What is an Individual Organism? Philosophical Problems

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Abstracts

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Making sense of the Fitness-Decoupling Paradox in Evolutionary Transitions in Individuality

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The nature of biological fitness is one of the most enduring problems in evolutionary biology. [1–5] The term 'fitness' features prominently in discussion of evolutionary transitions in individuality (ETIs) - events of major significance in which lower-level entities (particles) interact to form higher-level entities (collectives). Such events encompass evolution of the chromosomes (from genes), the eukaryotic cell (from two bacterial-like ancestors) and multicellularity (from unicellular types). The collectives thus formed become new units in their own right, engaging in the process of evolution by natural as a population of collectives. [6–10]

Although seemingly simple, the idea that selection can shift to encompass new levels of organization is puzzling, especially so given standard approaches to accounting for the transition process [6,11]. Since selection can only occur when there are differences in fitness among units at the focal level of organization, [12,13] it is necessary to invoke a mechanism that is causally responsible for particles becoming members of collectives with which fitness can be associated. One explanation involves the proposal that fitness is transferred from particles to collectives, [7,11] but this view is open to misinterpretation given that transference of fitness is ill-defined and difficult to implement in a model. [8,14]

Data arising from experimental studies of the evolutionary transition from cells to multicellular individuals using microbes [9,15,16] provides some understanding. In one experiment populations of the bacterium Pseudomonas fluorescens were propagated through a selective regime involving a lifecycle comprised of soma- and germ-like phases and where the nascent organisms participated directly in the process of evolution by natural selection. At the beginning of a transition, collectives with low fitness were composed of particles whose fitness was little different to the fitness of the ancestral type. Continued lineage selection led to the evolution of collectives with improved fitness (relative to ancestral collectives), but being composed of particles with reduced fitness relative to the ancestral cell type as determined by measures such as growth rate and population density. [16] Thus, as the transition progressed a decoupling might be said to have occurred between the fitness of the collective and that of its particles. How can the fitnesses of two entities, which are made of the same substrate - the collectives are made of particles - have different evolutionary goals? There seems to be a 'conflict' in evolutionary goals at the two levels of organization. In this paper, based on some foundational reasoning about fitness I show that this paradox can be dissolved. Doing so opens new directions of inquiries in this area. More particularly it forces us to focus on the ecological conditions under which ETIs can occur. It is hoped that this approach on fitness will be implemented in an experiment conducted at the Max Planck Institute for evolutionary biology, in collaboration with Professor Paul Rainey.

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Yeast engineering and evolution of multicellularity

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Evolution of unicellular organisms to multicellularity is one of the major transitions in biology. It requires consecutive events of aggregation of single cell followed by differentiation that can lead to the division of labour within its collectives. Budding yeast, *Saccharomyces cerevisiae* has been successfully used as an model in research studying the very first stages of the evolution of multicellularity as well as facultative division of labour. I will present various scientific approaches to these subjects involving genetic engineering, experimental evolution and exploring existing natural variation using bioinformatics analysis.

Individuality and binary fission

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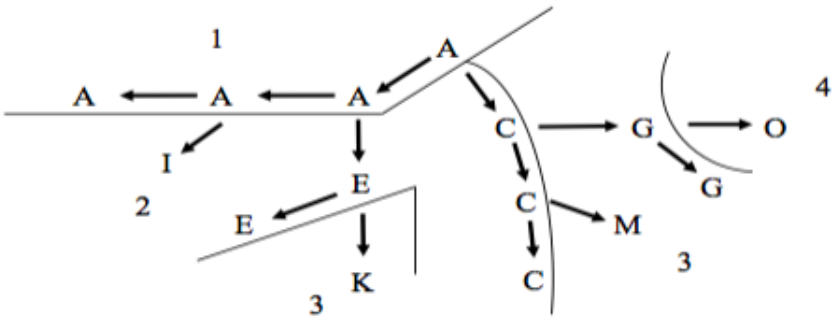
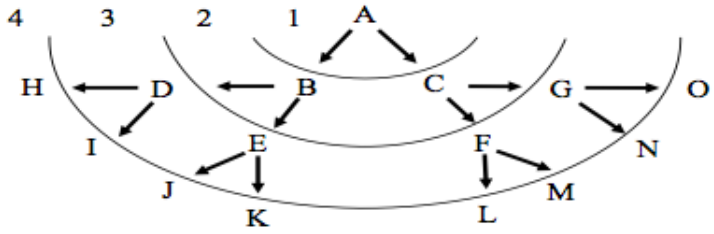
Asexually reproducing organisms are the most common form of life and yet they are among the most difficult organisms to individuate. This is often because certain forms of asexual reproduction make it difficult to discern parent organisms from their offspring. This paper focuses on binary fission as a paradigmatic example of an asexual reproductive process that presents an individuality problem: does an organism, like a bacterium, survive the process of reproductive fission? Microbiologists treat certain organisms as having both parental and sibling relations, i.e. the pre-fission organism is considered to be both the parent and simultaneously a post-fission sibling to the other organism that is generated during fission. Greater attention needs to be given to the individuality problem that fission presents.

I argue that this "fission problem" leads to three possible ways we could understand the relations of asexually reproducing organisms and individuate them (refer to attached diagrams on the second page, below). First, we might believe that a pre-fission organism survives the fission process to rightly be considered a parent (persisting model, version one). Second, we might believe the pre-fission organism doesn't survive the fission process and we're left with two offspring (death model). Lastly, we might believe that the identity of the pre-fission organism survives the fission process, but it continues on to inhabit both post-fission organisms (multiplying model). Depending on which model is adopted will alter how these organisms are individuated.

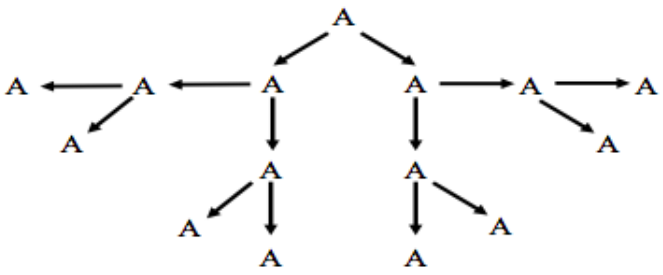
To highlight the differences on how individuation will change depending on which of the models is adopted, I consider biological research on functional immortality in microorganisms and symmetrical fission. This research shows that we must reject the first two of the models for individuating in certain species of symmetrically dividing microorganisms. In essence, the model that is adopted greatly depends on biological facts about the particular species in question. In particular, this means the only viable way to understand individuality in certain symmetrically dividing bacteria is that the colony is an organism, while the unicellular entities that make it up cannot be organisms. I believe this shows one of the ways in which single-celled organisms evolve into a multicellular organism.



Persisting Model Version 1



Death Model



Multiplying Model

Biological contingent identity and transient autonomy

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Background : Identity relations are of two kinds, absolute identity and relative identity. Absolute identity can be formulated in two ways:

a) $x = x$ - reflexivity property
b) $x = y \ (\Phi x) \supset (\Phi y)$ - indiscernibility of identicals

x is indiscernible from y if and only if x has a set of properties Φ, implies y has set of properties Φ then x & y are indiscernible in all respects (where x & y are objects of identity relation). Absolute identity of the $a)$ $x = x$, type is of the object with itself and of $b)$ $x = y$ type is between two objects usually taken for synchronic identity. While we are interested in diachronic identity which is the identity of the object (here organisms) with itself over a period of time from t_1 to t_2 .Here we see a combination of both the above 'reflexivity' as we are seeking identity with the object itself $x = x$ as $'x't_1 =' x't_2$ and 'indiscernibility' $x = y$ as $x't'_1 = x't'_2$. So in diachronic identity we are analyzing to find identity of x at time t_1 with x at time t_2. Where 'x' is any biological system.

Problem : The problem of diachronic identity in organisms is to show how persisting autonomy can emerge from transient biological processes.

Methodology : Empirically informed conceptual analysis.

Explanation : Transient autonomy : the macro-structure emerges and then persists through substitutions of micro-constituents of the same type as the original (Humphreys 2008). Using the concept of transient autonomy we try to show how identity of person persists over time even while going through fleeting biological processes. For instance the skin cell has life span of 28 days, so old cells die and are replaced by new cells but the macro-structure of the skin persists even though its constituents have a fluctuating character. Such instances of identity can be seen from various biological perspectives like cytology, genetics etc. In case of absolute identity we have, $(a = b) \supset (\Box(a = b))$ i.e. when we say $a = b$ it follows that necessarily $a = b$ there are no contingently true identity statements (Nicholas 1977). But in the case of organisms where the identities are relative and which vary over time, we need to introduce a new notation, $((\Phi x)t_1 = (\Phi x)t_2) \supset ((\Phi x)t_1 \ z \ (\Phi x)t_2)$ (where Φ can take isomorphic forms $\Phi x_1, \Phi x_2, \Phi z_3...$), where z is combination of $>, <$ & $=$ meaning different but equal to and Φ is the set of micro-constituents of object x. Where the identity of the whole as a macrostructure is preserved even though it's microconstituents change over time. The whole individual is quantitatively physically equivalent but qualitatively informationally different. In the case of individual we need a constitutional structural property analysis which has the temporal aspect as in perdurantism. This can be applied to the understanding of individual organism as a holobiont, symbiont where constituents keep changing according to the context.

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The nature and evolutionary dynamics of unusual symbiotic complexes of cicadas

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Cicadas, like other hemipteran insects that feed on nutrient-deficient plant sap, depend for the production of essential amino acids and vitamins on specialized heritable microorganisms that live inside their tissues. Two such endosymbiotic bacteria have co-diversified with cicadas for some 200 million years. I will explain how one of them, *Hodgkinia*, has repeatedly experienced a dramatic change in the genomic organization and function, with no known parallel in other forms of life. In many cicada clades, this symbiont has fragmented into complexes comprising multiple genetically and cytologically distinct lineages. Many of these lineages have gene sets smaller than any other known cellular organisms, comprising as few as 16 genes. The different lineages present in the same host insect are complementary, apparently relying on each other for the basic cellular functions, and working together to produce the same nutrients as the single ancestral symbiont. These unusual, rapidly evolving *Hodgkinia* complexes challenge our understanding of concepts as fundamental as what it means to be a cell or an organism. I will discuss how they function and evolve.

Hegel and Plessner on individuality pluralism. Rediscovering old theories for the contemporary debate

Ricardo Mona

The aim of this presentation is to claim the relevance of the conceptual and philosophical distinction between the form of individuality of plants and animals established by Georg W. F. Hegel and Helmuth Plessner. Both of them came to distinguish between a full form of individuality, which they considered to be proper of animals, from an incomplete form, typical of plants. Hegel (1830) claims that plant subjectivity, as compared to the animal one, is only "formal": the plant in fact, "is an aggregate of a group of individuals which form a single individual, but one whose parts are coompletely self-subsistent" (Hegel 1830: 314). In a similar way, Plessner (1928), argues that the organisation of the plant in its relationship to the environment is an "open form", because the plant is immediately and directly inserted in the environment; accordingly, individuality in plants is not constitutive,

but rather an "exterior moment of its phenomenic form" (Plessner 1928: 220). I will maintain that these two conceptions can be combined in order to create two different concepts of individuality; I claim that these, though they do not coincide with the plant/animal distinction as it is accepted in contemporary biology, can nonetheless be useful in the contemporary debate about individuality. According to Pradeu (2016b), in the current debate about individuality there is a considerable consensus on – among others – three claims: context-dependence (what counts as a biological individual depends on the specific scientific context in which the question is asked), continuity (biological individuality comes in degrees) and transitions (new levels of individuality have emerged in the course of evolution). In other words, there is a quite widespread acceptance of pluralism as a general theoretical framework. Nonetheless, the debate is still open; as a matter of fact, some researchers think that we should look for a unifying concept of individuality (Clark 2013), whereas others support different criteria in different scientific contexts (Santelices 1999, Sterner 2015, Pradeu 2016a). I am going to focus on these accounts, and try to underline how their pluralistic approach can be supplemented by a higher-level, organismal view of individuality based on the philosophical theories of Hegel and Plessner. In particular, I claim that the plurality of criteria given by Santelices can be grouped into the two categories which emerge from Hegel and Plessner, namely into the open form of individuality and the closed form. The different combinations of criteria identified by Santelices could, in this way, be inserted in a larger theoretical framework. This framework can both preserve the plurality of criteria, in that it does not deny that there are different relevant characteristics which contribute to define individuality and do not overlap, and try to give unity by providing a higher-level scheme, so that the different criteria are not simply juxtaposed but ordered. In addition, I claim it can link the pluralism about criteria to the other two points of the consensus named by Pradeu, because it provides two schemes which can be seen as gradually emerging in the course of evolution.

The notion of an organism in a context of brain death debate

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According to the current status quo that is still persistent in legislative documents brain death might be equated with a death of a human being because it is a death of an organism. Yet empirical evidences show that brain-dead bodies under artificial support are capable of maintenance of many functions that are essential for living organisms, so they cannot be always perceived as biologically dead. These evidences strive for changes in healthcare policies related to end-of-life care. I will argue for substituting biological concept of death it with moral one, which is based on the notion of irreversible loss of human's moral status. The goal of this inquiry will be to defend such a concept against argument according to which moral concept of death is too nebulous for healthcare policy purposes. I will show that the dominating in official documents biological view of death is no better in this respect. This is because its main thesis, according to which all living organisms die equally, makes

use of the concept of an organism that is no more unified in modern biology than the concept of moral status in modern ethics.

Biological individuality and the Extended Evolutionary Synthesis

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Much debate has arisen in the territory of Evolutionary Biology in relation to the alleged extension of some of the most central tenets of the Modern Synthesis (MS). Due to recent developments in the areas of Evolutionary Development Biology (Evo-Devo), epigenetics, phenotypic and developmental plasticity, niche construction and ecological inheritance and animal traditions to name but a few, an increasing array of leading evolutionary biologists, theoretical biologists and philosophers of biology agree to suggest that the structure of the MS as defined by the 20th Century understanding of the way evolution works is in dire need of a rethink. While both the theoretical contentions and the directions of empirical research that such a new framework encompasses is certainly multitudinous and multifaceted, some of the central topics around which the EEE revolves do include the origination and transmission of evolutionary novelty. This contributing paper reflects on the connection between this scientific debate and the notion of biological individuality. The paper proposes a discussion of two levels at which the concept of individuality relevantly intersects with the EEE and also takes notice of the tension between two accounts of the role of individuals in such an extended theoretical framework. First of all, taken at a face value many of the new developments in evolutionary thinking seem to point out to a much more organismal-centered view of evolution: one in which, in contrast to the classic assumptions of the MS as well as the gene-centered view of evolution, individual organisms and their activity are placed at the very center of the evolutionary process. Secondly, however, the concept of individuality appears to have been hugely modified. Indeed, both Multilevel Selection Theory and the framing of relevant ideas about the evolution of Darwinian Individuals and evolutionary transitions entail an expansion of the notion of individuality in which aggregations of (classical) organisms count as evolutionary individuals while (proper) organisms are coherently viewed as populations. In that respect, the conclusion appears to follow that while individuality has become increasingly relevant for the renewed view of evolution that the EEE presents, the frontiers of the notion seem blurrier and more fluid than ever. The paper concludes with a call for a pinch of pluralism when thinking of individuals (and many other evolutionary concepts).

Are all organisms biological individuals? (Viruses)

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The quest to identify biological individuality/organisms/species as a natural kind leads to a dilemma (Ruse 1987). Whether we *find* the individuality/organismality or make (construct) it? Whether the notion of natural kinds, organismality, or individuality is a metaphysical question or an epistemological one, requires a proper understanding. Evolution and genetics provide arguments veering off from Aristotelian metaphysical and Lockean epistemological proposals. Most of the philosophers of biology raise the question that is what constitutes an individual usually identical with what constitutes an individual organism? The complicate and complex relations between genetical, developmental processes and evolutionary processes tend to showcase some issues to an extent that what is meant by an 'organism' seems to lose its significance. Such problematic with the organismality and biological individuality arising from the evolutionary viewpoint highlights the issues related with identity over time. Also, evolution of individuality poses two lemmas that need further explanation: first, explanation for individuation of organismality; second, organismality of individuals. In this attempt, the question will be assessed on at least four basis: Evolutionary processes, heritability, hierarchical account, and sociality. Evolution of individuality could be categorised from an ontogenetic and phylogenetic viewpoint where an *a priori* notion of individuality meets the *a posteriori* aspect. Nested hierarchical (nested) or hetrarchical evolutionary viewpoints portray noteworthy positions to discuss these issues philosophically. From a phylogenetic perspective, can the notion of individuality have a nativistic account? Are living biological individuals active epistemic agents? Or it's the passivity of agency that makes the notion of individuals vacuous? Does the ontogenetic or autopoietic account of life and cognition provide an individuality or organismality to the living systems? Do complexities of *form* and *functioning* help in deciphering the status and defining feature of an organism? It is envisaged that the evolutionary epistemological account from a selectionist viewpoint throw some light on such points, positively.

Holobionts and biological individuality

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Research on symbiotic communities (microbiomes) of multicellular organisms seems to be changing our understanding of how species of plants and animals have evolved over millions of years. The quintessence of these discoveries is the emergence of the hologenome theory of evolution, founded on the concept that a holobiont (a host along with all of its associated symbiotic microorganisms) acts as a single unit of selection in the process of evolution. Although the hologenome theory has become very popular among certain scientific circles, its principles are still being debated.

In this talk, we argue, firstly, that only a very small number of symbiotic microorganisms are sufficiently integrated into multicellular organisms to act in concert with them as units of selection, thus rendering claims that holobionts are units of selection invalid. As a background for the discussion we chose the debate about the units of selection as presented by Godfrey-Smith, which is, as we believe, the most detailed elaboration of this sort. Then, we argue that holobionts do not fullfil requirements distiguished by Godfrey-Smith and, thus, should not be generally considered units of selection. Secondly, we present the idea that, even though holobionts are not units of selection, they can still constitute genuine units from an evolutionary perspective, provided we accept certain constraints: mainly, they should be considered units of co-operation. This can be achieved by analysing the idea idea of holobiont based on the concept of organismality, developed by Queller and Strasmann.

Ordinary objects, eliminativism and biological individuals

Artur Szachniewicz
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The domain of ordinary material objects is commonly believed to comprise of complex entities of both animate and inanimate kinds, composed of fundamental simple entities. However, eliminativists argue that's to much. Particularly, the organicist eliminativists (see Byrne 2019:18) argue the only complex objects are the subjects of life - living beings or organisms (van Inwagen 1990) or the subjects of non-redundantt causal powers (Merricks 2001) and since, it is argued, organisms are the only subjects of non-redundant causal powers, all that there is are simple fundamentals and complex organisms (see: Door 2003).

Insofar as biological individual is understood as a relatively well delineated and cohesive unit of the living world (Pradeu 2016), hence as a kind ordinary object, the conclusions of eliminativist's arguments may be applicable to the debate of biological individuality.

In my presentation I will elaborate on the category of ordinary objects along with the concept of biological individality, recap the organicists' arguments and draw attention to the possible consequences they may have for the debate of biological individuality.

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