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ORIGINAL RESEARCH

Cognizing the vital principle of the organism by interpreting the four Aristotelian causes in a Kantian perspective: an outline

Christoph J. Hueck[1]

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Abstract
This article outlines an epistemological perspective to understand the organism as a temporally changing whole. To analyze the mental faculties involved, the organism's development and persisting existence is differentiated into four interdependent aspects: descent, future existence, persistent species, and environmentally adapted physical appearance. It is outlined that these aspects are recognized by comparative memory, concept-guided anticipation, conceptual thinking, and sensory perception, respectively. Furthermore, it is pointed out that these aspects correspond to the famous four Aristotelian "causes" or principles of explanation. The descent of an organism corresponds to Aristotle's efficient principle ("where does it come from?"), its future existence to the final principle ("what is if for?"), its physical structure to the material principle ("out of what is it?") and its persistent species to the formal principle ("what is it?"). Aristotle regarded the unity of the efficient, formal and final principle as the ontological cause of the organism and called it the "soul" (*psyche*), while the material principle can be understood to represent its "body" (*soma*). I suggest that Aristotle's "soul" corresponds to three of the four mental faculties required for cognition of a self-maintaining organism. I argue that in a Kantian perspective, the Aristotelian "soul" represents the condition of the possibility of recognizing an organism at all. Therefore, the Aristotelian principle of life becomes intelligible and even empirically observable through the inner sense. In summary, I suggest that the four aspects of the organism described here can be viewed as the general, epistemological and ontological principle of the organism, the Bio-Logos.

Keywords Organism · Immanuel Kant · Aristotle · Teleology · Four causes · Development · Vitalism

✉ Christoph J. Hueck
hueck@akanthos-akademie.de

[1] Akanthos Academy, Zur Uhlandshöhe 10, 70188 Stuttgart, Germany

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"… some of us who cannot – by their life – pursue any longer the flawless, but sterile path that explores the properties seen to reside within objects, turn around to explore their very properties seen now to reside within the observer of these objects" (Von Foerster, 2003, pp. 284–285).

"The knowledge of the soul admittedly contributes greatly to the advance of truth in general, and, above all, to our understanding of nature, for the soul is in some sense the principle of (…) life" (Aristotle, De Anima I.1, 402a1-402a9).

1 Introduction

Living organisms pose a persistent problem for understanding. They are natural products, but their teleological organization appears as if constructed by a purposeful, intelligent mind. Scientists and philosophers have wrestled with this question since Aristotle, who viewed purposefulness as a natural property of organisms, caused by a specific principle of life, which he termed the "soul" (ψυχή, *psyche*) (Leunissen, 2007; Mix, 2018b). However, since the times of Bacon, Galileo and Descartes, many scientists considered formal and final principles useless and even harmful to science and rejected them as explanations of natural phenomena (Sorabji, 1980, summarized in Chase, 2011, p. 520)[1], while a specific non-physical principle of life has been deemed as "unknowable" (Mayr, 1982, p. 52), "anthropomorphic" (Hempel & Oppenheim, 1948, p. 145) and "inaccessible to empirical test and thus devoid of empirical meaning" (ibid.).

Nevertheless, and despite an enormous amount of experimental research and argumentation, the riddle of the organism has not yet been entirely solved. During the second half of the 20th century a mechanistic approach was widely regarded as successful, but the more we know about genetics and evolution, the more reductionist and Darwinian explanations prove not sufficient. Genes are not the master molecules that direct life, but depend on the organism like the organism depends on its genes (Moss, 2004; Robert, 2004; Sultan et al., 2021), and organisms are not only passive objects of genetic variation and selection but appear to actively adapt to environmental changes and thus to contribute to their evolutionary trajectories (Walsh, 2015; Nadolski & Moczek, 2023; Jaeger, 2024). Therefore, an "organismic" view describes organisms as self-generating, teleologically structured, autonomous and agential beings (Luisi, 2003; Nicholson, 2013; Mossio & Bich, 2014; Moreno & Mossio, 2015; Švorcová, 2024; Virenque & Mossio, 2024). However, explaining teleology, self-generation and autonomous agency is a significant challenge, given that these traits contradict the properties of inert matter, which only moves in response to external forces and lacks purposive

[1] Francis Bacon, one of the fathers of modern scientific theory and method, wrote paradigmatically in *The New Organon* (a title which was deliberately chosen against Aristotle [Cassan, 2021]): "It is a correct position that 'true knowledge is knowledge by causes.' And causes again are not improperly distributed into four kinds: the material, the formal, the efficient, and the final. But of these the final cause rather corrupts than advances the sciences, except such as have to do with human action. The discovery of the formal is despaired of" (Bacon, 1620/2000, p. 69).

action. Thus, a sophisticated framework to conceptualize "basic autonomous systems" has been proposed (Ruiz-Mirazo & Moreno, 2004) and elaborated in theoretical detail (Kauffman, 2000; Kauffman & Clayton, 2006; Moreno, 2018). However, real organisms are far more complex than these models account for, and efforts to artificially create organism-like, self-replicating systems are still unsuccessful (Porcar et al., 2011; Chang et al., 2023). Finally, the origin of life itself remains an unresolved question (Sutherland, 2017; Preiner et al., 2020; Lane & Xavier, 2024).

The problem to explain organisms may lead to the question of how we recognize organisms at all (cf. Van de Vijver & Haeck, 2024). Immanuel Kant had shown that our cognitive abilities are prerequisites for the experience and analysis of objects of inquiry[2], but the mental contribution to scientific results is often overlooked and has therefore been called the cognitive "blind spot" of natural science (Frank et al., 2024). This unawareness even points to a deeper epistemological issue: We have created a scientific worldview which excludes life, consciousness, and cognition, but is itself a product of living, conscious and cognizing beings. This inconsistency calls for a re-evaluation of how we integrate the dimensions of human experience and cognition into our conception of reality. Here, it is argued that such integration can facilitate an understanding of living organisms. However, this can only be an initial outline of the complex problem, which will be explored in greater depth in future work (cf. Hueck, 2023, 2024 [forthcoming]).

It is especially the organization of living beings, which neither can be understood as mechanical nor as intelligently designed, that draws attention to the epistemological question, and it was Kant who presented this question in unprecedented clarity in the *Critique of Judgment*– although his solution that we *must* judge organisms as teleological but cannot explain them as such is still controversially debated (Ginsborg, 2001; Kreines, 2005; Quarfood, 2006; Zammito, 2006; Breitenbach, 2009; Van den Berg, 2014; Gambarotto, 2017). Teleology is a concept derived from our personal experience of purposeful (concept-guided) action but cannot be considered a natural causality, for, according to Kant, nature has no goals.[3]

Kant also mentioned that in addition to the teleological structure of organisms, in which the parts and the whole appear to be mutually "cause and effect" of each other, living entities generate, maintain and proliferate themselves. However, although he argued that the concepts of teleology and self-generation are *both* required to distinguish organisms from mechanisms (Kant, 2008, AA V, § 65; cf. Ginsborg, 2015; Huneman, 2017), Kant mainly discussed the understanding of teleological organiza-

[2] "The conditions of the possibility of experience in general are at the same time conditions of the possibility of the objects of experience" (Kant, 1998, AA III, B197).

[3] Kant understood teleological causation as a "capacity of acting determined by concepts" (Kant, 2008, AA V, 369)"such as we experience in ourselves" (Kant, 2008, AA V, 360). However, "the universal idea of nature, as the sum of objects of the senses, gives us no reason whatever for assuming that things of nature serve one another as means to ends, or that their very possibility is only made fully intelligible by a causality of this sort", for "we do not take [nature] to be an intelligent being" (Kant, 2008, AA V, 359). He therefore claimed that "we read into [the organic bodies] our own concept of an end to assist our judging of [them]" (Kant, 2008, AA V, 193), and similarly: "We put, it is said, final causes into things, we do not draw them, as it were, out of our perception of things" (Kant, 2008, AA XX, 221).

tion but did not analyze in detail the mental faculties involved in the conception of an organism's temporal existence and change.[4]

Here, I attempt to provide such an analysis. I start with an outline of a phenomenological description of a developing organism (Sect. 2) and analyze which mental faculties are involved in understanding such development (Sect. 3). Based on this analysis, I propose a fourfold framework for both the temporally existing organism and its cognition. I further show that this fourfold ontological/epistemological structure corresponds to the famous four Aristotelian "causes" (Sect. 4). Finally, I interpret the Aristotelian principle of life (the "soul"), which corresponds to the unity of three of the four "causes", in Kantian terms as the condition of possibility of cognizing an organism and argue that this correspondence makes this principle intelligible (Sect. 5). In summary, I attempt to outline the idea that the living organism can be understood by considering the mental faculties involved in its cognition.

2 The phenomenological structure of the developing organism

This section gives a phenomenological discription of a developing and temporally persisting organism. The aim is not to provide a detailed biological or sophisticated theoretical description, but simply to show how an organism appears to us.

To begin with, each organism appears as a specific spatial form, e.g., a daisy, a fir-tree, a shark, an eagle, etc. This form results from a temporal process, since every organism originates from past predecessors and precursory states. Its specific structure is both enabled and constrained by what was generated by its predecessors or earlier states of development. Furthermore, an organism carries an intrinsic potential for its future development, maintenance and proliferation. A seed has the effective potential to develop into a flowering plant, a caterpillar into a butterfly. The structures and processes that exist within the organism, from the morphological to the molecular level, descend from past precursory states and have the potential to facilitate its future development. All structures and processes support the life and survival of the individual and the species as a whole, signifying an organism's intrinsic, teleological purposiveness.

Another aspect of an organism is that, despite its changing appearance, it belongs to a particular species, which remains constant during its development and in the preceding and subsequent generations. A rose is always a "rose", whether it exists as a seed, a leaf-bearing shoot, a blooming plant, or a rose hip.[5] The organism thus forms and maintains itself in a species-specific manner, and the species remains constant throughout the organism's apparent developmental change.

[4] In the *Critique of Pure Reason*, Kant analyzed the mental faculties involved in the recognition of temporally changing things, especially the power of imagination and the category of causality (Mörchen, 1970; Horstmann, 2018). It would exceed to scope of the analysis presented here to discuss these faculties.

[5] In a first approximation, such phenomenological description can leave out the evolutionary change of species.

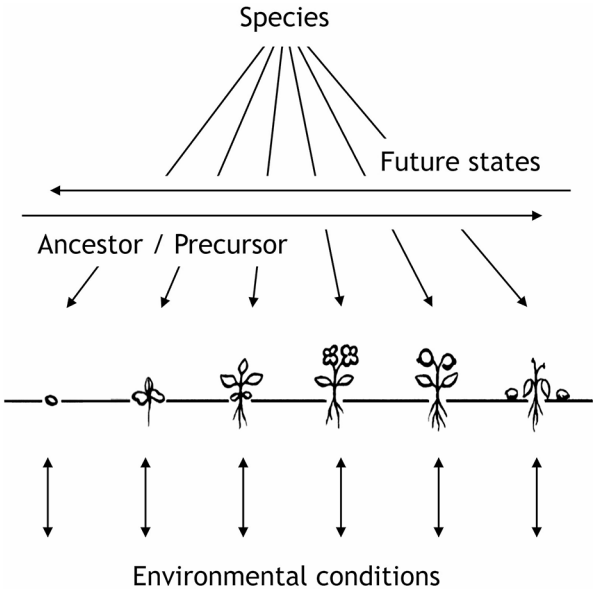

Fig. 1 Phenomenological depiction of different aspects of a developing organism (the fact that "species" is written above the organism is not meant to imply an external or even metaphysical principle, but its intrinsic identity and formative power)

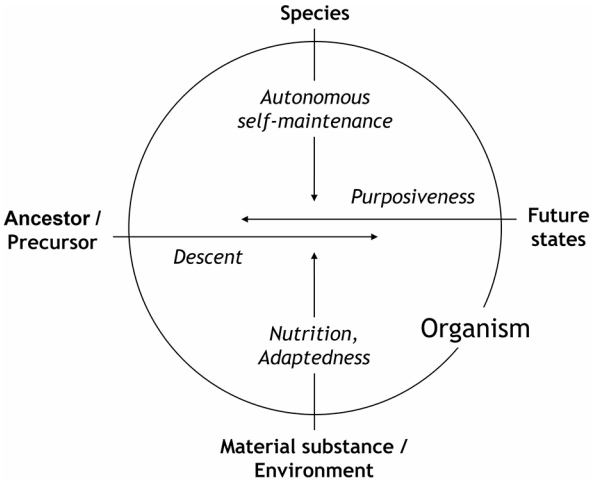

Fig. 2 A tetradic structure of the organism (the term "Purposiveness" here means that the potential for the future development of an organism is already effective in its present)

Finally, an organism is adapted to and dependent on its physical environment. While the species remains constant, the physical manifestation of an organism changes and interacts with its environment in its current physical state.

A living organism can therefore be described by four distinct but interdependent aspects or conditions: (i) its descent or origin from an ancestor or precursory state, (ii) its potential to further develop into future states, (iii) the self-maintaining constancy of its species, and (iv) its changing physical forms which are adapted to and depend on their environmental conditions (Fig. 1).

If the different developmental states shown in Fig. 1 are merged, a tetradic structure is obtained (Fig. 2).[6] Its horizontal dimension represents development, maintenance and proliferation of the organism in time. The two horizontal arrows signify two interpenetrating conditions of the organic process: Descent and purposive future-directedness are continuously relevant throughout an organism's life and reproduction. The vertical dimension illustrates the organism's specific, autonomous self-maintaining and persistent identity within its changing material manifestations and environmental conditions. The organism maintains itself in a species-specific manner, while it exchanges material substances with the environment and is closely adapted to the environmental conditions.[7] In a description of the living organism that is particularly consistent with this analysis, the renowned embryologist Carl Ernst von Baer wrote:

> Even though it is clear that, although every advance in development is only made possible by the previous state, nevertheless the whole development is dominated and guided by the entire being of the animal that is to become, and not the current state that becomes the sole and absolute condition for the future. (…) [I]t is not the matter as it is arranged, but the essence (the idea according to the new school) of the generating animal form that governs the development of the fruit (Von Baer, 1828, pp. 147–148).

Therefore, an organism can be described by the mutual interaction and interdependency of a *temporal* dimension of descent and purposiveness (horizontal in Fig. 2) and a *structural* dimension of species-specific autonomous self-maintenance and physical appearance and adaptedness (vertical in Fig. 2).[8]

Figure 2 thus can be viewed as representing a dynamic, integrated and general description of a living organism with descent, purposiveness, autonomous self-maintenance, and nutrition and adaptedness as its essential features. These four aspects are interdependent and can only be theoretically separated from each other, and it is argu-

[6] Figs. 1 and 2 are not meant to imply that the species is unchangeable. Species evolve over long periods of time. However, I will not delve into the discussion of the species-concept (Queiroz, 2007) and its biological, evolutionary and metaphysical aspects here. For my current purpose – a phenomenological description of a developing organism and the analysis of the mental faculties involved in this description– it suffices to consider a rose as a "rose".

[7] In his seminal book *Chance and Necessity*, Jacques Monod wrote about this species-specific self-forming capacity: "[A] living being's structure (…) owes almost nothing to the action of outside forces, but everything, from its overall shape down to its tiniest detail, to 'morphogenetic' interactions within the object itself. It is thus a structure giving proof of an autonomous determinism: precise, rigorous, implying a virtually total 'freedom' with respect to outside agents – which are capable, to be sure, of impeding this development, but not of governing or guiding it, nor of prescribing its organizational scheme to the living object" (Monod, 1972, pp. 10–11).

[8] The four aspects are weighted differently in different organisms. A bacterium develops rapidly, is highly dependent on its environment and therefore shows little organismic autonomy, while a mammal develops slowly and has a high degree of relative autonomy (cf. Rosslenbroich, 2014).

ably impossible to conceive of a living organism by leaving any one of them out.[9] I suggest that this figure is not only descriptive, but conceptual and therefore represents a general, dynamic concept of an organism which can be called the *Bio-Logos*.

3 Cognition of the developing organism

The phenomenological analysis of the developing and temporally persisting organism facilitates an analysis of the mental faculties involved in its cognition. Here too, only an outline is attempted, which I will demonstrate with an example.

Knowledge about an individual organism is initially gained through here-and-now *sensory perception*: On a certain day in May, I see the sprouting, delicate and bright green leaves of a rose bush in my garden. At this point in time, I can neither see the small, reddish buds from which the leaves have emerged, nor the dark green, fully developed leaves into which they will develop. Thus, an individual organism can only be sensually perceived in its current state of development, and sensual perception can only give us its current developmental state.

However, I know that the sprouting leaves emerged from small buds, because I remember observing them earlier and compare the memorized images with the current ones. The past states of an organism's development are being added through *comparative memory* to its current sensory perception.

In addition, I expect that the small leaves will soon have developed into larger and darker, mature ones and that – assuming favorable conditions – even colored rose blossoms will eventually appear. In this way, *anticipation* provides awareness of the organism's potential for future development. However, I do not anticipate a contingent future, but one that corresponds to the concept of the species in a lawful way. Thus, my anticipation is *guided by a concept*.

Finally, I know that it is the same plant which I observed earlier, perceive now, and will probably perceive tomorrow, because I link and compare the memory of my earlier perceptions with the present ones and with the imagination of its future by the concept of identity, which in this case entails the concept of the species "rose".

In the previous section it was stated that the organism has an autonomous self-maintaining ability by which it generates its species-specific forms.[10] On the mental side, the species-specific self-maintenance corresponds to *conceptual thinking*. Just as the organism, as Kant stated, "imparts" its formative ability "to material devoid of it – material which it organizes" (Kant, 2008, AA V, 374), we organize the manifoldness of sensual perceptions with unifying concepts (Meer, 2018; Schafer, 2022). Similar to the organism which organizes previously unorganized matter to generate

[9] The four aspects also apply at the physiological level of metabolism and the molecular level of genetics and biochemistry. These levels also encompass interdependent structural and temporal aspects. However, in these instances the term "species" must be supplemented with the concept of the organic whole, which determines the physiological and genetic processes as a persistent factor. For a detailed description cf. Hueck, (2023).

[10] Ina Goy summarized Kant's concept of the formative power: "The immaterial, natural formative power is a basic, ordering and form giving principle which is directed towards an end or purpose, and spreads out its organizing and ordering capacity in matter" (Goy, 2012, pp. 37–38).

specific forms (a rose, a tulip, etc.), unifying concepts generate specific forms out of a manifoldness of sensual perceptions (a "rose", a "tulip", etc.). Figure 3 denotes the difference and interplay between the structural and the temporal dimension of cognition of organic development.

I would not be able to perceive an organism without my senses, and I arguably could not realize that it developed from precursory states without the faculty of memory. Similarly, without concept-guided anticipation I could not have an idea about its potential existence in the future. Finally, if I could not form my current sensory perceptions with concepts of thinking, and if I could not combine all of this content with the concept of the organism's persistent identity, I couldn't regard it as a changing, temporal continuity. Thus, the four aspects shown in Fig. 3 are just as constitutive for the cognition of an organism as the four aspects in Fig. 2 are for the organism itself.

Kant stated that something only exists for us if and because we have the corresponding cognitive abilities. Thus, physical objects only exist for us because we have the abilities of sensual perception and conceptual thinking, and without these abilities there would be no experienced objects at all. An organism, however, appears as a physical object only in its current – sensually perceptible – state. Its prior and future states cannot be perceived through the senses. Descent, development, maintenance and future persistence manifest in successive physical states, but the link between these states *must* be established through the faculties of comparative memory and concept-guided anticipation (with the help of the concept of identity). In this way, an organism is cognized through four interweaving mental faculties.

Therefore, a developing organism cannot be understood like a mere physical object. According to Kant, physical objects are recognized by merging sensory impressions with unifying concepts. The recognition of a living, developing and self-maintaining organism requires integration of sensory impressions with a unifying concept, as well as with memories and concept-guided anticipations.

4 The concept of the organism and the four Aristotelian "causes"

Natural teleology has not always been regarded as an obscure or merely heuristic principle. For Aristotle, purposefulness was a self-evident property of living beings (Moya, 2000; Johnson, 2008; Leunissen, 2011; Ginsborg, 2015; Lennox, 2017; Mix, 2018a). In Physics II, the philosopher stated:

> If then it is both by nature and for an end that the swallow makes its nest and the spider its web, and plants grow leaves for the sake of the fruit and send their roots down (not up) for the sake of nourishment, it is plain that this kind of cause is operative in things which come to be and are by nature (Phys. II.8, 199a20-33).

However, Aristotle not only considered teleology, but a total of four "causes" or "principles" (αιτιαι, *aitiai*) to be required for comprehensive explanation of organisms: The so-called "material cause" (*out of what*?), the "formal cause" (*what is it*?), the "efficient cause" (*where does it come from*?), and the "final cause" (*what it is for*?)

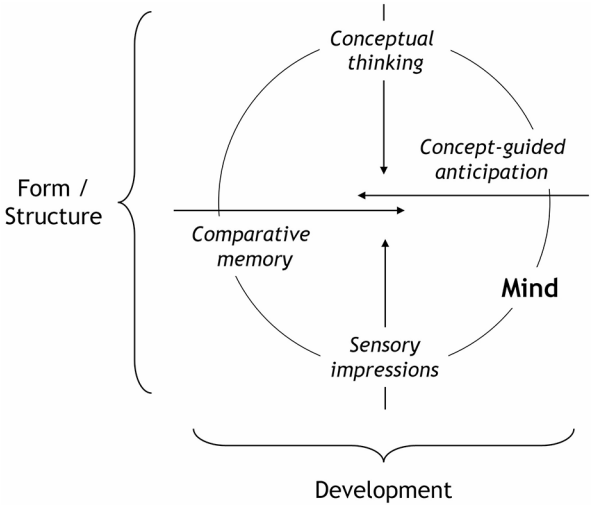

Fig. 3 Tetradic structure of the mental faculties involved in cognition of a developing organism

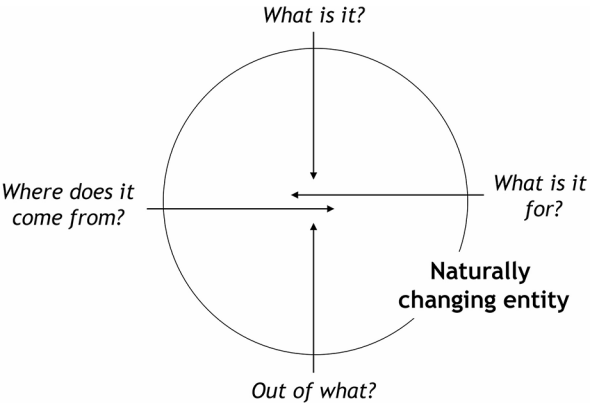

Fig. 4 The four Aristotelian "causes" or principles.

(Phys. II.3, 194b24-195a2). According to Aristotle, these four principles provide a framework for explaining transformations in the natural world, "as regards both coming to be and passing away and every kind of natural change, in order that, knowing their principles, we may try to refer to these principles each of our problems" (Phys. II.3, 194b16-23).

> Now, the causes being four, it is the business of the student of nature to know about them all, and if he refers his problems back to all of them, he will assign the 'why' in the way proper to his science – the matter, the form, the mover, that for the sake of which (Phys. II.7 198a22-32).

It is apparent that these four principles correspond to the fourfold ontological and epistemological concept of the developing and self-maintaining organism described above (Fig. 4). Although the four "causes" are often illustrated by human artefacts (e.g. a statue made out of bronze by a sculptor to honor the person depicted [e.g.,

Shields, 2023]), they are much better understood as principles of natural change (Sentesy, 2020), with organisms as the paradigmatic example of their effectiveness and explanatory power (Johnson, 2008; Hennig, 2009; Chase, 2011; Leunissen, 2011; Mix, 2018b). Thus, for Aristotle the four "causes" were not only heuristic principles. In his view not only material and efficient, but also formal and final causes exist in nature, even though plants and animals "neither enquire nor deliberate" (Phys. II.8, 199a20-22).[11]

Boris Hennig provided an interesting interpretation of the logical cross-relation of the four principles as a conceptual framework to understand organic development and self-maintenance:

> First, concerning any natural change, we may distinguish between the thing that changes and the change that it undergoes. Neither of these could be studied without in any sense referring to the other. Second, we may ask out of what a natural thing comes to be what it is, and we may ask an analogous question about a natural change. Conversely, we may ask what a thing or a change naturally comes to be. Again, the two questions, out of what something comes to be what it is, and what it comes to be, cannot be separated (Hennig, 2009, pp. 137–138).

Thus, in an organism's development and persistent existence, the four principles are inseparably linked. The "formal cause" is the *thing that changes* (in the example used in Sect. 3 the species "rose"), and its change is its development from seed to flower to seed. The current physical appearance of the rose – be it as a seed, a leaf-bearing shoot, or a blossoming plant – is that *out of what* the respective future states will come to be. Thus, when considering an organism, Aristotle's "material cause" does not only entail its physical substances (as the bronze of a statue) but denotes its current state of development, which – like all material stuff – is perceptible through the senses. The "efficient cause" (*where does it come from*?) is the preceding developmental state[12], and the "final cause" (*what is it for*?) is the life and proliferation of the whole (cf. Fulínová, 2024).

Thus, in the living organism, the four principles merge. Dalia Nassar wrote accordingly, focusing on the unity of formal and final "cause":

> The structure of a living being (…) is realized through the purpose (self-construction; self-maintenance), and the purpose is realized in and through the structure. (…) In the case of internally purposive beings, the purpose is nothing

[11] Mariska Leunissen pointed out that "Aristotle is a realist concerning both causes and explanations, which means that the four types of causal explanations he distinguishes in *Ph* II.3 and *Ph* II.7 are grounded in four types of causal relations that obtain in the world: the four *aitiai* are the kinds of answers one gives to four different why questions, and these answers will only be explanatory and hence productive of scientific knowledge if they pick out real causes (and not merely epistemic reasons why) under their causally relevant description" (Leunissen, 2011, p. 10). For additional discussion of the relevance of the four causes for biology cf. Moya, 2000; Lennox,2017; Oderberg, 2018; Karaca, 2021.

[12] Accordingly, Aristotle called "the father [the] cause of the child" (Phys. II.3, 194b30-32).

> other than the maintenance of the structure. The final cause (…) is the ongoing realization of the formal cause (Nassar, 2022, p. 41).

One might add that the purposeful structure of the organism continuously manifests itself in changing physical appearances and that this change of the material principle depends on its precursory states and is at the same time the ongoing realization of the combined efficacy of the formal and, thus, the final cause. The logical and ontological interdependency of these relations shows once again that an organism must be conceptualized by a dynamically interrelated set of parameters, the four principles of organismic life, which I call the *Bio-Logos*.

5 Aristotle's "soul" as the life-principle of the organism

The physical appearance of an organism – which is only a section of a self-generating developmental process[13]– stands out from the other three principles in that it is perceptible through the outer senses. This perceptibility causes the illusion that organisms are merely material entities and, therefore, should be explainable like other material objects, i.e., by mechanistic causation. However, although an organism consists of perceptible matter, its material structure cannot exist – and even cannot be conceived of – without considering its teleological life-processes driven by an autonomous intrinsic ability of self-generation and self-maintenance, because this ability generated the material composition and structure of the organism. Therefore, there is the long-standing debate about a special non-physical and active principle of organic life, which has been called "entelechy", "soul", "archaeus", "formative power", or otherwise (Haller, 1986). Many researchers consider such a principle as obscure and therefore not to be taken seriously. However, it is interesting to note that Aristotle saw three of the four "causes" in direct connection with the principle of life. In Phys. II.7, he wrote about the causes:

> … the matter, the form, the mover, that for the sake of which. The last three often coincide; for the what and that for the sake of which are one, while the primary source of motion is the same in species as these. For man generates man– and so too, in general, with all things which cause movement by being themselves moved (Phys. II.7 198a22-32).

[13] Ludwig von Bertalanffy wrote accordingly: "[t]he organism is the expression of an everlasting, orderly process, though, on the other hand, this process is sustained by underlying structures and organized forms. What is described in morphology as organic forms and structures, is in reality a momentary cross-section through a spatio-temporal pattern" (Bertalanffy, 1952/1960, p. 134) Or, as John Dupré and Daniel Nicholson put it: "What we identify as [organic] things are no more than transient patterns of stability in the surrounding flux, temporary eddies in the continuous flow of process" (Dupré & Nicholson, 2018, p. 14; my addition).

Table 1 Correspondences between aspects of the living organism, faculties of the cognizing mind, Aristotelian "causes" or principles, and Aristotelian ontology

	I	II	III	IV
Organism	Physical appearance	Persisting species	Descent / preceding states	Future life and proliferation
Mental faculties	Sensual perception	Conceptual thought	Comparative memory	Concept-guided anticipation
Aristotelian principles	Out of what? ("Material cause")	What is it? ("Formal cause")	Where does it come from? ("Efficient cause")	What is it for? ("Final cause")
Aristotelian ontology	"Body" (σῶμα, *soma*)		"Soul" (ψυχή, *psyche*)	

Aristotle called the coincidence of the three non-material causes the "soul" (Leunissen, 2007; Mix, 2018b)[14], which in his view is the principle or cause of the body:

> The soul is the cause or principle of the living body. (…) It is the source of movement, it is the end, it is the essence of the whole living body (De Anima II.4, 415b9-11).

Interpreting Aristotle, John Lucas Mix wrote that.

> [i]n living things, the formal, efficient, and final causes are the same. The essence of an organism is its purpose, and both are inseparable from how it came about. In other words, a living thing can be defined through understanding its source (similar parents) and end (similar children). Aristotle used souls as a kind of explanation unique to living things, where formal, efficient, and final causes coincide (Mix, 2018b, p. 49).

Since the four Aristotelian principles are answers to four questions which "we may try to refer to (…) each of our problems" (Phys. II.3, 194b16-23), Mariska Leunissen pointed out that for Aristotle the "soul" was both an ontological *and* an epistemological principle:

> In identifying the soul with the formal, efficient, and final cause of the natural body that has life potentially, Aristotle conceives of the soul not only as the ontological principle of living beings (in the sense of its essence, internal origin of movement and rest, and internal orientation towards its complete realization through the 'use' of the natural body), but also as the epistemological principle facilitating an explanation of life (Leunissen, 2007, p. 108).

[14] The Aristotelian "soul" is usually known as comprising three capacities, the nutritive (found in all living beings), the animal (found only in animals and humans) and the rational soul (found only in humans) (Johansen, 2012). Here, the nutritive soul which gives life to organisms is being discussed.

This notion corresponds to the relation described above between the phenomenological structure of the developing and self-maintaining organism and the mental faculties involved in its cognition. Thus, the principle of an organism's life, i.e., the unity of its efficient, formal and final "causes" (as perceived through the intertwined cooperation of comparative memory, conceptual thinking and concept-guided anticipation) is expressed by the Aristotelian notion of "soul" (ψυχή, *psyche*), whereas an organism's "body" (σῶμα, *soma*) is the material principle which is perceived through the outer senses. Table 1 summarizes these correspondences.

In summary, the mental faculties of sensual perception, comparative memory, concept-guided anticipation and conceptual thinking are necessary conditions for the possibility of experience of a living organism. Without these faculties, a developing and temporally persisting organism would not exist for us. And since the content of sensual perception can be called an organism's "body", while comparative memory, concept-guided anticipation and thinking are faculties of the "soul", Aristotle's notion becomes intelligible that the "soul" (i.e., the unity of the efficient, final and formal principle) – which is the source of memory, anticipation and thinking – is both the epistemological *and* the ontological principle of the material body.

6 Discussion

In the *Critique of Judgment*, Kant showed that we need the principle of teleology to judge the empirical structure of a living being. However, he did not analyze the conditions of cognizing an organism's developmental change. Here I show that in order to cognize the organism's temporal existence, we need sensual perception to become aware of its current physical appearance, comparative memory to know about its past states, concept-guided anticipation to know about its potentiality of future existence, and thinking to link these various aspects with the concept of an organism's persistent species. Therefore, a fourfold epistemological/ontological structure of the living organism can be described, which I call the *Bio-Logos*.

I further show that this structure neatly corresponds to the four Aristotelian "causes" or principles ("efficient", "final", "formal", and "material"). This correspondence is more than just a historical coincidence, for the "causes" can be interpreted as a logical system of interrelated and co-dependent principles of natural change (Hennig, 2009; Leunissen, 2011; Sentesy, 2020). Therefore, a living organism can be viewed as being constituted by the dynamic unity of these four principles.

Aristotle understood the three non-material principles ("efficient", "formal" and "final") as the explaining cause (*aitia*) or principle (*archê*) of an organism, and he denoted their unity as the "soul" (Leunissen, 2007; Mix, 2018b). Thus, the sensually perceptible part of the organism is its material "body", while the other three aspects constitute its "soul". Since the structure of the material organic body cannot be explained by the properties of matter (i.e., by mechanistic causality), the soul is the explanatory principle of the organism.[15]

[15] It would exceed the purpose and scope of this paper to further discuss the Aristotelian notion of "soul" (for an overview, cf. Lennox, 2009).

The Aristotelian notion of the "soul" as the cause of the organic body corresponds to the fact that the mental faculties of comparative memory (corresponding to "efficient cause"), conceptual thinking ("formal cause") and concept-guided anticipation ("final cause") are necessarily required to cognize a living organism. Therefore, Aristotle's notion that "[t]he soul is the cause or principle of the living body; (…) [i]t is the source of movement, it is the end, it is the essence of the whole living body" (De Anima II.4, 415b9-11) can be reformulated in a Kantian perspective: "*The faculties of the soul* are the cause or principle *of the cognition* of the living body. (…) They are *the principle of cognizing* its movement, its end, and the essence of the whole living body". Therefore, the Aristotelian "soul" can become intelligible as a non-physical principle of cognition of the living organism.

Since the times of Bacon, Galileo and Descartes, Aristotelian concepts have been banned from natural science. In his *New Organon*, Francis Bacon rejected Aristotle's notion of formal and final causes:

> [T]he final cause rather corrupts than advances the sciences, except such as have to do with human action. The discovery of the formal is despaired of. (…) For though in nature nothing really exists besides individual bodies, performing pure individual acts according to a fixed law (Bacon, 1620/2000, p. 69).

Bacon and his contemporaries strongly promoted the conviction that nature is only material and, thus, has to be explained in materialistic and reductionist terms. It can be claimed that they laid the ground for the persistent inability to scientifically understand living organisms. In the light of the analysis presented here it does not seem to be true that "in nature nothing really exists besides individual bodies", i.e., sense-perceptible objects. Organisms are perceptible (only) in their current state of development (or, for that matter: of their life), but not in their respective past nor future states. However, past and future states appear to be miraculously integrated and active within the current appearance of an organism, which throughout all its changes nevertheless remains the same. Here, I suggest a way in which this structure can be explained.

Several researchers have argued that organisms should be viewed as processes rather than things (Dupré, 2014; Koutroufinis & Araujo, 2023; Meincke, 2023), a view which sees biological structures as "time-extended properties" which are "sufficiently stable on the timescale of the further processes that they in turn undergo" (Dupré & Nicholson, 2018, p. 13). This notion fits well with the fourfold Bio-Logical structure, since the sensual/material side of an organism is the changing product of the dynamic stream of life which is caused by the cooperation of the efficient, final and formal principle.

The conclusion of my analysis raises further ontological and metaphysical questions, which cannot be discussed here. However, although the idea of a principle of life seems incompatible with today's prevailing materialism, an understanding of

organisms should be derived from empirical observations and logical analyses and not be distorted by preconceived notions about alleged ontological and metaphysical impossibilities. In fact, metaphysical ideas should be derived from empirical insights and not the other way round (Nagel, 2012; Masi, 2022).

Vitalistic principles have been regarded as obscure (not observable nor intelligible, Mayr, 1982), or dualistic (not empirically testable and therefore not compatible with an empirical concept of nature, Hempel & Oppenheim, 1948). Nevertheless, vitalism is still being discussed, albeit more in the sense of a heuristic principle for understanding the organism than as an ontological concept with problematic metaphysical implications (Donohue & Wolfe, 2023; Chen, 2024). However, here I show that the Aristotelian "soul", if understood in the manner described above, is observable (albeit only by the evidence of an "inner sense"[16], with which we know about our memories, anticipation and conceptual thinking) and intelligible. It is also testable in thought-experiments. Imagine you would not be able to memorize the past developmental states of an organism and to compare them with your current perceptions, or to anticipate its specific future development, or to combine your various perceptions and images through the concept of identity. Although this field of observation is not the field of sensory perception and empirical investigation in a physicalist way, such thought-experiments demonstrate the necessary requirement of these mental faculties and, therefore, of the "efficient", "final" and "formal" principle.

In summary, I argue that an organism must be understood as more than a mere sensual (physical) entity. It can be described by the fourfold *Bio-Logos*, which facilitates a conceptual distinction between its physical and non-physical side and a differentiation of the latter into three different, albeit closely related aspects. Finally, I argue that the organism can be explained by a non-physical entity, the Aristotelian "soul". Ernst Mayr claimed in the early 1980s that "[i]t is fair to say that for biologists vitalism has been a dead issue for more than fifty years" (Mayr, 1982, p. 52). Another 40 years later the time seems ripe to revive it.

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[16] According to Kant, nature "has two principal parts, in accordance with the principal division of our senses, where the one contains the objects of the *outer* senses, the other the object of *inner* sense. In this meaning, therefore, a twofold doctrine of nature is possible, the *doctrine of body* and the *doctrine of the soul*, where the first considers *extended* nature, the second *thinking* nature" (Kant, 2004, AA IV, 467).

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