-at-a-time of a 3D object with the temporal part of that object conceived as a 4D one (McCall and Lowe 2003, 2006).[10]

Reydon (2008) applies this equivalence criterion to show that intertranslation between 3D and 4D conceptions of species is not possible.[11] His argument is based on his conception of 'species' as a homonymous term. Thus, *evolverons* and *phylons* are two different ontological entities constituted by different organisms (Reydon 2005). In fact, it is the difference regarding the constituting organisms that is crucial for the non-intertranslatability of the 3D and 4D theories of species. In this regard, Reydon highlights two problems. Firstly, *evolverons* contain as parts only living (present) organisms, while *phylons* contain living and dead (present and past) organisms. Secondly, given their role in evolutionary biology, *evolverons* contain only fertile hybrids. Neither sterile hybrids nor asexual organisms are part of the species since they cannot contribute to the genetic pool. In the case of *phylons*, notwithstanding, both fertile and sterile hybrids, as well as asexual organisms are part of the species.

In our previous work, we challenged the homonymy thesis and argued that *evolverons* and *phylons* are not two different ontological entities, as Reydon claims, but one entity that can be considered under two different perspectives (Triviño and Cerezo 2015). Despite the arguments we offered, the detractor of 3D/4D ME might insist that the biological examples invoked in Reydon's paper (2008) are valid as counter-examples and problematic cases. Thus, they challenge the idea that *evolverons* and *phylons* are just two dimensions of the same entity. In addition, further arguments could be invoked to defend the view that synchronic and diachronic species are two different entities, like their different cohesion criteria. Lee and Wolsan (2002), for example, consider that integration, possessed by synchronic but not by diachronic species, is a necessary condition for individuality. Thus, synchronic species are truly *species*,

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[10] McGrath has objected to Lowe and McCall translation procedure on the basis that their view implies that there is something that can be described either as instantaneous temporal parts or as 3D objects which exist at one time only. But since temporal parts are physical objects, while pairs of physical objects and times aren't, it seems that equivalence fails (McGrath 2007: 746-747). However, we think that this is not a fair interpretation of Lowe and McCall. What is being translated is the temporal part *o-at-t* and the sum of particles of a 3D object that exists at *t*. Both temporal parts and sums of particles are physical objects, and time allows to determine the particular sum of particles that is equivalent to the temporal part (in the same way as time determines the particular temporal part to be translated).

[11] Reydon (2008) also takes into account Miller's criterion for metaphysical equivalence, namely: *assertability mapping* (Miller 2006). Although in our previous paper we considered both Miller's as well as McCall and Lowe's criteria for ME (Triviño and Cerezo 2015), here we are going to focus only on McCall and Lowe's criterion. As we see it, if intertranslatability between 3D and 4D is guaranteed, Miller's criterion is satisfied as well.

since they are integrated entities that evolve, while diachronic species are only *lineages*, that is, non-integrated historical entities.

On this occasion, we want to argue that, even if the term 'species' referred to two different entities, the thesis of 3D/4D metaphysical equivalence would still hold because the persistence of each of those entities can be adequately described in 3D or in 4D terms. Our strategy lies in challenging the association between both *evolverons* and an endurant 3D conception of an object, and *phylons* and a perdurant 4D conception. Under this perspective, intertranslatability is possible for both synchronic and diachronic species, and therefore 3D/4D equivalence can be restored.

2. Interaction, Coexistence, Extended Temporality, and Persistence

As we have previously introduced (§1), *evolverons* are essentially dynamic entities. They are the units on which the process of evolution depends, due to their interactions with other species and with their environment. In Reydon's words: "What matters for the further evolution of the species from *t* onward are the genetic makeup of those organisms that constitute it at that time, the actual interactions between these organisms (who mates with whom, who competes with whom, who cooperates with whom, etc.), the actual genetic mutations that occur and the actual selective forces that the environment exerts on this system of organisms" (Reydon 2008: 169).

In order to play the role of evolving units in evolutionary biology, we propose the following four necessary conditions that *evolverons* must satisfy, namely:

(IC) Interaction Condition: *Evolverons* must be constituted by *living* organisms since living organisms are the ones that can interact with each other, and contribute to the gene pool.

(CC) Coexistence Condition: At each time *t* of their existence, *evolverons* must be constituted by *coexisting* organisms, that is, organisms existing at *t*, so that they can interact with each other and actually participate in the causal processes that give rise to evolution.

(ETC) Extended Temporality Condition: *Evolverons* must be entities that exist at intervals of time, since they are constituted by organisms that *exist at least for a*

minimal period of time so that the processes involved in the causal evolutionary mechanisms can take place (mating, reproduction, competence, cooperation, and so on).

(PC) Persistence Condition: *Evolverons* must persist as being the same entity through the changes they undergo during their existence. Only if there are persistence conditions for a species, it is possible to say of that entity that it originates, evolves, or becomes extinct.

Reydon defends IC, CC, and PC. Regarding ETC, he does not seem to explicitly endorse or reject it. However, he argues that what matters in evolutionary biology are the organisms that constitute a species at a time *t* and, thus, species at *t*. This idea together with CC determines his view on the relation of synchronic species (or *evolverons*) to time. He actually quotes Bock's notion of species as "(...) the complex of interbreeding individual organisms *co-existing at one point in time* which is genetically isolated from other such complexes" (Bock 2004: p. 179; emphasis added by Reydon). This conception of *evolverons* as species *at a point in time* leads him to oppose *evolverons* and *phylons* in those terms, as if existence at a time were a sufficient condition for *evolverons* to play their role in evolution, since that guarantees coexistence[12], while extension in time were necessary for *phylons.*

In what follows, we offer two arguments to show that ETC is necessary for *evolverons*, namely the process argument and the gene-flow argument.

2.1. The Process Argument

Evolutionary Biology focuses on the general processes of evolution and conceives of species as "evolutionary process units" (Reydon 2008: 167-168). To account for the evolutionary mechanisms, it is important to consider the processes involved in interactions of the constituent organisms of those species, such as mating, reproduction, competence, or cooperation, among others. To think of a species as this kind of synchronic entity requires a consideration of it

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[12] This also seems to be Rieppel's interpretation (2009). He thinks that Mayr's non-dimensional species concept is committed to a presentist-endurantist metaphysical conception of persistence and time, since Rieppel opposes it to the four-dimensional historical species concept. Our arguments in this paper can be extended to Rieppel's conception of synchronic species. Even if one can consider a species at a particular time, and explore the sympatric and synchronous (in the sense of coexistence at the same time) relations with other species, this is not sufficient to account for species as units of evolution.

as existing at the successive times at which its organisms (say, $<O_1, O_2, …, O_n>$) exist when they participate in the corresponding causal processes underlying evolution. There is, therefore, a minimum interval of time (say, $<t_1,…., t_n>$), corresponding to those processes, at which a particular species must exist to be able to play the explanatory role required by evolutionary biology (Stamos 2002). A synchronic species S then exists at least from t_1 to t_n.

Let us see in more detail what the process argument amounts to. The process argument appeals to processes that take place in time intervals and in which *evolverons (and the organisms constituting them)* participate to infer that *evolverons* must exist at more than one time. It is crucial to distinguish the object (the *evolveron*) that undergoes (participates in/is actively involved in interactions within) a process, and the process itself. Notice that both things are different: processes cannot change their parts, while objects can change them. This difference is crucial. Otherwise, one could think that insofar as enduring objects are wholly present at a particular time, and processes require intervals, it is difficult to see how something like an enduring *evolveron*, which is wholly present at t, can instantiate a processual property at t. But this is not what the argument claims. The point is that *evolverons* do not instantiate processual properties, but they rather undergo or participate in those processes. As a consequence, *evolverons* can instantiate properties that derive from that participation.

Strictly speaking, *processual properties* (such as *is a reproduction process*, or *lasts for such and such time interval*, or *is longer than such and such a process*) can only be instantiated by processes themselves at intervals. As we have just said, *evolverons* are not processes but temporal dynamic entities undergoing (participating in/actively involved in interactions within) processes. However, we can speak of *processual derived properties* that can be instantiated by *evolverons* at particular times iff they undergo (participate in/are actively involved in interactions within) a process for an interval of time that includes those particular times at which *evolverons* instantiate the *processual derived properties* (such as *is competing with evolveron e'* at t, *has an organism A that begins an interaction with B* at t). This is why a necessary condition for an *evolveron* to instantiate a *processual derived property* is that it exists at more than one time, or during an interval, the interval during which the process takes place.

This argument can be reinforced in a threefold way so that the time interval required is larger. Firstly, we can consider that what is necessary for the class of organisms $<O_1, O_2,… O_n>$ to interact is not only the minimum time

necessary for a particular process to take place (i.e., reproduction) but also the whole life of those organisms involved in those processes. The participation of those organisms in those processes requires that they have a life with a beginning and an end, so that it is necessary to consider time intervals corresponding to whole life cycles. Secondly (and more relevant for evolution), in order to assess differences in fitness among organisms in a population, it is not sufficient to take into account one isolated process of reproduction, but many of them. The plurality of organisms involved in those processes has, in turn, their own life spans, some of which might have beginnings and ends at earlier and later times than the original class of organisms. Finally, once these intervals of time are taken into account, there will be other organisms of the same species, older or younger, coexisting with the initial organisms, and interacting with them, with earlier births or later deaths, so that the time interval will be enlarged.

Actually, Stamos considers *horizontal* (that is, *synchronic*) species as existing during an interval quite long: "the minimum time required would be the period of time that is necessary for the relations to obtain that delimit species, and the maximum time allowable would be the period of time that still allows for the species-membership relation to be transitive (i.e., if organism *a* is conspecific with organism *b* and organism *b* is conspecific with organism *c*, then *a* and *c* must also be conspecific)." (Stamos 2003: 67). It is precisely this way of conceiving horizontal species as existing at different times that makes Reydon characterise Stamos as a four-dimensionalist (Reydon 2008: 180). But we disagree. Stamos' point is precisely that it does not make sense to speak of an entity as actively participating in evolutionary processes and playing an explanatory role in evolutionary mechanisms if it does not exist at more than one time (Stamos 2002). Actually, Stamos also considers a vertical notion of species corresponding to the diachronic species (*phylons*), even if this one has secondary importance. The fact that he uses such distinction (horizontal vs vertical species) shows that his horizontal species *is not* Reydon's four-dimensional *phylons.*

Another discussion of this issue in the literature can help us to clarify our point. As previously seen (§1), Lee and Wolsan (2002) defend the idea that synchronic species are the only ones that have the kind of cohesion that is required for species to be individuals, namely integration. Diachronic species cannot be individuals since they lack integration and the same organism can belong to more than one lineage (via hybridization, for instance). Lee and

Wolsan claim that organisms at a particular time-point constitute a synchronic species (even if it is not extended in time) simply because they are integrated. Organisms at a particular time-point have the *potential* to interact with other coexisting organisms and with all other component organisms of such species, even if those interactions are not actually realised. Baum (1998) is even stronger since he considers that such potential provides a delimitation criterion for synchronic slices: "The potential to interbreed and the degree of genealogical relatedness serve as the individuative criteria for interbreeding and genealogical species, respectively. Note that *potential to interbreed* and *degree of genealogical relatedness* are properties of the organisms living at an instant of time and do not require the passage of time to apply. They, therefore, serve to delimit synchronic slices that connect through time to form time-extended diachronical individuals" (p. 645).

But what does it mean to say that an organism that exists at a point in time has the potential to interbreed? Of course, there is a sense in which having particular properties (genotype, reproduction organs, recognition mechanisms, and so on) makes it possible for an organism to reproduce. But a further condition is necessary for it to interbreed: an organism O has the potential to interbreed *at t* only if there is a later t', such that at some interval between t and t', O could interbreed. And this condition assumes that O persists from t to t'. In other words, interbreeding is a dynamic temporal interaction, and dynamical interactions can only be attributed to entities existing at more than one time.

Stamos also rejects the idea of an instantaneous synchronic species on the basis that reducing synchronic species to species at a point in time would challenge the numerical identity of species through time. In Stamos' words: "But to say that species conceived instantaneously play the same kind of role, though now as part of species lineages, creates more difficulties than it solves. For a start, it would mean that the members of a conspecific population at time t_1 would not be members of numerically the same species at time t_2 even though the membership has remained exactly the same throughout the time interval. Extremely few biologists would be willing to accept this implication" (Stamos 2002: 175-176).

The process argument refers to the fact that, in order to offer an explanatory/causal account of evolution, those processes must actually be realised. Our argument is, therefore, a metaphysical argument: if some processes are involved in the notion of a synchronic species, then given the fact

that processes take time to occur, synchronic species must be extended in time. This, we think, is also what is behind Stamos' argument.

A further metaphysical annotation can shed light on the underlying problem. One possible reason why authors such as Bock and Reydon defend a concept of synchronic species as interbreeding organisms coexisting *at one point in time* is that they consider interbreeding and other crucial interactions in evolution as relations rather than processes. Mate and competence, for example, can be conceived as relations among organisms at a particular time. But such conceptions are static. A real dynamic conception must conceive of them as processes, and processes are extended in time.

2.2. The Gene-Flow Argument

Synchronic species correspond, mainly, to the so-called biological species concept (Mayr 1970). This concept has been recently defended by Kunz (2012), who conceives of species as gene-flow communities, that is, "communities of organisms that are connected by gene flow through sexual reproduction" (p. 127). However, as Kunz explicitly considers, not all organisms of a species stand in actual gene-flow relations at a particular time: biparental sexual connection combines some genomes but not all existing genomes at that time. Thus, Kunz concludes that "a contemporarily cohesively connected gene-flow community does not exist" (p. 130), and reformulates his definition of a gene-flow community considering it as "a network of biparental sexual connections and genealogical connections" (p. 131).[13] (See figure below).

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[13] Reydon 2013 challenges the adequacy of this species concept on the basis of two problems. Firstly, he appreciates no motivation to assume that units of evolution are found at the large-scale populations level as Kunz's gene-flow communities species concept establishes. As it will be clear in what follows, our argument does not depend on particular scales of populations, but on the temporal extension that any gene-flow community entails. Thus, our proposal could be adjusted to revised gene-flow communities species concepts that could be defined at other scales. Secondly, Reydon thinks that Kunz does not offer any argument to conceive of his gene-flow communities as *species*. We think that Kunz's species concept as biological units that play a role in evolution and is subject to natural selection is close to Reydon's *evolverons*, and that Kunz's concept captures a crucial minimum of one of the meanings of the term 'species' according to Reydon 2005.
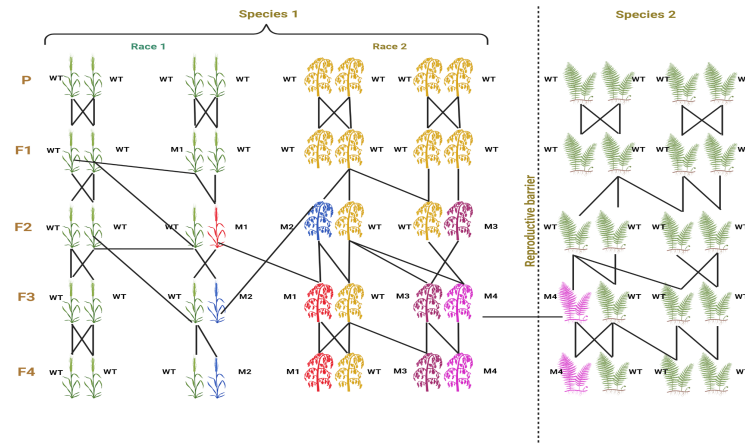
Figure 1. Gene flow cohesion between races and species. F_1 to F_4 represent the four filial generations of couples of parents P. Gene flow is shown in the pathway of mutated alleles M1-M4. (Created with BioRender.com)

Biparental sexual connections are horizontal, like the fusion of sperm and egg, so that gene flow takes place horizontally at a time in which both cells coexist. Genealogical connections are intergenerational ones, and the gene flow occurs vertically, from the mother to the offspring organisms (Kunz 2012: 129). This notion of species has a twofold potential since it accounts for connection and delimitation. Thus, organisms are joined by the exchange of genes, and delimited by the barriers to this gene flow.[14]

Notice two important facts about this notion of species. Firstly, it corresponds to *evolverons* rather than *phylons.* Kunz's species concept is related to the mechanisms of evolution, and the interactions required for genetic interchange to occur. Such genetic flow is crucial for variation to occur. It concerns only the organisms actually participating in such flow, that is, living organisms. Secondly, since this species concept includes not only biparental sexual connections but also genealogical ones, it requires taking into account the organisms occurring at an interval of time, not only those given at a point in time. This is reflected in the network character of the representation, in which gene flow takes place among different generations at different times. The consequence is that Kunz's species concept has ETC as a necessary condition.

A possible general objection to our account stems from Burma (1949) and Mayr (1949) short and interesting discussion. According to Burma, there is a sort of time paradox when we intend to define a species. If we consider it

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[14] For the difference between this concept of species as gene-flow communities and Mayr's concept as reproductive communities, see Kunz 2012: 38-39 and ch. 6. Among other issues, Kunz shows how organisms of geographically distant gene-flow communities belong to the same species if their populations are connected uninterruptedly by gene flow.

diachronically, the difficulty to cut the tree of life into species-lineages leads to the conclusion that there is only one species, extending from the origin of life until today. But if we try to overcome this difficulty by considering species as "any one series of breeding populations *as it exists at any one time*", we end up having infinite species, given the infinite divisibility of time (Burma 1949: 370). Burma concludes that species are not real, but arbitrary and abstract classifications. Mayr replies by invoking a non-dimensional species concept, in which the reality of species does not depend on temporal or spatial considerations, but on the presence or absence of a reproductive gap between two sympatric-synchronous breeding populations. Burma's reaction is illustrative: "Dr. Mayr's criticisms, I believe, do not actually attack the fundamental basis of my argument, the complete subjectivity of the concept of 'species' when viewed in a four-dimensional space-time rather than in the unreal three-dimensional space of static time".

What is the conclusion of this discussion? Let us translate it into our terms. *Evolverons*, when considered at particular time-points like Burma's breeding populations existing at any one time are as static as *phylons,* the results of the evolutionary process. In order to account for the dynamics of evolution, *evolverons* must be conceived as actively participating in the process, and therefore as extended in time too.

3. Extended synchronic species

As we have argued, *evolverons* are extended in time, so the notion of synchronic species calls for revision. We offer a new characterization of species synchronicity that satisfies the four conditions we have previously introduced (§2): interaction, coexistence, extension in time, and persistence. Let us now turn to the Species Synchronicity Theses:

Species Synchronicity Theses:

Organisms Synchronicity Thesis (OST):
Given two organisms A and B of a species *S*, A and B are *o-synchronic at t* iff A and B coexist at *t*, even if they exist at more times than *t*.

Evolverons Synchronicity Thesis (EST):

Given a time *t*, and all organisms of species *S* that are o-synchronic at *t*, a *t-evolveron* or *t-synchronic species* S_t is the one constituted by all the organisms living in the interval $(t_i,...,t,...t_j)$, where t_i is the time of coming into existence of the earliest born organism that is o-synchronic at *t*, and t_j is the time of ceasing to exist of the latest dead organism that is o-synchronic at *t*.

The interval $(t_i,...,t,...t_j)$ is the time interval during which *t-evolverons* exist. But *t-evolverons* change during those intervals having different constituents (organisms) at different times of their existence. A *t-evolveron* requires the time interval to exist and to undergo processes, but it instantiates properties at particular times, such as the *processual derived properties* introduced in Section 2.1.

Notice that *evolverons* are defined relative to a time *t,* so that at each time a different synchronic species is defined according to EST. This captures Coexistence and Extended Temporality conditions.

In OST and EST, we consider a given species *S* as already given and defined. How such a species is determined depends on the species concept adopted, which provides the persistence conditions of a species (when it is the same species at different times, and when it is a new species). In the previous section, we assumed a gene-flow concept of species, so that in OST and EST such a concept would provide those conditions. But other concepts would be equally valid (morphological, reproductive, ecological).[15] Synchronicity is a temporal consideration of a species and it is independent of the species concept used as a criterion to individuate species.

One advantage of the EST way to define the time interval for the existence of synchronic species in terms of organisms' generation is that it allows relativizing the intervals to kinds of organisms since life cycles vary across different species. This is an advantage with respect to intervals whose duration is established in terms of a range of years (Stamos 2002). Actually, Stamos makes a twofold observation in this regard. Firstly, he considers that different species concepts (morphological, reproductive, ecological) might give rise to different intervals of time for a horizontal (synchronic) species to be

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[15] In this case, one might question our Gene-Flow argument. We think that the argument also holds in case of adopting other species concepts. In an evolutionary context, gene-flow seems to be a necessary condition for species identity, even if it might not be a sufficient condition under other species concepts. In any case, if an advocate of other species concepts challenges this point, the Process Argument would be sufficient to support Condition 3 (ETC).

determined (p. 177). But he also considers that the intervals are relative to different kinds of organisms under the same species concept (p. 178).

However, these alternative ways to define the length of the time interval (organisms generations vs years) hide an important possible objection to our definition of synchronic species: that the determination of the length of the interval is arbitrary (see, for example, Burma 1949). Actually, as we have seen before, Stamos (2003) determines the interval during which horizontal species exist as longer than our definition. But this is not a problem. In significantly reducing the period of time required for a synchronic species to exist, we intend to better capture Reydon's motivation for paying attention mainly to the cohesive whole that interacts, rather than to the lineage.

Nevertheless, it is not essential to our account that the duration is the particular one we propose. If empirical reasons considered by evolutionary biologists require a longer existence of *evolverons*, EST can be easily modified in that sense. The only thing that is necessary for our account is (i) that it is possible to define some beginning and end for the existence interval of a species, so that it can be actually conceived as an individual, and (ii) that this interval has a minimum duration. This is what we intend to capture in EST. But, of course, we find no problem in extending such an interval for a longer period of time. Nothing in our argument depends on that, and the translation procedures to be presented in the next Section can be adjusted to longer *evolverons*. Indeed, according to Stamos, to be diachronically a real species requires a beginning and an end, but to be synchronically a real species does not require them. This suggests that there is no problem in arbitrarily demarcating the beginning and end of the existence interval of an *evolveron* (Stamos 1998: 462). This would allow even for a *pluralistic* approach to synchronicity: depending on particular variables (species concepts defining S, particular S and the duration of the life cycle of its organisms, evolutionary processes at stake, and so on), we could have different EST formulations relative to those variables.

We end this Section by offering the two correlative definitions for diachronicity. Diachronic species or *phylons*, as Reydon presents them, do not display the problems that we found in *evolverons*. This is shown in the fact that Reydon himself indicates that *phylons* or diachronic 4D species could be translated into 3D (Reydon 2008: 174). In any case, our new temporal approach to *evolverons* requires us to adjust the definitions of diachronic species in our framework.

Species Diachronicity Theses:

Organism Diachronicity Thesis (ODT):
Given two organisms A and B of a species *S*, A and B are *o-diachronic* iff they exist at different intervals of time, so that there is no time at which A and B coexist, but there is a chain of organisms existing at times between the times of existence of A and B which can link A and B through reproduction relations between o-synchronic organisms.

Phylons Diachronicity Thesis (ODT):
A species *S* is *diachronic* or a *phylon* when there are organisms constituting *S* that are o-diachronic.

Notice that this conception of species diachronicity satisfies conditions analogous to ETC and PC for *evolverons,* but they do not satisfy IC and CC.

4. *Evolverons* and *phylons* endure and perdure

Once we have seen that synchronic species exist at more than one time and that at those different times some of their properties change (different space occupied by the species, loss and gaining of parts/organisms, different states resulting from the participation of their organisms in processes, and so on), the idea of accounting for the persistence and change of those entities arises. A *t-synchronic species* S_t can gain or lose parts/organisms during its existence along the different times in the interval $(t_i,...,t,...t_j)$ while remaining the same species, or can begin, continue, or end interactions at particular times while remaining the same species. Such persistence of *t-evolverons* can be accurately described as endurance or as perdurance, and the species can be thus considered as a 3D or 4D object.

  Let's start considering the *t-evolveron* as a 3D entity that persists by endurance. Recall that, on the new notion of synchronicity, *t-evolverons* are relative to time *t*. In this case, according to EST, such *t-evolveron* S_t refers to the living organisms that constitute the species at each time at which the species exists during the interval $(t_i,...,t,...t_j)$. In particular, a *t-evolveron* is constituted at every time in the interval by the living o-synchronic organisms at that time. We can consider a *t-evolveron* S_t that exists throughout the interval t_i to t_j, where O_3 ,

O_4 and O_5 are the earliest born organisms that exist at t and O_5, O_6 and O_7 are the latest dead organisms that exist at t (see Figure 2). In this case, at each time at which S_t exists, it is composed of living organisms that are o-synchronic at that time. There will be organisms that constitute S_t at earlier times than t, even if they are not o-synchronic at t, and organisms that constitute S_t at later times than t, even if they are not o-synchronic at t either. As we can see in Figure 2, change has occurred because some organisms that constitute the *t-evolveron* at t_i have ceased to exist at later times: O_1 at t_{i+1}, O_2 at t, and so on, whereas other organisms have born and constitute the species at t_{i+1} and t, i.e., O_6 and O_7.[16]
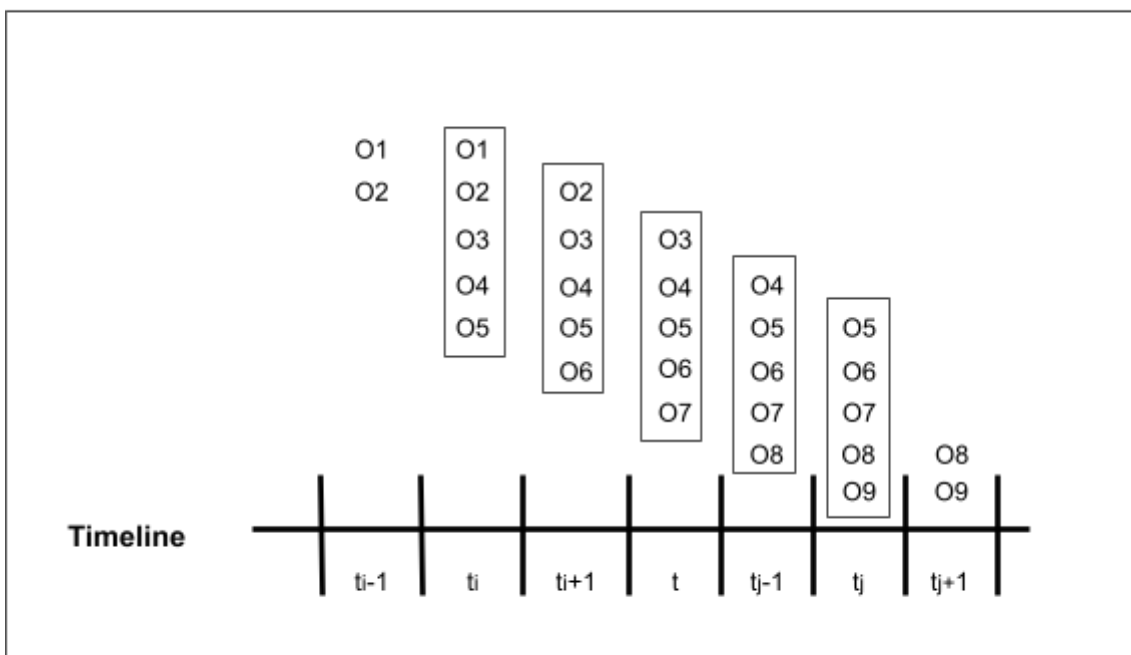
Figure 2. 3D-*t-evolveron*. Notice that the time of coming into existence of the *t-evolveron* is not the time of origin of the species (*phylon*).

The persistence of S_t can also be described in terms of perdurance. In this case, the *t-evolveron* S_t is an entity that is extended in time (from t_i to t_j) and that it is composed by different temporal parts (TP1-TP5) that are manifested at each time at which S_t exists (see Figure 3). Change, therefore, consists in the fact that

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[16] Here we are considering a change in the species as a change in its constituents (gaining of new organisms by birth or losing of organisms by death). Of course, there are other changes that can occur in a species, such as variations in other properties (geographical distribution, ecological properties, changes resulting from their interactions, and so on). To make things simpler and to follow a discourse close to McCall and Lowe's we have taken into account only variation in the spatial parts of the species, that is, in the organisms that constitute it. Our argument can be intuitively extended to changes of other properties.

different temporal parts have different o-synchronic organisms constituting them.[17] And persistence is the fact that those are *its* parts.
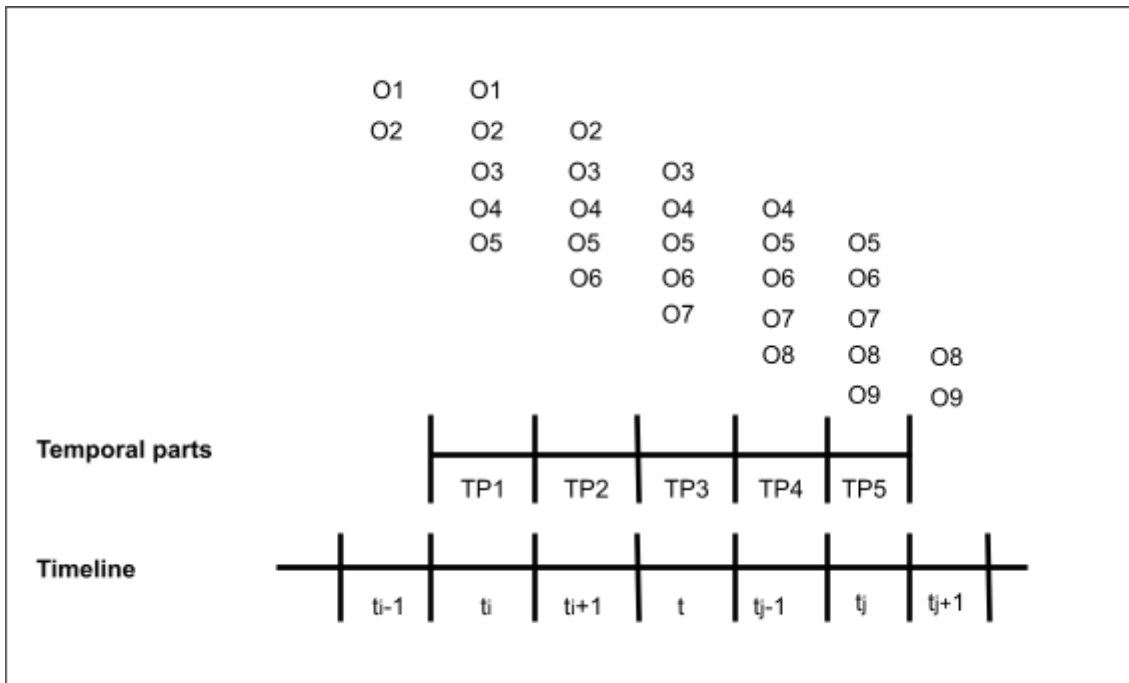

Figure 3. 4D-*t-evolveron*

A possible objection to this conception of *t-evolverons* as 4D entities arises from the fact that, as an entity that extends from *ti* to *tj*, our *t-evolveron* has TP1 as a temporal part, which in turn includes organisms O1 and O2 as parts that are not living organisms at *t*. But notice that when our 4D *t-evolveron* is interacting with the environment at t_i and t_{i+1}, those organisms are alive. In other words, when the dynamic interactive character of a species is at stake, as is the case in *t-evolverons* (either considered as 3D or 4D entities), it is the temporal time-indexed talk that is crucial, since the evolutionary processes involved take place by particular organisms interacting in different ways at specific times during a particular interval. The atemporal talk about the *t-evolveron* and its having temporal parts with one or another organism is

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[17] The relativity of *t-evolverons* to time raises the question of the relation between the different *t-evolverons* that can be defined at different consecutive times. For instance, in our example above, t_{i+1}-*evolveron* extends in time for the interval (t_{i-1}..., t_{i+1}...t_j). This *evolveron* would be different from *t-evolveron*. Different *evolverons* that can be defined according to different times overlap. This is not a problem, it rather shows the crucial dynamic nature proper of synchronic species.

secondary.[18] When the evolutionary biologist makes assertions about particular interactions, only the temporal parts satisfy whatever non-sortal predicates are attributed to the 4D-*t-evolveron.* Since such truth-assessments are relative to time, the constituent organisms are always considered to be alive as constituents of those temporal parts. Of course, in a certain sense dead organisms are now part of the *t-evolveron.* But this is just a residual and innocuous consequence, since the atemporal perspective is irrelevant in dynamic *t-evolverons.*

Evolverons, therefore, can persist by both endurance/3D and perdurance/4D. What about *phylons*? In this case, we must recall that living and dead organisms are part of the species. As in the case of *evolverons*, the persistence of *phylons* can be accurately described in terms of endurance (3D) and perdurance (4D). We can start considering the *phylon S* as a 4D entity that is extended during its whole life, say from time t_o to time t_e, where t_o is the time of origin and the t_e is the time of extinction of *S*. At each time at which the *phylon S exists*, a particular temporal part, namely TPO to TPE is manifested (see Figure 4).

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[18] Our point becomes clearer if we translate it into the terms of stage theory. Stages are constituted by the living organisms that exist at the particular times of the stage's existence, i.e., they are not extended in time. In our example, the stages TP1 and TP2 that exist at t_i and t_{i+1} respectively, exist at only those times, so that all stages are obviously constituted by living organisms and stand in atemporal suitable relations to later stages, such as TP3, TP4 and TP5. Yet, since stages are instantaneous, organisms O1 and O2 only exist, properly speaking, while stages TP1 and TP2 exist. In other words, they exist only as living organisms.
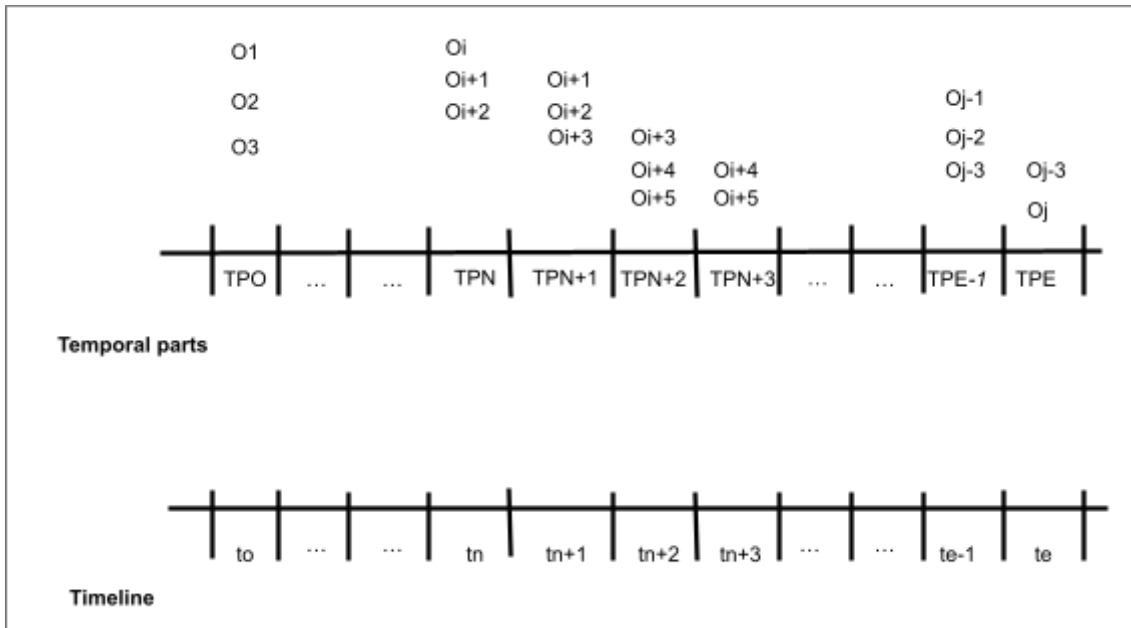
Figure 4. 4D-*Phylon.*

The persistence of *phylons* can also be described in terms of endurance. In this case, the *phylon S* is characterised as a 3D entity that is constituted by different organisms at different times at which the *phylon S* exists (see Figure 5).
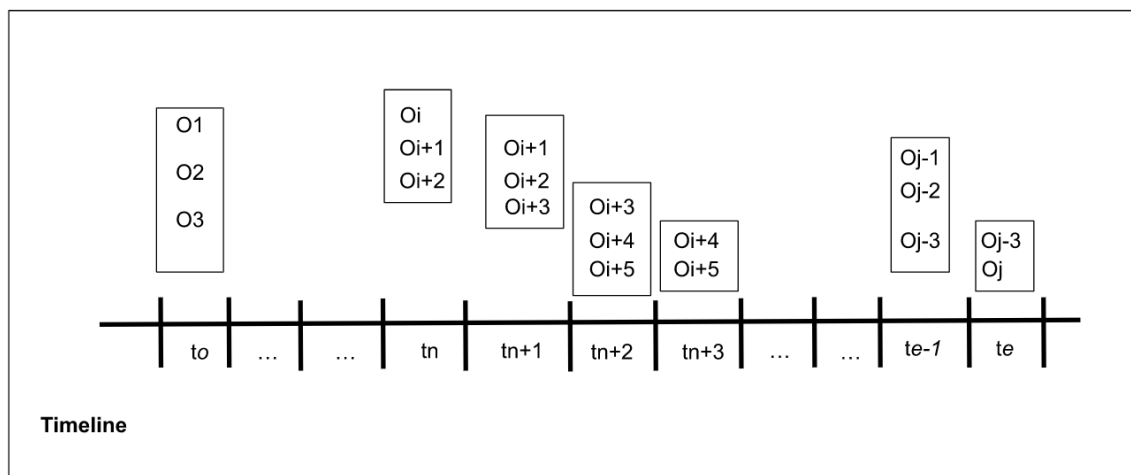

Figure 5. 3D-*Phylon.*

Notice that, unlike the evolverons, in the case of *phylons* it is the *atemporal talk* that is primary. We are now interested in the result of evolution and this requires having an atemporal perspective, a perspective that is not relative to a particular time, so that one can say that a *phylon* is constituted by all the

temporal parts that compose it along its life. Notice that this "is constituted" is atemporal. Under this perspective, living and dead organisms are on a pair, since they are all equally atemporal constituents of the *phylon.*

Once we have seen that the persistence of both *t-evolverons* and *phylons* can be accurately described in terms of endurance and perdurance, the intertranslation between the 3D-*t-evolverons* and the 4D-*t-evolverons,* on the one hand; and between 4D-*phylon* and 3D-*phylon*, on the other, can take place. Thus, to translate the 4D-*t-evolveron* into the 3D-*t-evolveron*, we need to reduce the 4D entity to its temporal parts and replace each temporal part by the sum of organisms that constitute the temporal part at each time. This sum-of-organisms at each time refers to the 3D-*t-evolveron*. In our case, the temporal part TP1 will be reduced to the sum of organisms O_1, O_2, O_3, O_4, O_5; temporal part TP2 will be reduced to the sum of organisms O_2, O_3, O_4, O_5, O_6; and so on and so forth. These sums of organisms correspond to the 3D-*t-evolveron* existing at different times throughout the interval $(t_i,...,t,...t_j)$. Conversely, to translate from 3D-*t-evolverons* to 4D-*t-evolverons* we need to consider all the organisms that constitute the *t-evolveron* at each time, and replace them by the corresponding temporal part that composes the 4D-*evolveron* at that particular time.[19] An analogous procedure allows translating the 4D-*phylon* into the 3D-*phylon.*

How are we now able to deal with the problems that seem to compromise the intertranslation between 3D (endurance) and 4D (perdurance) (Reydon 2008)? According to Reydon, since *phylons* are 4D entities constituted by both living and dead organisms, whereas *evolverons* are 3D entities constituted only by living organisms, the intertranslation cannot take place since there is a loss of information: dead organisms cannot be seen in *evolverons*.

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[19] As a reviewer has observed, since t-evolverons are defined relative to a time t, it is possible to define different evolverons relative to very close times, so that they can overlap at particular times (see note 17). This could give rise to a problem. Suppose that two t-evolverons e_1 and e_2 exist during intervals (t_1, t_2, t_3) and (t_3, t_4, t_5) respectively, and thus overlap at t_3. For example, at t_1 e_1 is composed of organisms A and B, at t_2 it is composed of B and C, and at t_3 it is composed of C and D, while at t_3 e_2 is composed of organisms C and D, at t_4 it is composed of D and E, and at t_5 it is composed of E and F. Then at t_3 the two t-evolverons would be identical under a 3D reading, since they are composed of the same organisms, while they would be different under a 4D consideration, since they are temporal parts of different 4D entities. But this overlooks the crucial point of our paper: that evolverons must exist for intervals and it does not make sense to consider their isolated existence at particular times. Even if at t_3 those two different t-evolverons have the same organisms as constituents, they will have different dynamic properties, so that at t_3 e_1 has the property "having had A and B as constituents", while evolveron e_2 does not have this property. Analogously, at t_3 evolveron e_2 has the property of "coming into existence", while e1 does not have this property. This is sufficient to argue that both evolverons are different under a 3D reading, since it is necessary to conceive of an evolveron as existing during an interval.

And the same occurs regarding fertile and sterile hybrids: whereas fertile hybrids constitute *evolverons*, they do not constitute *phylons*, since only sterile hybrids constitute the *phylon* (see Figure 6).
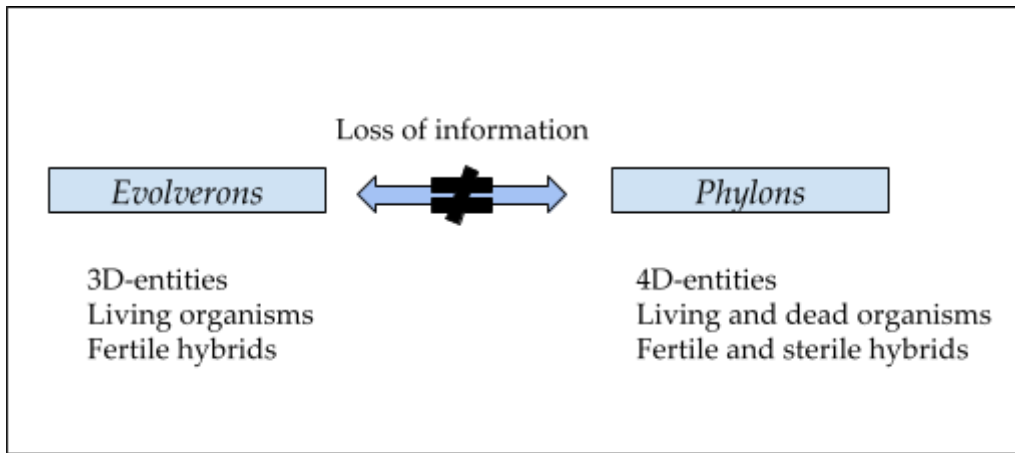
Loss of information

Evolverons ⟵ ⟶ Phylons

3D-entities
Living organisms
Fertile hybrids

4D-entities
Living and dead organisms
Fertile and sterile hybrids

Figure 6. Reydon's position regarding intertranslation.

Let us start with the second of the problems, which does not affect our position since our argument is that the persistence of *evolverons* and *phylons* can be properly described in terms of both endurance-3D and perdurance-4D. Thus, in the case of *evolverons*, if this entity only refers to organisms that include fertile hybrids but not sterile hybrids, intertranslation will take place between the constituents without loss of information. And the same occurs in the case of *phylons*. Regarding living and dead organisms, as we have seen, the question is one of the perspectives to be adopted when the 4D-entity is considered. In the case of *t-evolverons*, given the fact that what is crucial is their dynamic character, it is a temporal perspective that is at stake. Such a perspective requires taking into account the organisms that exist at each time, that is, the living organisms at each time. In the case of *phylons*, given their classificatory role in Systematics, it is the atemporal perspective that is relevant, so that both living and dead organisms are on a pair. Thus, we can conclude that the persistence of both *evolverons* and *phylons* can accurately be described in terms of endurance and perdurance, which implies that both *evolverons* and *phylons* can be characterised as being 3D or 4D entities (see Figure 7).
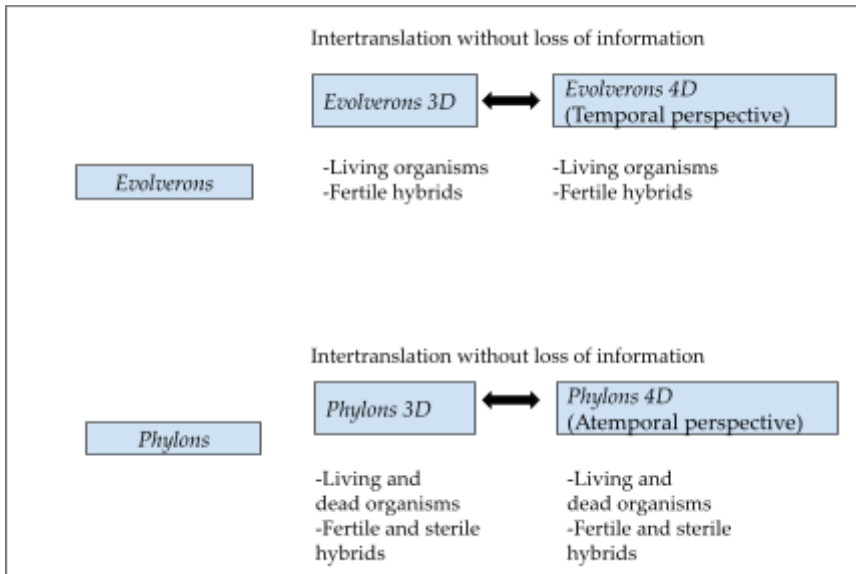
Figure 7. Our position regarding intertranslation between 3D-endurance and 4D-perdurance.

As we have seen, the defence of 3D/4D ME requires us to take into account the particular temporal/atemporal perspective that is primary when intertranslation takes place. But this should not be seen as a problem since it is in accord with the different roles that the concept species plays in Evolutionary Biology and in Systematics, as conceived by Reydon in his introduction of the distinction between *evolverons* and *phylons.*

5. Some consequences for the metaphysics of change and persistence

In the previous sections, we have shown that any conception of synchronic species aspiring to account for the mechanisms of evolution must consider them as existing at more than one time, and then their persistence can be described as endurance (3D) or perdurance (4D). Reydon's association of synchronic entities with an endurantist 3D conception of a persistent object lies in the idea that attributing particular properties and actions to a species at a time (fitness, mating, and so on) requires for such species to be *wholly present* at such time. But we have shown that a species considered *at a point in time* is a static entity. Therefore, in order to attribute dynamic properties to a species, an interval is needed. Once this is done, we can conceive of the persistence of a synchronic species as endurance or perdurance, with no consequences for our biological understanding of evolution. To conceive of a species (synchronic or diachronic) as a 3D (enduring) or 4D (perduring) object is only a strict metaphysical

descriptive matter. Depending on our characterisation of change and persistence, we will employ one way or another to metaphysically *put into words* that a species evolves (changes), that it persists as being the same species through some variation, that it originates (comes into existence) or that it becomes extinct (ceases to exist).

The distinctions between 3D/4D theories of objects (or endurantist and perdurantist theories of persistence) do not shed light on the temporal consideration of species. In other words, a horizontal or synchronic conception of species in which the interactive character of its coexisting constitutive organisms has primacy does not have to be confused with a 3D or 4D consideration of persistence.

Let us consider in more detail what the consequences of this view are. As we have seen, *evolverons* are dynamic species extended in time, so that they actively participate in biological/evolutionary processes that take place. As such, they can be described as 3D or 4D entities. Yet, the particular description of them as 3D entities, where at each point in time the 3D-*t-evolveron* is constituted by a sum-of-organisms, does nothing to explain such dynamic nature. At each point in time, those sums are as static as the temporal parts of the equivalent temporal parts of 4D-*evolverons.* Actually, some endurantists speak of "replacement" to describe the sequence of 3D-entities through time: "In 3D ontology, O is the set of particles which successively constitute it at each moment O exists, a set which "changes", i.e., is replaced by a new set, each time O gains a new particle or loses an old one" (McCall and Lowe 2006: 574).

Actually, considerations about the interaction and the activity of species, rather than making us choose between one or another persistence theory, show us that these persistence theories are only different ways of describing the result of the dynamic nature of the corresponding entities, but they do not really explain the activity itself. They account neither for change nor for persistence. This is crucial since metaphysical theories of persistence are considered to be *theories*, that is, explanations of change and persistence. In a certain sense, this debate in philosophy of biology helps to illustrate a misunderstanding behind contemporary reflections on metaphysics of change and persistence, the confusion of the *explanation* of change and persistence (which is what is behind Reydon's approach) with the *description* of the entities persisting through time (which is what 3D and 4D theories actually do).

Two contemporary debates on this matter will help us to illustrate our point. The first one refers to the metaphysical discussion regarding powers and

persistence. In this regard, Mumford has claimed that a realist about powers should side with an endurantist view of persistence (Mumford 2009). A perdurantist view will not do, since (i) temporal parts are static and thus they cannot bear dynamic dispositional properties, and (ii) powers manifest processually and processes occur over many stages, so that it is difficult to think of a static stage at a time as determining future stages of the process (Mumford 2009). But why an object that is wholly present at *t* should be in a better position to bear dynamic properties or to determine future states of the object? An object *O* at *t*, considered as such, as a 3D object at a particular time, constituted by particular parts and having specific properties at that time, is as static as the corresponding temporal part *O-at-t* of *O* considered as a 4D object.

In other words, that an object is wholly present at *t* means that all spatial parts that it has at *t* are present at *t*. But this is also true of temporal parts of the corresponding 4D object. The only way to *explain* rather than just *describe* change and persistence is by the character of the properties attributed to an object at a time. The attribution of a dispositional property, for instance, is what is *explanatory of the dynamic behaviour of* the object in question, but the property can be attributed to an object at a time (3D description), or to its temporal part (4D description). Furthermore, if those properties are really dynamic, their processual manifestation will require time intervals, and the entity possessing those properties can be described in 3D or 4D terms as changing during that interval.

The second debate is the one about the ontological vs the explanatory versions of persistence theories (Wasserman 2016).[20] According to Wasserman, while perdurance, as defined by Lewis, can be said to be explanatory for grounding persistence in temporal parts (x perdures iff x persists *by* (=in virtue of) having temporal parts), this is not the case with endurance. Wasserman reviews different plausible definitions of endurance and argues that none of them is able to provide an explanatory version of endurance, that is, one introduced by "by" or "in virtue of", so that the clause after these expressions offers the grounding of endurance, as it happens in perdurance. But we disagree, and think that the case is symmetric with perdurance. Let us see, for example, the definition of endurance that Wasserman considers: x endures iff it persists by having different properties at different times. Wasserman thinks that this definition "invites a Euthyphro-style question (Does an object persist

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[20] We thank Roberto Loss for hinting at this point in discussion of our work.

through time because it has properties at different times, or does it have properties at different times because it persists?)" (p. 248).

But why does not perdurance invite analogous questions? Does an object persist through time because it has temporal parts at different times or does it have temporal parts at different times because it persists? In other words, in the same way that, in perdurance, we can say that if an object had not different temporal parts, it would not persist (it would not exist at different times), we can also say that, in endurance, if an object had not different properties, it would not persist (it would not exist at different times, since it would not change).

Both endurance and perdurance associate some kind of differences to times to describe change and persistence, although they appeal to different apparatus (different properties or constituents, or different temporal parts, respectively). Yet, if there were no differences in time, there would not be either perdurance or endurance: persistence makes sense only when change is presupposed. In more detail: when one says that x persists by having different temporal parts, change is captured in the *differences* among these *temporal* parts, while persistence is captured in these temporal parts *being parts of* x. Similarly, when one says that x persists by having different properties at different times, change is captured in the *difference* of properties *at different times* (the variation of these properties over time), while persistence is captured in those properties *being properties of* x (*belonging to* x). The output is that the two theories are merely descriptive: the persistence of an entity can be *described* by means of endurance or perdurance, but appeal to the existence of temporal parts or of different properties at different times[21] does not *explain* neither change nor persistence.[22]

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[21] Notice that this symmetry is also shown in the fact that temporal parts are determined, precisely, by the difference regarding the properties of the object at that time.

[22] As a reviewer has pointed out, the 3D/4D ME might be nonsubstantive in Sider's terms. As we see it, 3D/4D metaphysical equivalence involves a certain deflationism since 3D and 4D approaches are just different descriptions of the result of change without properly offering metaphysical explanations of change and persistence. However, we do not think this entails that the question about persistence is nonsubstantive in Sider's sense (Sider 2011). According to Sider's characterization of substantivity, a question Q is nonsubstantive iff it contains an expression E such that (i) there exist several equally plausible interpretations of E and none of them carves at the joints better than the others, and (ii) each conflicting viewpoint regarding the question can be supported by one of these interpretations (and not by the others) (Sider 2011, 46-47). Thus, for example, the question whether *t-evolveron Mus musculus* persists from time t to time t', is substantive under our view, because although given 3D/4D ME (i) is satisfied ("persists" can be interpreted as *endures* or *perdures* or *is a stage related to other stages in suitable relations*, and none of these interpretations is privileged), (ii) is not satisfied, since the question has the same answer under the two interpretations. The point of nonsusbstantive questions is that "their answers turn on which of a range of equally good available meanings we choose for the words in these questions" (2011, 46). And

We can thus revise Reydon's consideration of the way philosophy of biology and metaphysics cross-fertilize. According to him, the *evolverons/phylons* distinction has metaphysical consequences: it challenges the thesis of 3D/4D ME. We do not think so. However, we make a stronger suggestion: the discussion offered in this paper has shown, via the exploration of the application of 3D/4D theories of persistence to species, that an important misunderstanding lies behind contemporary analytic metaphysics, namely, the confusion of description for explanation regarding change and persistence.

6. Concluding Remarks

The *species-as-individuals* thesis together with the *species concept problem* does not compromise the thesis of equivalence between three-dimensionalism (3D) and four-dimensionalism (4D). Even if the term 'species' refers to two different entities (*evolverons* and *phylons*), the equivalence thesis would still hold because the problem of persistence would arise *for each of* those entities. Both *evolverons* and *phylons* can be considered as entities that exist at different times and the persistence of each of them can be described according to 3D or 4D theories.

Notice that our view takes into consideration Reydon's thesis of homonymy more deeply: if *evolverons* and *phylons* are two completely different entities, with different constituents, why translate one into the other? It seems more reasonable to maintain their independence and consider the persistence of each of them as endurance or perdurance according to other metaphysical preferences. Our analysis of the four conditions that *evolverons* must satisfy to play their role allows us to point out a crucial correction of Reydon's approach: the separation of two considerations regarding the temporal dimension of species. On the one hand, there is the issue about the *temporal consideration* of an object (*synchronic* and *diachronic*) in relation to other objects, that is, their relation *with regard to the time of existence*; on the other hand, there is the issue of the persistence of an object, that is, its existence in more than one time while remaining the same entity, that can be conceived as *endurance* or *3D* and *perdurance* or *4D*.

Finally, considerations about the interaction and activity of species rather than making us choose between one or another persistence theory, show us that

this is something that does not happen given 3D/4D ME. Sider would consider the question also substantive, but for a different reason, since he would say that one of the interpretations carves at the joints better than the others.

these persistence theories refer to different ways of describing the result of the dynamic nature of the corresponding entities, but they do not really explain the activity itself (evolution) nor their persistence (identity of species through change).

Acknowledgements

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