The Purpose of This Element

This Element analyzes interdisciplinary and philosophical discussions of biological individuality. For philosophers, biological individuality is a problem space both old and new. The problem of individuality occurs across numerous disciplines and is wrapped with notions of identity, time, categories, nature, and quite frankly ourselves and what makes us who we are. The life sciences continue to provide exciting puzzles challenging intuitions about how nature is organized, and in turn, how we use concepts to organize nature.

Yet, some have challenged whether biological individuality matters in the production of scientific knowledge and its usefulness as a topic more generally: Why does individuality matter for biology? For philosophy? In other words, *what is its value*?

There are two ways philosophers tend to think about values in science. One concerns epistemic, or “knowledge-based” values about reasoning, method, theory, success, and characteristics of how knowledge is attained. And so, Sections 1 and 2 of this Element focus on the theoretical and methodological aspects of biological individuality, and its role in the production of scientific knowledge. The second way philosophers consider value concerns social and political features, often called “non-epistemic values.” Section 3 takes that non-epistemic (i.e., social and political) turn.[1] The non-epistemic value of biological individuality has been under-explored. By drawing from naturalists like Darwin, the Huxleys, and Asa Gray in the history of evolutionary thought, I argue that biological individuality promoted politics of social ideologies about managing the direction of human evolution with the life sciences.

In that sense, I submit that biological individuality is not, and never has been, value-free. Biological individuality’s dark side serves as a cautionary tale; the concept is shaped by social and political ideologies about progress and perfection.

The following contains a series of essays meant to inform those new to the problem of biological individuality. The aim is to analyze recent trends against select histories of evolutionary thought, specifically around the early twentieth century.

To the experts, many of whom are cited in these pages, a single Element on this topic cannot apply across all contexts nor comprehensively capture the details of every intellectual endeavor worthy of analysis. This Element is designed for accessibility to students and junior scholars, but it also aims to contribute to the intellectual arena. The sections are structured accordingly.

[1] The distinction between epistemic/non-epistemic values is a useful heuristic but rationality and reasoning are not devoid of social features: non-epistemic (or perhaps better “contextual”) values matter for knowledge in Longino’s sense.

Section 1: An Ontic Landscape maps the ways biological individuality is theoretically and conceptually defined according to the life sciences. "Ontic" refers to what exists (i.e., objects, concepts, categories, properties, etc.) in a domain (i.e., physical, chemical, biological, but also subspecialty domains like immunological, ecological, etc.). I call these approaches "domain-driven" because their analyses derive from select disciplinary domains or subspecialties including evolutionary biology, immunology, ecology, and so on. Certain domains have received more attention than others. As we'll see, domain-driven approaches yield many (sometimes non-evolutionary) ways to define biological individuality, and that resulting plurality and its ambiguities must be sorted and discussed.

Section 2: Critics & Methodology. Critics of work discussed in Section 1 ask epistemic questions like what value, if any, biological individuality has in producing empirical knowledge. These critical approaches I take to be "practice-based"; attention directs to how biologists, working in lab and field contexts, use and think about biological individuality. And so, I distinguish three types of practice-based approaches, which include how individuality concepts function in producing empirical results. Further, preoccupations with phenomenal qualities of biological objects – for example, what those objects are like in terms of how their boundaries are distinguished from their environments – is critically analyzed. Recommendations are provided for newcomers to avoid a cottage industry of this topic. Philosophers must avoid remanufacturing standard puzzle cases against received concepts of biological individuality. In light of that critique, Section 2 closes with a new opportunity for philosophical analysis at the cross-section of philosophy, biotechnology, and values.

Section 3: In Historical Context. Biological individuality has a long (and fraught) history outside of analytic philosophy, a history led by naturalists of the nineteenth and twentieth centuries. The historical figures in this section are anything but obscure in the history of biology: they wrestled with notions of agency, design, perfection, and progress in their disputes with the church concerning intellectual authority over nature. While Sections 1 and 2 focus on theoretical and methodological aspects of individuality's value for gaining knowledge about the biological world, Section 3 takes a social and political turn showcasing biological individuality's social significance. I argue that biological individuality was used to promote political and social ideologies about managing the "perfection" of human evolution. There are not only theological features, but alarming eugenics-overtones harnessing biological individuality as a tool for control over humanity's evolutionary future.

I hope *Biological Individuality* will reveal new ways for readers to think about individuality, while also revisiting places some readers know well.

As a graduate student, I found the topic very complicated and difficult. The sections of this Element are written in a way that draws from what I wish I would have known and where I hope to see work go in the future. Biological individuality is anything but a trivial conceptual space both in the concept's complexity and its relevance for philosophical and scientific debates.

I invite all readers to make this Element their own. While shaped by an overarching thread of argument concerning biological individuality's value, sections can be approached by prioritizing different routes of investigation.[2] However, all three sections are intended to cohere such that each carries a sense of belonging and function taken all together as one single individual Element.

1. An Ontic Landscape

Introduction to Section 1

Life in general consists of the life-histories of individuals.
—Child (1915, 5)

Upward of 30 trillion human cells are outnumbered by approximately 39 trillion bacterial cells. Some cells, for example, microbes in the gut and brain, are capable of altering behavior and neurotransmitter levels (Sampson and Mazmanian 2015). In what sense, then, are humans *individuals* in their own right, rather than merely part of a greater microbial complex? Some argue that a symbiotic view of life, one prioritizing interactional relationships among and between organisms and their microbes, reveals that humans have never been individuals (e.g., Gilbert et al. 2012). What exactly are biological individuals and why do they matter for the biological sciences? And how might philosophers develop answers to such questions?

Challenges like the above case invite exploration of traditional philosophical terrain informed by empirical disciplines. Disciplines are distinguished by their domain of subject matter. Broader domains, like the life sciences, can include subspecialties meaning that individuality concepts, like evolutionary,

[2] Nelson Goodman's 1978 *Languages of Art* inspires the structure of this book with different possible routes of investigation. Readers may prioritize historical analysis in Section 3 before ontological and methodological analyses in Sections 1 and 2. Alternatively, readers may start with Section 2's methodological focus before reading the theoretical and historical works in Sections 1 and 3. In contrast, standard linear reading develops a narrative about biological individuality's value through theory (Section 1), practice (Section 2), and history (Section 3), which for conventional reasons prioritizes a theoretical survey and analysis, followed by methodological critique, and finally a historical analysis to contextualize biological individuality's social and political value.

immunological, ecological, and metabolic individualities, are each defined and understood according to their own domain of study. That is what it means to develop an ontic landscape as *domain-driven*: conceptual analysis is theoretically and conceptually derived from disciplinary specialties in the life sciences. For example, evolutionary individuals are discussed in relation to evolutionary biology, which are contrasted against individuals relevant to other areas, such as immunology.

This section surveys recent disputes developing a pluralistic approach to biological individuality. Organismality as an organizing principle is discussed first, then species as individuals. How evolutionary individuality expanded reproduction's conceptual scope is also considered. After, individualities in non-evolutionary contexts, such as immunology and ecology, are analyzed to demonstrate biological individuality's theoretical value to matters of life and health.

There are many types of biological individuals. While biological individualities are categorized and classified according to a domain, there are different approaches to pluralism that must be sorted. I develop that pluralism both synchronically and diachronically; there are many types of biological individualities both at a time and over time. As a reference tool, the appendix (Table A.1) gathers several cases discussed throughout this Element from clonal organisms, to eusocial colonies, to social amoeba and more.

Let's start with organisms.

Organisms

'Individual' and 'organism' were once synonymous terms (see Buss 1987). However, organismality is now considered one organizational category under the umbrella of Individuality. In what follows, organismality is explored according to historical considerations, conceptual contrasts, and etymological analysis. After, key takeaways are provided about organismality's epistemic value as an organizing category.

1. Historical Considerations

Organisms were, at one time, the best representatives of individuality. First, consider how naturalist and evolutionist Julian Huxley professes his views to the philosopher in the preface of his book *The Individual in the Animal Kingdom* (1912):

> Living matter always tends to group itself into these "closed, independent systems with harmonious parts." Though the closure is never complete, the independence never absolute, the harmony never perfect, yet systems and tendency alike have real existence.

Huxley believed that organisms were more individuated than nonanimate crystals. Organism boundaries were definite: their size and form were defined by a scheme of architecture in contrast to inorganic crystal systems growing without limits. Organisms were more independent in their self-determining qualities (1912, 51). That is, their agency – their capacity to self-sustain and repair against perturbations – is what made organisms proper objects of biology. For Huxley, they were not only the best representatives of individuality, but organisms were central to navigating differences among organic and inorganic materials.

In contrast, consider the physician Sir William Osler's Ingersoll Lecture (1904) when he discussed the meaning of death against lessons of embryology:

> The individual is nothing more than the transient off-shoot of a germ plasm, which as an unbroken continuity from generation to generation, from age to age . . . "the individual organism is transient, but its embryonic substance, which produces the mortal tissues, preserves itself imperishable, everlasting, and constant".

Osler is not denying organismality's existence, but rather the *significanc*e of individuatedness it's supposed to represent. Osler's view draws from Weismann's germ-soma distinction identifying the germ plasm as central to heredity across generations. He isolated the germline from developmental events of the individual organism's life cycle (Richmond 2001, 169). Organismality for Osler, then, is ontologically secondary to the eternal generational thread.

The historical considerations above yield one lesson about organismality's significance: Huxley prioritized organismality as an entry point to access relevant features of individuality for *life's* evolution (versus changes in nonliving, inorganic material). However, Osler emphasized continuity of genetic lineages for which organismality was just a vessel. As products of their time in the early twentieth century, for Huxley and Osler organismality was representative of individuality, yet as an organizing principle it functioned differently in their approaches.

2. Conceptual Contrasts

How organismal parts work together in the larger system sustaining life was historically conceptualized in relation to structural constitutions of inorganic systems, like crystals and "habits" of minerals exhibiting change and structural order. What distinguished organisms as alive prior to nineteenth century biology was the unobservable, nonmaterial substance *elan vital* or "the force of life." However, a post-Newtonian scientific world demanded rejection of mysterious qualities in favor of mechanical descriptions, that is, in favor of how parts function together to produce system-level effects.

Organisms as complex systems were analyzed into component parts by different naturalists including anatomists, physiologists, embryologists, and so on (see Hull 1978, 336). Ruse (1987, 225) argued that individual organisms can be fragmented into structurally various parts functioning together interdependently to sustain the entire unit. At the same time, he acknowledged the complexities of decomposing organisms into discrete characters based on function and ancestry. In an evolutionary context, decomposition matters for building phylogenies and classifying taxa, which sort organisms across the Linnean hierarchy.

However, decompositional approaches are often contrasted with holist goals. Nuño de la Rosa (2010, 290) explains that Organicism – a holistic tradition regarding organisms defined as functionally-integrated and autonomous systems – has more ancient and historical roots than Darwinian theory. But at least two traditions can be distinguished for conceptually analyzing organismality.

On the one hand, under Darwinian traditions in the shadow of modern synthesis orthodoxy, "organisms are included in the more general category of biological individuals, defined as those entities (not only organisms but also genes or species) on which natural selection acts" (Nuño de la Rosa 2010, 290). Continuing the critique of organisms as mere vessels of adaptative characters: "organisms are conceived of as a non-problematic kind of individuals composing populations, and their distinct parts [their characters] are abstracted as adaptive traits that assure [an organism's] reproductive success within specific environments" (290). In other words, organisms matter for more than their role as adaptation bearers, a role that atomizes and isolates parts as theoretically primary.

On the other hand, Nuño de la Rosa argues that in fact there are non-evolutionary morphological or physiological theories that prioritize organisms as integrated wholes through their developmental lifetime. By appeal to organicism's longstanding history of varied views emphasizing connectedness and integration, she argues that strong theoretical grounds persist from Aristotle and Kant to the experimental embryology and developmental biology of the late nineteenth and twentieth century.

Sometimes the organism concept is used to synthesize intellectual traditions just discussed. For example, Huneman (2017) offers a conception of organismality to support evo-devo traditions combining developmental and adaption-focused views. One maps onto epigenetic self-production of parts within a viable whole, and the other explains design of the whole by natural selection. In sum, organismality has been conceptually considered according to approaches that decompose organisms into their adaptive character traits, approaches that consider their developmental features as living cycles, and combined approaches.

3. Etymological Analysis

Finally, "[o]rganisms are so called because they are literally *organized*" (Simpson 1958, 519). The term 'organism' has a long history. Etymology reveals 'organic' in reference to natural organization occurred around the late 1600s to early 1700s. The suffix 'ism' denotes a distinctive practice or system of some kind: organ-*ism* in its literal sense refers to a form of organization adapted for use in natural (i.e., non-artificial) contexts. Cheung (2006, 319) traces first appearances of the term in the life sciences and its usage in different settings. In the later 1700s, 'organism' became an ordering principle and a "generic name for individuals as natural entities or living beings" (2006, 319). However, *living* order as a mechanical product of an organism's parts working together needs more historical context.

Historian Jessica Riskin explains that the ancient model of living machinery persisted through the medieval Scholastics. By the mid-1600s it was as familiar as "automata on clocks and organs in churches and cathedrals" (2018, 159). When Descartes wrote the *Treatise of Man* in the 1630s, an anatomical treatise, he applied a different method from his predecessors in ancient and medieval anatomy (2018, 144). Riskin states that the analogy about mechanistic clockwork,

> . . . did not imply that the phenomenon in question [organismality] resembled a clock. It meant rather that the comprehension to be achieved was comparable to a clockmaker's understanding of a clock . . . . clockwork meant intelligibility in terms of material parts, not literal clockwork. Descartes's animal-machinery resembled ancient and medieval animal machinery in many respects: it was warm, fluid, responsive, mobile, sentient, and full of agency. Its salient difference was that it was fully material and so completely intelligible in Descartes' new science (2018, 147).

And so, the intelligibility of organism function was realized in terms of its material parts – its anatomy, which was *not* Cartesian machinery in the pejorative sense.

Three vantage points, historical, conceptual, and etymological, were just considered as depicted in Figure 1 below. So, organismality's epistemic value as an organizing principle can be summarized as follows.

First, organismality was a conceptual lens for understanding how living (versus nonliving) systems function. Organismality was considered in contrast to inorganic systems like crystals and compared with artificial systems and machines.

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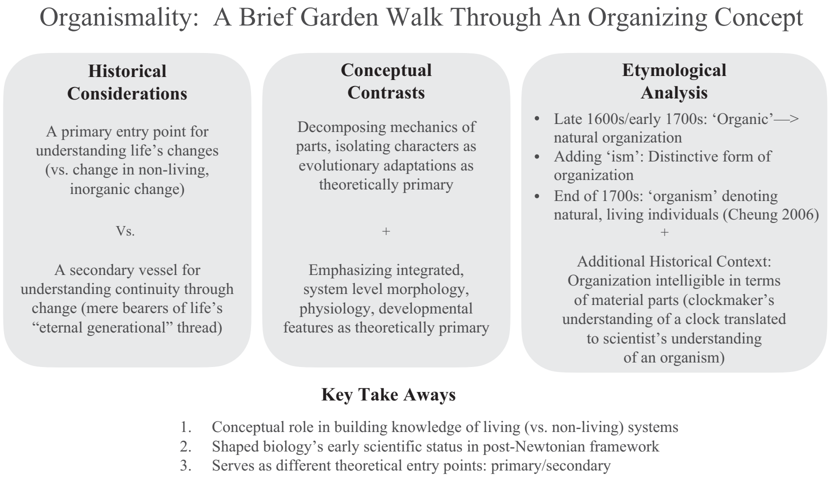

Figure 1 Summary of organismality as an organizing concept

Second, organismality's epistemic value is evidenced by its role in shaping biology's early scientific status in a post-Newtonian era. Mechanical function and decomposition of machines informed and constrained analysis, even organicist critiques that challenged the mechanical–vitalism dichotomy. Mysterious qualities to explain organisms as *living* systems were rejected in both decompositional and organicist accounts.

Third, organismality served as both a primary and secondary analytic entry point: for prioritizing quasi-closed and autonomous systems as agents of change (as per Huxley) and as a mere vessel for continuity (as per Osler's rendition of the eternal thread). However, there's more to biological individuality than organisms alone.

Individuality, Classes, & Species

Species taxa consist of organisms grouped together in a particular way. There are numerous species concepts to group organisms into species (e.g., Mayr's 1970 interbreeding and Van Valen's 1976 ecological approaches). In the latter twentieth century, debate ensued over the metaphysical nature of species: What *is* a species? Are species like classes akin to chemical kinds on the periodic table? Or something else?

The species-as-individuals thesis or S-A-I is the view that species taxa are not classes or kinds, but instead individuals. The following centers on David Hull's 1965, 1976, 1978, and 1980 papers. One thread of Hull's work concerns an argument by analogy: he identified features of organisms representing their individuality, which he then extended to the case of species because species share those same features. That is, if organisms are individuals because they are cohesive, discrete, spatiotemporally restricted entities with beginnings and endings in time, and species have those features, then species are individuals too. According to Hull, organisms and species are similar: they satisfy criteria of *metaphysical* individuality.[3] However, why argue that species are individuals? Motivations of S-A-I are traced before assessing (and rejecting) some interpretations of Hull's work.

1. Tracing the Motivations of S-A-I

Why argue that species are individuals? The S-A-I thesis was proposed in response to ancient, pre-Darwinian views that species are static categories of nature.

As Ereshefsky (2022) points out, since Aristotle species have been the main examples of natural kinds (i.e., of natural categories independent of our classification schema) with essences. In pre-Darwinian contexts, species were created (by the gods or later, God), each endowed with essential characteristics – an essence – signaling species membership. Classifying species taxa occurred by shared qualitative characteristics, which were unique to a species and necessary in that all and only members of a species have them. However, even Linnaeus had difficulty determining a species' essence, and evolutionary theory explains why: Forces like selection, mutation, recombination, and random drift can cause traits to disappear over time (Ereshefsky 2022, 2001).

Early on, Hull (1965) explained negative effects of essentialism on taxonomy, what he called "two thousand years of stasis" in response to Ernst Mayr's paradox. Mayr pointed out that while taxonomists accepted evolution, they still adhered to conceptualizing species as static entities. Hull (1965, 316) worked to unpack what he and others viewed as the problem's crux. Essentialism's residue was responsible for the conflict taxonomists faced. In particular, Mayr's paradox was due to essentialist views of species as natural kinds or classes defined by shared essences precisely because evolutionary change precludes species taxa as static, unchanging entities.

Hull (1978) contrasted metaphysical notions of natural kinds and classes with individuals. Classes are groups of entities that can function in scientific laws, whereas individuals are historical entities that occupy particular space-time regions (1978, 337). Members of a certain class belong to that class because of the attributes they share. In modern contexts, most common examples to

[3] An expansion of concepts marked the 1970s: the organism concept was controversially used by James Lovelock and Lynn Margulis to describe the earth itself as a single living "organism" known as the Gaia hypothesis. So, the nature of organismality was conceptually expanded across levels of organization. But if individuality is supposed to be distinguished from organismality by *individuality's* expansion across levels of organization, then their relevant differences remain under-explored.

illustrate natural kinds and their essences draw from chemical kinds on the periodic table, for example, all instances of gold have the atomic number seventy-nine. Consider the following three features of classes.

First, classes serve nomothetic aims by providing a stable, reliable base for induction; laws generalize over features of classes; reliable inferences can be made about how members behave under certain conditions. For example, pure gold melts at 1948 degrees Fahrenheit in standard atmospheric pressure, pressure which is defined at sea level. The melting point of gold is reliably inferred not only by its chemical constitution but also by how that constitution behaves under specific conditions.

Second, classes are spatiotemporally unrestricted or "forever open" meaning that members can in principle re-appear at different times and places, whereas individuals are spatially and temporally located with beginnings and endings in time.

Third, members of classes share similar attributes and do not exist in part–whole relationships with other members of their class. Parts of an individual need not be similar, for example, an individual organism can be fragmented into structurally various parts that function together interdependently to sustain an entire organism (Ruse 1987, 225).

So, if species are *not* classes, this implies: (1) It's possible for inferences to fail. There is no guarantee for species behavior (i.e., genetically, morphologically, or behaviorally) in certain conditions. (2) The same species cannot go extinct and re-emerge later because species taxa are unique to specific times and places.[4] And (3) not all organisms in a species will necessarily share an essential "core" set of attributes.

Later, Ruse (1987) argued that most philosophers discussing species as natural kinds were not in touch with biological reality. While Ruse raised objections against the S-A-I thesis, he clarifies motivations behind S-A-I. Typological views infused with static isolation and unchangeability dominated pre-Darwinian thought about species. We want to say that species are real, Ruse argues, but also that they can change. And so, one theoretical motivation driving S-A-I was its promise to designate species as tangible, concrete, *and* changing entities.

While Hull's 1965 paper characterized the problem of species as natural kinds in light of evolution, that was one year after S-A-I's initial formulation emerged from Ghiselin (1966, 208–209) who proposed that biological species are "in the logical sense" individuals. He argued that to think otherwise is

[4] For Hull (1976, 184), the individuality status of species meant that "the same species can no more re-evolve than the same organism can be born again."