

Metaphysics of Evolutionary Transitions

The main thrust of Aristotle's philosophy of nature is to provide a proper account and description of the causes and mechanisms of the processes of generation, change, corruption, and decay in nature, and to posit the plausible characteristics of both the changing and persistent aspects therein. So, although the idea of juxtaposing Aristotle and Darwin may appear counterintuitive at first (as the latter is commonly believed to have ultimately proven the inadequacy of the biology of the former), it is still quite reasonable, given Aristotle's method, to search his philosophy, as well as its further development in Aquinas, for the metaphysical principles that may help us to better understand and philosophically ground evolutionary processes.

The aim of this chapter is to develop a constructive proposal of the Aristotelian–Thomistic metaphysics of evolutionary transitions. In order to accomplish this goal, I will proceed in the following way. First, I will present the hylomorphic notion of a living being, paying attention to and defending a metaphysically robust interpretation of the categories of matter and form. In the next step, I will address the notion of substantial unity of a living being in classical philosophy. Special attention will be paid to the need and relevance of the contemporary interpretation of the concept of virtual presence of parts in a whole. Next, preparing ground for the metaphysical analysis of speciation, I will present and discuss the concepts of the disposition of matter and levels of potentiality, as well as Aristotle's and Aquinas's suggestion that matter strives for greater perfection. The following and central section of this chapter will delineate my constructive proposal of the metaphysical analysis of evolutionary transitions. In the next step, I will address the challenging question of

whether the proposed model goes against the classical principle of proportionate causation. Various aspects and interpretations of this principle, as well as several possible responses to the challenge of its violation, will be discussed. A short conclusion will close the entire chapter.

HYLOMORPHIC NOTION OF A LIVING BEING

The first and crucial aspect of Aristotle's philosophy that grounds the interpretation of the theory of evolution I am about to propose can be found in his most basic metaphysical rule: the concept of hylomorphism (from Greek ὕλη [*hylē*] = matter, and μορφή [*morphē*] = form). The idea seems to be quite simple. Things consist of matter and form, and the process of change is explained in terms of imposing a new form on a given chunk of matter. Yet, hylomorphism is a much deeper metaphysical concept.

Primary Matter

In order to understand the depth and philosophical acumen of hylomorphism, we must first realize that, when introducing the category of "matter," Aristotle refers not only to empirically verifiable things (such as elements) out of which more complex objects are made but also – and predominantly – to a principle from which they become. He introduces the concept of "primary matter" (PM) (πρώτη ὕλη – *prōtē hulē*), which is best understood and defined as a metaphysical principle of pure potentiality, something that persists through all the changes to which a given substance may be exposed. In other words, PM constitutes the very possibility of being a substance at all and should be distinguished from secondary (proximate) matter, which is perceptible to our senses and quantifiable.

In his most cited, preliminary account of four causes, Aristotle defines material cause in terms of empirically traceable things:

[T]hat out of which a thing comes to be and which persists, is called 'cause', e.g. the bronze of the statue, the silver of the bowl, and the genera of which the bronze and the silver are species (*Phys.* II, 3 [194b 24–25]).¹

Nevertheless, he makes it clear through a number of further assertions that what he has in mind is ultimately PM.

¹ See also *Meta.* V, 2 (1013a 24–25).

The underlying nature [ὑποκείμενον φύσις, *hypokeimenon physis*] is an object of scientific knowledge, by an analogy. For as the bronze is to the statue, the wood to the bed, or the matter and the formless before receiving form to any thing which has form, so is the underlying nature to substance, that is, the “this” or existent (*Phys.* I, 7 [191a 8–12]).

The matter comes to be and ceases to be in one sense, while in another it does not. As that which contains the privation, it ceases to be in its own nature, for what ceases to be – the privation – is contained within it. But as potentiality it does not cease to be in its own nature, but is necessarily outside the sphere of becoming and ceasing to be. (...) For my definition of matter is just this – the primary substratum [πρώτον ὑποκείμενον] of each thing, from which it comes to be without qualification, and which persists in the result (*Phys.* I, 9 [192a 25–33]).

By matter I mean that which in itself is neither a particular thing nor of a certain quantity nor assigned to any other of the categories by which being is determined. ... The ultimate substratum is of itself neither a particular thing nor of a particular quantity nor otherwise positively characterized; nor yet is it the negations of these, for negations also will belong to it only by accident (*Meta.* VII, 3 [1029a 20–21, 24–25]).

And if there is a first thing, which is no longer, in reference to something else, called “thaten,” this is prime matter (*Meta.* IX, 7 [1049a 24]).²

Building on Aristotle’s metaphysics, Aquinas states in *De principiis naturae*:

[13] Only that matter which is understood without any form or privation, but which is subject to form and privation, is called prime matter, inasmuch as there is no other matter prior to it. It is also called “hyle.” ... [14] We know prime matter as that which is related to all forms and privations, as bronze is related to the form of a statue and to the privation of some shape. It is called primary without qualification. ... [16] We should note also that prime matter is said to be numerically one in all things.³

In addition, in *In Meta.* VII, lect. 2 (§ 1285), we find him saying that:

[PM is] neither a what, nor a quality, nor any of the other categories by which being is divided or determined.

An attempt at grasping and delineating the exact nature of PM as a metaphysical principle remains a challenge. Approaching it from the perspective of analytic philosophy, Jeffrey Brower speaks about PM as having a distinct character and suggests defining it as nonindividual atomless gunk. He adds, “it is best understood in terms of what

² See also *Phys.* I, 7 (191a 8–12); II, 7 (198a 21–22); *Meta.* VII, 3 (1029a 20–21); VIII, 4 (1044a 15–23); IX, 7 (1049a 19–22, 24).

³ English trans. in *Selected Writings of St. Thomas Aquinas*, trans. by Robert P. Goodwin (New York: Bobbs-Merrill, 1965).

contemporary philosophers sometimes refer to as *stuff* rather than *things* (in a technical sense of both terms).” Consequently, he claims, “such matter is not merely atomless gunk, but *gunky stuff* – that is, a type of stuff whose parts are all such as to have proper parts.”⁴ While intriguing, this description risks hypostasizing PM. For that reason, it might be useful to turn toward contemporary physics and build an analogy between PM and electromagnetic and/or quantum fields (quantum vacuum), which are believed to ground the entire physical reality as a source of potentiality. Naturally, both electromagnetic and quantum fields are physical realities (physical systems), while PM is a metaphysical principle of pure potentiality. Yet, the analogy I am proposing may help the reader get beyond all categories traditionally and intuitively associated with matter. I find it necessary in order to have an insight into what PM is. Once again, I define it as pure, unactualized possibility of there being anything at all. Even if this definition may sound abstract, it is metaphysically profound.⁵

⁴ Jeffrey E. Brower, *Aquinas’s Ontology of the Material World: Change, Hylomorphism, and Material Objects* (New York: Oxford University Press, 2014), 125.

⁵ Metaphysical status of PM in both Aristotle and Aquinas became a point of division among experts in classical philosophy. Concerning Aristotle, the traditional view stating that he believed in PM as a single, everlasting, and completely indeterminate substratum of all change in nature has become an object of controversy among some contemporary Aristotelian scholars. To grasp the conversation – the analysis of which goes beyond my interest here – I refer the reader to the following articles: (1) challenging the traditional view, Hugh R. King, “Aristotle without Prima Materia,” *Journal of the History of Ideas* 17 (1956): 370–89, and William Charlton, “Did Aristotle Believe in Prime Matter?,” in Aristotle, *Physics: Books I and II*, trans. with introduction and notes by W. Charlton (Oxford: Clarendon Press, 1983), 129–45; (2) answering King and Charlton (successfully, in my opinion), Friedrich Solmsen, “Aristotle and Prime Matter: A Reply to Hugh R. King,” *Journal of the History of Ideas* 19 (1958): 243–52, and H. M. Robinson, “Prime Matter in Aristotle,” *Phronesis* 19 (1974): 168–88.

With regard to the notion of PM in the Middle Ages, already in the thirteenth and fourteenth centuries, representatives of the Franciscan school of the English Province (John Peckham, Richard of Middleton, William of Ware, John Duns Scotus, and William Ockham) claimed that it had a degree of actuality (even if it was still far from the status of physical objects available to our sensory perception), which they saw as necessary to support the thesis that God could keep it in existence as not in-formed by any SF. It seems that this position was also indirectly supported by Bonaventure. More recently, a number of commentators see Aquinas himself as being anti-realist about PM. They claim PM is for him merely “a conceptual tool” (Rebecca Konyndyk DeYoung, Colleen McCluskey, and Christina Van Dyke, *Aquinas’s Ethics: Metaphysical Foundations, Moral Theory, and Theological Context* [Notre Dame, IN: University of Notre Dame Press, 2009], 19), “a theoretical terminus of form-matter analysis rather than an actual component of nature” (Norman Kretzmann, *The Metaphysics of Creation: Aquinas’s Natural Theology in Summa Contra Gentiles II* [Oxford: Clarendon Press, 1998], 212),

Most importantly, we can say that PM, as pure potentiality, underlies each and every substance, remaining a principle of continuity in the process in which one substance (S_1) becomes another substance (S_2) (as well as in the case of accidental changes). Even if all physical aspects of S_1 change on the way to its becoming S_2 , we are not dealing with a total annihilation of S_1 and coming to be out of nothing of S_2 . Rather, due to PM as the principle of potentiality underlying all existing substances (that can be reidentified over time), we observe the continuity of the process of S_1 changing into S_2 . Moreover, it is due to PM that both S_1 and S_2 are characterized by the persistent passive potentiality for change, which is actualized by substantial form (SF).

Substantial Form

Substantial form, on the other hand, is not merely an organizing principle, arranging the geometrical structure and shape of the constituent parts of an entity (substance).⁶ Rather – described by Aristotle as “the definition” or “the statement” of the essence of an entity (ὁ λόγος τοῦ τι ἦν εἶναι [*ho logos tou ti en einai*]) – it is an informing principle of actuality, that by which a thing (secondary matter – *materia secunda*) is what it is; an intrinsic, determining principle that actualizes PM and thus constitutes an individual being.⁷ As such, similar to PM, SF is a simple

or “just a logical abstraction ... a conceptual part of material objects” (Pasnau, *Thomas Aquinas on Human Nature* [Cambridge and New York: Cambridge University Press, 2002], 131). If this is true, adds Pasnau, then it follows that “Material beings are not composites of actuality plus some kind of elusive stuff known as matter, they are instead just composites of certain sorts of actuality. Reality is actuality all the way down, and substances are bundles of actuality, unified by organization around a substantial form” (*ibid.*). Yet, others claim that numerous fragments in Aquinas’s corpus prove that he radically opposed this assertion (e.g., *ST I*, 7, 2, ad 3; *ST I*, 44, 2, ad 3; *ST I*, 66, 1, co.). See John F. Wippel, *The Metaphysical Thought of Thomas Aquinas: From Finite Being to Uncreated Being* (Washington, DC: Catholic University of America Press, 2000), 312–27; Brower, *Aquinas’s Ontology*, 119–129; Christopher Brown, *Aquinas and the Ship of Theseus: Solving Puzzles about Material Objects* (London: Continuum, 2005); David P. Lang, “The Thomistic Doctrine of Prime Matter,” *Laval Théologique et Philosophique* 54, no. 2 (1998): 367–85; Eleonore Stump, *Aquinas* (New York: Routledge, 2003).

⁶ “‘Cause’ means (...) (2) The form or pattern, that is, the definition of the essence, and the classes which include this (e.g., the ratio 2:1 and number in general are causes of the octave), and the parts included in the definition” [*Meta. V*, 2 (1013a 27–28)]. See also *Phys. II*, 3 (194b 26–27).

⁷ Trying to avoid the error of reducing the metaphysically robust notion of SF to geometrical shape or outward appearance, Terrence Irwin rightly notes that “if the form of the statue is essential to it, then other features besides shape must constitute the form,

metaphysical principle (not a thing) that does not have the property of quantity or extension. For this reason, says Michael Dodds, “we cannot make an imaginative picture of a substantial form. It is not imaginable, but it is intelligible.”⁸ SF cannot increase or decrease. It is “educated” from the potentiality of PM and remains present in the entire substance and its parts as a fundamental principle of operation. It is expressed in essential qualities of a given substance, which classifies Aristotelian ontology as essentialist.⁹

Contrary to PM, which is a principle of continuity and a passive principle of change (as pure potentiality), SF is a principle of novelty and an active principle of change in causal processes. Hence, even if in a process of change from S_1 to S_2 , PM does not change; we distinguish S_1 and S_2 as separate substances due to different substantial forms (SSFF) that inform PM in them and are educated from its potentiality. But what if S_1 changes in a way that makes it different but does not lead to its transformation into a completely new substance S_2 (e.g., a puppy growing up and becoming a mature dog)? Here, Aristotle introduces an important distinction between what was later on classified as SF and accidental form (AF). This distinction is easier to grasp in the context of Aristotle’s account of accidental and substantial change:

[T]here is “alteration” when the substratum is perceptible and persists, but changes in its own properties, the properties in question being opposed to one another either as contraries or as intermediates. The body, e.g., although persisting as the same body, is now healthy and now ill; and the bronze is now spherical

and the reference to shape can at most give us a very rough first conception of form. If we turn from artifacts to organisms, it is even clearer that form cannot be just the same as shape.” (Terence Irwin, *Aristotle’s First Principles* [Oxford: Clarendon Press, 1988], 100).

⁸ Michael J. Dodds, *The Philosophy of Nature* (Oakland, CA: Western Dominican Province, 2010), 25. Michael Storck notes that “not only do we not sense substantial forms, but we do not measure them with scientific instruments either. We sense the size, shape, color, and so forth, of things, and we measure their frequency, mass, temperature, electrical charge, and so on. It is only through our intellect that we are able to grasp something, often not very clearly, of the substantial forms of natural things” (Michael Hector Storck, “Parts, Wholes, and Presence by Power: A Response to Gordon P. Barnes,” *The Review of Metaphysics* 62 [2008]: 55).

⁹ Dismissing ontological uncertainty and the tendency to treat substantial unity as mereological structure, Aquinas distinguishes among notions of form as (1) arrangement of parts, (2) union by contact and bond, and (3) union effecting an alteration of the component parts. Only the last refers to SF, which is thus not a mere aggregation of building blocks but a source of the quiddity of an entity. See *In Meta.* V, lect. 3 (§ 779). See also Tabaczek, *Metaphysics*, 217–18.

and at another time angular, and yet remains the same bronze. But when nothing perceptible persists in its identity as a substratum, and the thing changes as a whole (when e.g., the seed as a whole is converted into blood, or water into air, or air as a whole into water), such an occurrence is no longer ‘alteration’. It is a coming-to-be of one substance and a passing-away of the other – especially if the change proceeds from an imperceptible something to something perceptible (either to touch or to all the senses) (*De gen. et corr.* I, 4 [319b 10–18]).¹⁰

To give an example, the SF of a dog is more than just its shape or the principle uniting the dynamic activity of its parts (e.g., organs and biomolecules). As an intrinsic and constitutive principle of the essence of this particular living organism, SF radically (substantially) transformed the matter of ovum and sperm when they joined at the moment of its conception. In other words, it organized particular physical matter (ovum and sperm in the zygote) and made it exist in a particular way, proper for the particular natural kind, that is, the natural kind of a dog. The matter in question has lost its identity and (in the course of substantial change) has become a new unified being, that is, a hylomorphic unity, which is distinct from a meromorphic unity, defined as an aggregate of parts (e.g., atoms, particles, and biomolecules).

At the same time, apart from indispensable, necessary, and fixed features defined by its SF, our dog is characterized by a number of attributes that are important yet may take different “values,” for example, its sex or temperament (it may be very active or phlegmatic – in analogy with human temperaments). Moreover, some of these attributes may change during its lifetime (e.g., the color of its fur, the size of its body, secretion of hormones, and its vocal cords). These characteristics are usually classified as accidental and are defined as grounded in AFs (AAFF).¹¹ Some of them are inseparable (or proper), that is, present as long as that particular individual exists (just as the act of burning is an inseparable or proper accident of fire). For example, our dog’s temperament is such an accident. Even if it changes with time, as our dog progresses from being active to being phlegmatic and slow, it needs to have one or the other temperament at any given moment of its life. Other accidental features

¹⁰ Aquinas discusses this distinction in *De prin. nat.* 5–7.

¹¹ “Accidental forms are possessed by substances via inherence (since they are properties inhering directly in substances), whereas substantial forms are possessed by substances via constituency (since they are properties inhering directly in their prime matter) ... Unlike substantial forms, which characterize substances *primarily* or *simpliciter* (in virtue of being constituents of them), accidental forms characterize them *secondarily* or *derivatively* (in virtue of being constituents of things that share the same matter as these substances)”. (Brower, *Aquinas’s Ontology*, 111–12, 113).

are separable (or not proper). For example, having all teeth or being able to procreate and produce fertile offspring.¹²

Matter and form are intrinsically related for Aristotle. They cannot exist separately. In other words, we know form only as realized in prime matter, and we know prime matter only as in-formed; there is no place for Platonic dualism of separable substances here.¹³ Aristotle observes a substantial unity of being at first and introduces a distinction between PM and SF to explain this unity and the fact that things can change.¹⁴ In Book VIII of the *Metaphysics*, we read:

What then, is it that makes man one; why is he one and not many? (...) [I]f, as we say, one element is matter and another is form, and one is potentially and the other actually, the question will no longer be thought a difficulty. (...) The difficulty disappears, because the one is matter, the other form. (...) [T]he proximate

¹² Aquinas briefly defines inseparable (or proper) accidents in *Q de an.* 12, ad 7. Brower notes that “although the characteristics determined by accidental forms fall outside of the nature or essence of substances, and hence can be thought of as non-essential properties of substances, we must be careful not to conflate Aquinas’s distinction between substantial and accidental forms with the contemporary distinction between essential and contingent properties. For even if all substantial forms are essential (in the sense of being non-contingent properties of substances), it is not true that all accidental forms are contingent properties. On the contrary, like most other medieval Aristotelians, Aquinas insists that there is a class of accidents which are possessed by substances non-contingently – the so-called *propria* or necessary accidents” (Brower, *Aquinas’s Ontology*, 113).

¹³ Concerning PM, Aquinas states: “Because prime matter is not a being in actuality [*ens in actu*], but merely in potentiality [*potentia tantum*], it does not exist in reality through itself [*per seipsam*]” (*ST I*, 7, 2, ad 3). In *De prin. nat.* (17) he adds: “[PM] can never exist by itself [*per se*]; because, since it does not have any form in its definition, it cannot exist in act, since existence in act is only from the form. Rather it exists only in potency [*est solum in potentia*]. Therefore whatever exists in act cannot be called prime matter.” Brower notes that the notion of PM as pure potentiality “enables Aquinas to insist that not even God could create prime matter in the absence of any forms or properties, since prime matter, so understood, can have no being or actuality apart from a form or property” (Brower, *Aquinas’s Ontology*, 120).

¹⁴ We must acknowledge that apart from living beings, the question concerning substantiality of things, that is, the distinction between mere aggregates of (lower level) substances and higher substances that emerge in the process of substantial change of several lower substances, becomes a challenge. Thus, Andrew van Melsen suggests, we should speak about degrees of self-existence (individuality) and substantiality. Concerning the latter, he claims that “[T]he actual substantial forms, the actual fundamental determinations of matter do not have the idealized form which they have in our theoretical concepts. They are realized in a deficient, or rather mixed, way. For this very reason the distinction between substantial and accidental form has to be taken in a relative sense” (Andreas Gerardus Maria van Melsen, *The Philosophy of Nature*, 3rd ed. [Pittsburgh: Duquesne University Press, 1961], 147; see also *ibid.*, 130–151).

matter and the form are one and the same thing, the one potentially, and the other actually. (...) Therefore there is no other cause here unless there is something which caused the movement from potency into actuality.¹⁵

SUBSTANTIAL UNITY OF A LIVING BEING
AND VIRTUAL PRESENCE OF ITS PARTS

Yet, an intriguing and difficult question arises, with respect to substantial unity of a living being, when analyzed from the perspective of natural sciences. I have mentioned above that SF radically (substantially) transforms the matter of ovum and sperm when they join at the moment of conception of an animal. Although this explanation may seem plausible from the metaphysical point of view, it is certainly counterintuitive scientifically speaking. Trying to bring these perspectives together and answer the challenging question of what happens with basic elements and their causal activities as they go through substantial changes that lead to the emergence of complex substances, we may refer to Aquinas who – commenting on Aristotle’s *De gen. et corr.* I, 10 (327b24–32) – develops a theory, which is traditionally referred to as the doctrine of the virtual (*virtute*) presence of elements in mixed substances:

The powers of the substantial forms of simple bodies are preserved in mixed bodies. The forms of the elements, therefore, are in mixed bodies; not indeed actually, but virtually (by their power). And this is what the Philosopher says in book one of *On Generation*: “Elements, therefore, do not remain in a mixed body actually, like a body and its whiteness. Nor are they corrupted, neither both nor either. For, what is preserved is their power.”¹⁶

Despite its rejection by many followers of the contemporary version of atomism, the Aristotelian–Thomistic theory of virtual presence seems to offer a powerful and plausible argument against the Democritean

¹⁵ *Meta.* VIII, 4 (1045a 14, 21–25, 29–30; 1045b 18–19, 21–2). We find a similar argumentation in *On the Soul*: “That is why we can wholly dismiss as unnecessary the question whether the soul and the body are one: it is as meaningless as to ask whether the wax and the shape given to it by the stamp are one, or generally the matter of a thing and that of which it is the matter. Unity has many senses (as many as ‘is’ has), but the most proper and fundamental sense of both is the relation of an actuality to that of which it is the actuality” (*De an.* II, 1 [412a 6–9]). See also *De part. an.*, I, 1 (640b 22–29).

¹⁶ *De mixt. elem.* 17–18. It is important to remember that “mixture” in ancient and medieval philosophy often means a compound, that is, a unified new entity informed by a new SF, and not merely a composite or a combination of elementary particles, which, metaphysically speaking, is informed by an AF, which does not include a substantial change of the components.

view of matter. Leaving it up to the physicists to specify the most basic “primary components” that can be classified as physical objects, we may assign to these entities the principles of PM and SF and claim that as such they can enter compounds and remain virtually present in them, with their powers retained yet (possibly) altered and with SSFF not entirely corrupted away but instead retrievable in the processes of corruption of these “mixed” (composite) bodies or in the reclaiming of given elements from complex substances, which nevertheless “keep” their SF (e.g., an oxygen atom leaving a dog’s organism, which, nonetheless, remains the same organism).¹⁷

On the physical, chemical, and biochemical level of observation, a given primary component or a more complex entity such as an atom, molecule, or chemical compound may be perfectly traceable in a composite being. This fact, however, does not prevent or invalidate a philosophical (metaphysical) reflection stating that the properties and causal powers (dispositions) of that primary component, although retained, are now properties of a given compound (which is informed by a new and separate SF). Moreover, due to the fact of being “a part of” – or, better to say, “being now compounded” (e.g., a carbon atom consumed by me becomes me) – the set of properties and dispositions of a given elementary particle is usually altered, that is, we might attribute to it properties and dispositions it does not have when separated from the compound.

We may take as an example nitrogenous bases (nucleobases) that are part of the nucleotides that make up DNA. On the one hand, based on experimental science, we can conclude that their inherent activity and reactivity are entirely preserved or slightly limited in a living organism. On the other hand, the analysis of the mechanism of reading DNA proved that the order of the nucleobases carries (encodes) genetic information, the content of which contributes to the proper functioning of the entire living organism. This feature cannot be ascribed to nitrogenous bases outside a living organism (outside the structure of DNA), even though chemically speaking, these molecules have an identical structure. When tested *in vitro*, they do not contribute in any way to the maintenance of the equilibrium state of any living being.

This preliminary reinterpretation of substantial unity and virtual presence is far from being satisfactory or conclusive. Both categories

¹⁷ In modern English the term “virtual” means “almost” or “nearly.” For the medieval thinkers *virtualiter*, derived from *vis*, refers to the presence of a power that can produce a particular effect.

require further study in reference to contemporary science and philosophy of science.¹⁸ At the same time, they need to be kept at the risk of departing from hylomorphism toward meromorphism, which assumes that SF unites parts that retain their substantial identity. This would suggest that the same “portion” of matter is actualized by more than one form, which is counterintuitive, as one thing cannot have simultaneously two separate identities.¹⁹

DISPOSITION OF MATTER AND LEVELS OF POTENTIALITY

My detailed presentation of the hylomorphic view of living organisms becomes an important step on the way to develop a consistent metaphysics of evolutionary transitions. One of its key aspects is the notion of the disposition of matter. In *In Meta.* V, lect. 14 (§ 963), Aquinas states, after Aristotle, that “what is capable of being acted upon in some way must have within itself a certain disposition which is the cause and principle of its passivity.” He understands disposition as an order through which some qualities of a given thing direct it toward some other qualities (acquired in an accidental change) or becoming something entirely new (in a substantial change).²⁰

As pure potentiality, PM can be actualized by any SF. At the same time, the type of SF actualizing PM in the case of a substantial change in which a given substance *A* is replaced by another substance *B* is not random. It depends both on the SF and on AAFF actualizing *A*. These principles of actuality dispose *A* to enter specific accidental or substantial changes, which narrows the scope of potentialities of PM that may be actualized in a given change. We might speak, respectively, about

¹⁸ For more on contemporary application and interpretation of the concept of virtual presence see Christopher Decaen, “Elemental Virtual Presence in St. Thomas,” *The Thomist* 64, no. 2 (2000): 271–300; Tabaczek, *Emergence*, 229–234; Mariusz Tabaczek, *Divine Action and Emergence: An Alternative to Panentheism* (Notre Dame: University of Notre Dame Press, 2021), 75–78. In the first monograph mentioned here, I also confront the classical and new Aristotelianism with emergentism, the concept of supervenience, multiple realizability of phenomena at higher levels of complexity of matter, and the theory of latent properties – as the most popular versions of nonreductionist physicalism.

¹⁹ This view seems to find support (more or less explicit) among some of the contemporary advocates of hylomorphism. For the critical analysis of their views, see Christopher J. Austin, “Contemporary Hylomorphisms: On the Matter of Form,” *Ancient Philosophy Today* 2, no. 2 (2020): 113–44; Tabaczek, *Emergence*, 216–41; Jeremý Skrzypek, “Three Concerns for Structural Hylomorphism,” *Analytic Philosophy* 58, no. 4 (2017): 360–408; Brower, *Aquinas’s Ontology of the Material World*, 103–184.

²⁰ See *ST I-II*, 49, 2, ad 1.

“remote” and “proximate” disposition of PM. To give an example, if you put a wooden log into a fire, it does not melt but burns and turns into a pile of ash and not, let us say, into a butterfly. Although pure potentiality of PM underlying the log can be actualized by any SF (“remote disposition” of PM), the fact that it is currently actualized by the SF of wood and a number of AAFF (e.g., color, shape, and moisture) changes its disposition and sets up a limited scope of its potentialities that can be actualized within a limited range of substantial changes a wooden log may undergo (“proximate disposition” of PM).

In other words, we may say after Aquinas that – together with AAFF, which are responsible for secondary properties of a given entity (such as its size or color) and may change without it changing its identity – the SF of the entity in question disposes it, that is, becomes decisive about the array of new SSFF that may be educed from the potentiality of PM that underlies it. The action of eduction (actualization of PM) is exercised by the efficient causality of one or many agents.

Commenting on this topic in the *Metaphysics*, Aristotle states what follows:

Regarding material substance we must not forget that even if all things come from the same first cause or have the same things for their first causes, and if the same matter serves as starting-point for their generation, yet there is a matter proper [i.e., properly disposed] to each, e.g., for phlegm the sweet or the fat, and for bile the bitter, or something else; though perhaps these come from the same original matter (*Meta.* VIII, 4 [1044a 15–20]).

Aquinas, in turn, comments on this passage thus:

From the things which are said here then it is evident that there is one first matter for all generable and corruptible things, but different proper [i.e., properly disposed] matters for different things (*In Meta.* VIII, lect. 4 [§ 1730]).

And earlier, in the *Summa contra gentiles*, Aquinas has already postulated:

Thus, form and matter must always be mutually proportioned and, as it were, naturally adapted, because the proper act is produced in its proper [i.e., properly disposed] matter. That is why matter and form must always agree with one another in respect to multiplicity and unity (*SCG* II, 81, no. 7).

Consequently, we may speak about the two levels of potentiality inherent in the very fabric of the cosmos: (1) pure potentiality of PM (*materia prima*), which can be actualized by all possible types of SSFF, proper for both inanimate and animate natural kinds, and (2) potentiality of PM underlying each and every instantiation of secondary matter (*materia secunda*), which is specified (qualified) by the SF and AAFF

characteristic of a particular natural kind it belongs to. To put it differently, we might classify (1) as “remote potentiality” defined in reference to the wide scope of all logically possible SSFF that may actualize PM and (2) as “proximate potentiality” defined by the narrow range of SSFF that may actualize a given “portion” of PM underlying an actually existing entity in the next substantial change it will go through. In other words, the principles actualizing entities classified as instantiations of secondary matter dispose their underlying PM in particular way, enabling thus – in the course of substantial change – an eduction of particular types of new SSFF (typical of other natural kinds) from its potentiality.

What is crucial in this account is – once again – what the Aristotelian – Thomistic metaphysics understands of the term “potentiality.” It does not perceive it as the potency for a limited number of (fixed) natural kinds to unfold from the already existing secondary matter. Rather, it sees it, ultimately, as one of the most basic metaphysical principles underlying the very fabric of the universe, a potency that may be actualized by any SF. Obviously – as noted above – PM, as such, is always actualized by a given SF, which limits the range of possible future actualizations it may go through. At the same time, the flexibility of the dynamic processes is such that the fact that PM is informed at time t_1 by the substantial form SF_1 , which disposes it to be actualized in the next substantial change at t_2 by the substantial form SF_2 , while preventing it from being actualized (in the same substantial change at t_2) by the substantial form of SF_{2*} does not prevent it from being actualized by SF_{2*} after a number of substantial changes it may go through. They may dispose it such that, at one point, it may actually be “ready” to be informed by SF_{2*} . For the potentiality of the secondary matter, although relative and limited, as ultimately grounded in the pure potentiality of PM, changes in the course of substantial and accidental transformations that a given “portion” of secondary matter enters. Refer to Figure 1.1.

Hence, the two levels of potentiality that we can define within the Aristotelian – Thomistic metaphysics seem to enable us to provide an accurate description of the dynamic and flexible character and nature of reality – the one that is in line with contemporary science. Moreover, they also allow to introduce the idea of evolutionary changes and transitions as compatible with the framework of the Aristotelian – Thomistic metaphysics and philosophical theology. But, before I offer a constructive proposal of such developments, I should first refer to one more important aspect of Aristotle’s and Aquinas’s thought.

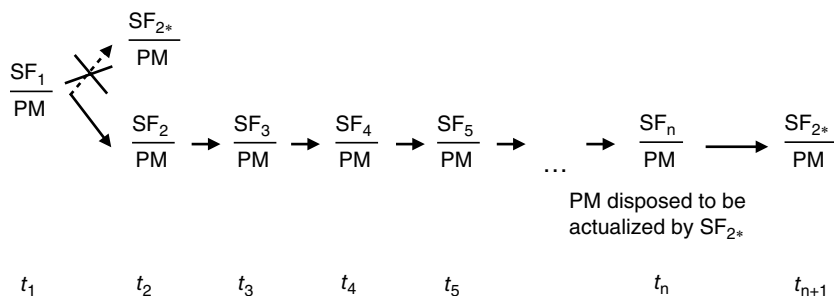


FIGURE 1.1 Two levels of potentiality and the flexibility of the dynamic processes in nature.

MATTER AS STRIVING FOR PERFECTION – SCALA NATURAE

The idea of the disposition of matter is related – in both Aristotle and Aquinas – to a natural tendency of matter to be actualized (in-formed) by more perfect forms. Aristotle is the first to recognize an ascent of perfection of the beings in nature. On his *scala naturae*, we can observe a gradual crescendo from nonliving, through plant and animal, to human forms:

Nature proceeds little by little from things lifeless to animal life in such a way that it is impossible to determine the exact line of demarcation, nor on which side thereof an intermediate form should lie (*Hist. an.* VIII, 1 [588b 4–6]).

Aristotle gives an example of the ascent of nature from plants to animals:

[T]here is observed in plants a continuous scale of ascent towards the animal. So, in the sea, there are certain objects concerning which one would be at a loss to determine whether they be animal or vegetable (*Hist. an.* VIII, 1 [588b 11–13]).²¹

On another occasion, Aristotle presents us with a similar reflection concerning transitions between various forms of life:

[N]ature passes from lifeless objects to animals in such unbroken sequence, interposing between them beings which live and yet are not animals, that scarcely any difference seems to exist between two neighbouring groups owing to their close proximity (*De par. an.* IV, 5 [681a 12–15]).

Aristotle gives an example of the sponge, which here he classifies as a plant: “A sponge, then, as already said, in these respects completely resembles a plant, that throughout its life it is attached to a rock, and

²¹ With the advance of modern science, we find it easier to define taxon-specific characteristics. However, as we shall see in Chapter 2, the very notion and precise definition of species remain a great challenge for both biology and philosophy of biology.

that when separated from this it dies” (*De par. an.* IV, 5 [681a 15–17]), whereas in *History of Animals*, he compares it to animals, due to its sensation: “Stationary animals are found in water, but no such creature is found on dry land. In the water are many creatures that live in close adhesion to an external object, as is the case with several kinds of oyster. And, by the way, the sponge appears to be endowed with a certain sensibility” (*Hist. An.* I, 1 [487b 9–10]).

Aristotle’s careful empirical and speculative analysis justifies his constatation that “There is a good deal of overlapping between the various classes” (*De gen. an.* II, 1 [732b 15]). Commenting on it, O’Rourke goes as far as to say that “Without exaggerating its importance, Aristotle recognizes man’s link to the primates: the ape, the monkey, and the baboon, he states, *dualize in their nature with man and the quadrupeds*” (*Hist. an.* II, 8 [502a 16–18], trans. A. L. Peck). In *De par. an.* IV, 10 (689b 31–33) Aristotle adds that: “The ape is, in form, intermediate between man and quadruped, and belongs to neither, or to both.”²²

The position of Aquinas with regards to *scala naturae* is analogous. Similar to Aristotle, he notices a spontaneous tendency of nature toward superior forms in the processes of generation and corruption. In his *Summa Contra Gentiles*, we find an important reflection on the hierarchy of degrees in substantial transformation in human embryology, which I should quote extensively:

[T]he more posterior and more perfect an act is, the more fundamentally is the inclination of matter directed toward it. Hence in regard to the last and most perfect act that matter can attain, the inclination of matter whereby it desires form must be inclined as toward the ultimate end of generation. Now, among the acts pertaining to forms, certain gradations are found. Thus, prime matter is in potency, first of all, to the form of an element. When it is existing under the form of an element it is in potency to the form of a mixed body; that is why the elements are matter for the mixed body. Considered under the form of a mixed body, it is in potency to a vegetative soul, for this sort of soul is the act of a body. In turn, the vegetative soul is in potency to a sensitive soul, and a sensitive one to an intellectual one. (...) So, elements exist for the sake of mixed bodies; these latter exist for the sake of living bodies, among which plants exist for animals, and animals for men. Therefore, man is the end of the whole order of generation (SCG, III, 22, no. 7).²³

²² Fran O’Rourke, “Aristotle and the Metaphysics of Evolution,” *The Review of Metaphysics* 58 (2004), 39–40.

²³ This passage refers to human embryology, where Aquinas (following the science of his day) thought that a fetus was actualized successively by vegetative, sentient, and human souls. Although contemporary science proved this idea to be wrong, the more general

A more general formulation of the same principle can be found in *In Meta.* XII, lect. 2 (§ 2438), where Aquinas emphasizes that in order to receive a given SF, PM must be previously under other specific SSFF. Hence, potentiality for perfection can be actualized only gradually and in accordance with some determinate order:

[E]verything capable of being generated has a definite matter from which it comes to be, because there must be a proportion between form and matter. For even though first matter is in potentiality to all forms, it nevertheless receives them in a certain order. For first of all it is in potency to the forms of the elements, and through the intermediary of these, insofar as they are mixed in different proportions, it is in potency to different forms. Hence, not everything can come to be directly from everything else unless perhaps by being resolved into first matter.

Moreover, speaking of the importance of the proper disposition of PM for particular accidental and substantial changes of a given substance, Aquinas formulates an observation that might inspire a new development of the classical notion of hylomorphism, enabling it to provide a necessary metaphysical foundation for the contemporary version of the theory of evolution:

From the fact that matter is known to have a certain substantial mode of existing, matter can be understood to receive accidents by which it is disposed to a higher perfection, so far as it is fittingly disposed to receive that higher perfection (*Q. de an.* 9, co.).²⁴

On another occasion, we find him saying that matter, properly disposed, “turns towards the act or prepares itself to receive it” (*Super IV Sent.* 49, 3, 2, co.).²⁵ Once again, in his commentary on Aristotle’s *On the Soul*, Aquinas comes to a similar conclusion that “everything in a lower form of existence is inclined to the maximum possible assimilation to the higher form” (*In De an.* II, lect. 7 [§ 315]).²⁶

metaphysical principle (concerning affinity of matter to higher forms) that stands behind it may be still defended as relevant. See also Antonio Moreno, “Some Philosophical Considerations on Biological Evolution,” *The Thomist* 37 (July, 1973), 440–441.

²⁴ See also *In De an.* II, lect. 7, (§ 315); *Q. de pot.* 5, 1, co. and ad 5; SCG III, 22, no. 7.

²⁵ All translations from *Super Sent.* are mine.

²⁶ Consequently, it should be stated that Aquinas’s belief in the “tendency” of properly disposed matter to be actualized (in-formed) – in a line of consecutive accidental and substantial changes – by various new types of AAFF and SSFF (including SSFF of increasingly higher natural kinds) does not concern only his views on human embryology (as in the quoted passage from SCG III, 22, no. 7) but can be regarded as a generally binding principle in his metaphysical system.

METAPHYSICS OF EVOLUTIONARY TRANSITIONS

Our reflection on hylomorphism, substantial and accidental change, the disposition of matter, and its tendency to be in-formed by more perfect forms enables us to delineate and propose the metaphysical foundation of the mechanism of biological evolution. Here, I agree with O'Rourke who is convinced that "If Aristotle's metaphysical analysis of growth and change is correct, the principles of form and the affirmation of potency will hold *a fortiori* for the evolutionary process."²⁷

Speciation

An evolutionary transition might be thus defined, in this account, as a series of minor genetic and epigenetic changes that effect minor phenotypic variations (accidental changes). These variations – remaining within the range of active and passive powers typical for a given species (natural kind) – may become permanent (i.e., transmitted from one generation to the next), which, in turn, gradually changes the "proximate disposition" of PM underlying subsequent organisms of the lineage L_1 of the species S_1 . This process, highly complex and extended in time, might lead to a precise instant at which the PM underlying the egg and the sperm coming from particular female and male organisms of sexually reproducing species S_1 ,²⁸ at their entering the substantial change in which they join and give an origin to a new organism, is not disposed to be actualized by the "old" type of SF that defines species S_1 but by a "new" type of SF that defines species S_2 , which is educed from the potentiality of PM that underlies them. The new organism (or organisms, as the process described here is commonly considered to be taking place within a population) starts a new lineage L_2 , which happens to be the lineage of the new species S_2 . See Figure 1.2.²⁹

Anticipating our analysis presented in Chapter 2, we should emphasize that, on the proposed metaphysical/ontological model of speciation, each organism in an evolutionary lineage must belong to a distinct and clearly

²⁷ Fran O'Rourke, "Aristotle and the Metaphysics of Evolution," 27.

²⁸ Similar metaphysical analysis may be developed with reference to organisms reproducing asexually.

²⁹ The category of species used here and in all other aspects of the philosophical and theological modeling of speciation developed in this book, refers primarily to metaphysical notion of species (and of natural kinds). As such, it remains in correspondence to – while not being coextensive with – empirically based classifications used in biological attempts to formulate a definition of a species. This will become more apparent especially in light of the research presented in the remaining part of this chapter and in Chapters 2 and 5.

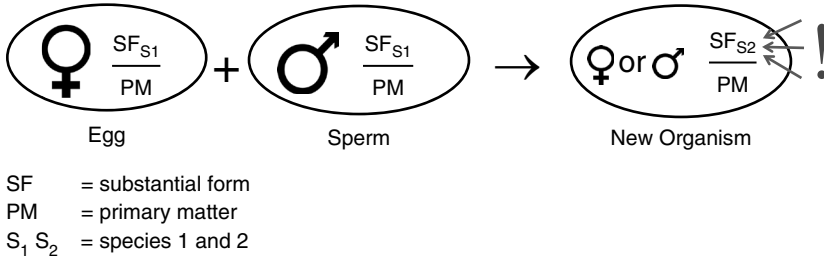


FIGURE 1.2 Hylomorphic metaphysics of an evolutionary transition.

demarcated species. In other words, there can be no organisms that are literally “in-between” ancestral and descendant species, not belonging to either one of them. This also refers to the category of transitory or intermediate species. Albeit less numerous and less distinct in their genetic and morphological features, they form a separate natural kind. Moreover, intermediate species should be distinguished from intermediate organisms that belong to one and the same species but differ in their accidental dispositions and features – which can be captured in biological research. In other words, while intermediate species are different natural kinds, intermediate organisms belong to the same natural kind.³⁰

Gametes – parental egg and sperm – are separate entities and may be treated as instrumental causes, acting under principal causation of the organisms that produced them.³¹ Normally, when they join, entering thus a substantial change, which becomes an origin of the existence of a new organism, the PM that underlies them is disposed to be actualized by the original SF of the type S_1 . In case of an evolutionary transition, however, accidental changes in the DNA and the epigenetic causal factors inherently affecting phenotypes of the consecutive organisms within the lineage L_1 lead to the situation in which PM, actualized by the given egg and sperm, produced by female and male organisms of species S_1 , is disposed to be actualized in the substantial change these gametes enter by a new SF of the type S_2 , which is educed from its potentiality. This originates the new evolutionary lineage L_2 .³²

³⁰ To put it yet another way, on the proposed model of speciation an SF “of a new type” should be distinguished from a new SF *simpliciter*. The latter actualizes an organism in a way that makes it belong to an already established natural kind, while the former actualizes an organism in a way that makes it belong to (establish) a new natural kind.

³¹ See *Q. de pot.* 3, 11, ad 5.

³² Even if contemporary biology is willing to acknowledge the reality of distinct species only at given points in time (due to constant genetic and phenotypic changes of

Interestingly, the described scenario finds support in Aristotle's example of the generation of a mule. Commenting on it Aquinas states: "[S]ince in the generation of a mule the sperm of a horse cannot induce the form of a horse in the matter, because it is not adapted to receive the form of a horse, it therefore induces a related form" (*In Meta.* VII, lect. 6 [§ 1432]). The "related form" here means the SF characteristic for a different species. Interpreting Aquinas's point today we may suggest that the disposition of PM underlying gametes is decisive for its potentiality to be actualized by a new SF characteristic of the same species. At rare occasions, it may happen that this condition is not met, which leads to the eduction of the "related form" that belongs to another (new) species. Reflecting on this passage from Aquinas's commentary on Aristotle's *Metaphysics*, Steven Snyder notes:

Although Aristotle had no scientific basis for asserting that semen could have formal powers and potencies not directly derived from the male, we now know that via chance mutations there can exist significant formal differences between the form of the parent and the form potential in the semen or ovum as instruments of reproduction. Mutations can arise from chance encounters with x-rays, for example, or in ways we do not yet fully understand in the process of bio-chemical union of sperm and egg. The point to emphasize is that these chance mutations in the genetic packages of the instruments of reproduction, and so differences in kind between the parents and offspring, are not alien to an Aristotelian natural philosophy.³³

It takes many mutations and epigenetic changes (the outcomes of which are regulated by natural selection) to produce such an effect (i.e., the difference in kind between parents and their offspring), and its actual instantiation may be extremely difficult (if not impossible) to capture. But this does not exclude the possibility of its occurring, especially in a situation where some members of a species migrate to a new environment and can be modified gradually in subsequent generations, to the point where they can no longer mate with the other descendants of their ancestors. Thus, it becomes clear that, even if Aristotle's biological research was far from discovering the possibility of the transformation of species, his metaphysics, picked up and developed by Aquinas in the Middle Ages, left much room for such a possibility.³⁴

organisms), it seems to me that the Aristotelian categories of potency/act and PM/SF provide a sufficient ground for accommodating both essentialist and processual aspects of living beings. I will say more on this in the next chapter.

³³ Steven Snyder, "Evolution and the Origin of Species: Aristotelian Reflections," <https://maritain.nd.edu/jmc/ti/snyder.htm> (retrieved 19 August 2022).

³⁴ My concept of the metaphysics of evolutionary transitions is inspired by the works of a number of Thomistic philosophers and theologians. Among them, I would like to mention in particular: (1) Antonio Moreno, "Some Philosophical Considerations"; (2)

The proposed scenario provides a clear response to a metaphysically ill-conceived argument against the possibility of evolution within the paradigm of classical metaphysics, stating that a number of accidental changes cannot lead to a substantial change that gives an origin to a new nature.³⁵ In answer to it, we must notice, firstly, that accidental changes indeed cannot bring a new nature in an already existing thing (this is a straw man argument on the part of an antievolutionary approach to Thomism as no follower of Aquinas that is open to evolution argues in this way). But this does not preclude the possibility of them changing the disposition of PM such that, in the course of many generations, a proper efficient cause educes from its potentiality a SF of a new type.³⁶ Secondly, on the proposed scheme, speciation takes place in the course of multiple substantial changes (with multiple new SFFF educed from the potentiality of PM) that accompany the processes of generation of offspring in a given evolutionary lineage. As such, it is not equivalent to any of those substantial changes in particular. Antievolutionary-oriented Thomists commit a mistake of reducing causal complexity of an evolutionary transition to its final step, in which the first organism of a new kind comes into existence (I will address this common misconception below, in a section on virtual and eminent presence of perfections). They also seem to confuse metaphysical categories assuming

Fran O'Rourke, "Aristotle and the Metaphysics of Evolution"; (3) William E. Carroll, "At the Mercy of Chance? Evolution and the Catholic Tradition," *Revue des questions scientifiques* 177 (2006): 179–204; and (4) Étienne Gilson, *From Aristotle to Darwin and Back Again: A Journey in Final Causality, Species, and Evolution* (Notre Dame, IN: Notre Dame Press, 1984). Concerning the question of the mono- and polygenetic character of speciation, it will be addressed in Chapter 8, on the occasion of my analysis of evolutionary anthropogenesis.

- ³⁵ This argument is repeatedly raised by Michael Chaberek. In one of his papers, he states that "accidental change will always produce only accidental differences, never bringing about a new substance or a new nature of a thing. The creation of a new substance would require substantial change: that is, the production of a new substantial form." (Michael Chaberek, "The Metaphysical Problem for Theistic Evolution: Accidental Change Does Not Generate Substantial Change," *Forum Philosophicum* 26, no. 1 [2021], 38). On another occasion, he once again emphasizes that "accidental change cannot produce substantial change" ("Classical Metaphysics, and Theistic Evolution: Why are They Incompatible?" *Studia Gilsoniana* 8, no. 1 [2019], 57).
- ³⁶ It is worth remembering that for Aquinas, substantial changes are usually preceded by a series of accidental changes. As notes Gloria Frost, "Aquinas claims that it is obvious in the case of natural substances that their powers do not produce substances immediately. Even when one substance generates another substance, it does so by gradually transforming its patient's matter" (Gloria Frost, *Aquinas on Efficient Causation and Causal Powers* [New York: Cambridge University Press, 2022], 113). See also *ibid.*, 193.

that speciation, which is a change in kind, is equivalent to a substantial change. This thesis is misleading, for while the latter always accompanies the former, the former does not always accompany the latter. Hence, they are not equal.

Levels of Similarity of Adjacent Species

Now, we need to acknowledge that substantial changes accompanying the conception of offspring are of a special kind. They result in coming into existence of new organisms whose SF is of the same type as that of their parental organisms. This is even more obvious in cases of asexual reproduction (e.g., by fission), yet unusual when compared with much more primitive chemical or biochemical substantial changes, which typically lead to the emergence of substances that are radically different from the reagents. Consequently, in the case of speciation, the last substantial change (conception) that crowns the entire process of an evolutionary transition is abnormal. The result is an organism whose SF belongs to a natural kind that differs from that of its parental organisms.

Understood in this way, speciation seems to violate the classical principle of similarity which says that “[E]very agent produces its like” (SCG II, 21, no. 9).³⁷ In other words, in the reproductive process the agent cause of a given type gives an origin to offspring that is similar to it. In response to this difficulty, it should be noted that according to the theory of biological evolution, the newborn first representative of the species S_2 is in most aspects and dispositions similar to the organisms of the preceding species S_1 from which it originates. Indeed, one of the major interpretations of evolutionary transitions claims that due to the specificity of speciation mechanisms and the low population size of the so-called transitional species, they have not been preserved in the fossil record. Hence, in the common understanding of evolutionary changes (based on a comparison of the forms that have been recorded in the fossil material), species differ considerably from one another. In fact, the differences between immediately adjacent phylogenetically related taxa are not so radical.

Nevertheless, the fact that the parents and their descendants do belong to different species requires some modifications in the interpretation of the classical principle in question. We need to agree that the similarity

³⁷ The principle of similarity is a particular variant of the broader principle of proportionate causation, which will be discussed below.

between parents and their offspring should not be understood as an absolute, strict, and nonexceptional qualitative identity of their SSFF. Rather, it can be defined in terms of a proportional proximity to the SF of the offspring, when compared with SSFF of its parents. It is worth noting that Aquinas himself admits departure from the strict interpretation of the principle of similarity. In *ST I*, 104, 1, co. we read:

Sometimes, however, the effect has not this aptitude to receive the impression of its cause, in the same way as it exists in the agent: as may be seen clearly in all agents which do not produce an effect of the same species as themselves: thus the heavenly bodies cause the generation of inferior bodies which differ from them in species.³⁸

The same observation made by Aquinas becomes even more apparent in his above-mentioned commentary to the seventh book of Aristotle's *Metaphysics* (lect. 6 [§ 1432–33]), where he distinguishes between substantial changes that happen by nature and substantial changes that happen by chance.³⁹ The latter fall outside of the normal and regular occurrences in nature, and yet they are not completely random. He suggests that the likeness defined by the principle “like produces like” can be interpreted not only as (strong) similarity in terms of belonging to the same species but also as (weak) similarity in terms of belonging to the same genus:

[E]ach natural thing produces something similar to itself in species, unless something beyond nature [i.e., by chance] happens to result, as when a horse begets a mule. And this generation is beyond nature, because it is outside of the aim of a particular nature. For the formative power, which is in the sperm of the male, is designed by nature to produce something completely the same as that from which the sperm has been separated; but its secondary aim, when it cannot induce a perfect likeness, is to induce any kind of likeness that it can ... Hence in the generation of a mule the generator is similar in a way to the thing generated; for there is a proximate genus, which lacks a name, common to horse and to ass; and mule is also contained under that genus. Hence in reference to that genus it can be said that like generates like; for example, if we might say that that proximate genus is

³⁸ Following Aristotle, Aquinas was convinced that the energy of the sun was necessary for substantial changes to occur on earth. In reference to the example of celestial bodies causing the generation of lower bodies, one can argue that for Aquinas effects that do not resemble their causes are always ranked ontologically “lower” than their causes, while speciation, as defined above, entails the possibility of originating an organism, which is ontologically “higher,” that is, one that has new and metaphysically “more perfect” dispositions in respect to its direct efficient cause. This issue will be addressed in the last section of this chapter.

³⁹ I will say more about chance and teleology in Chapter 3.

beast of burden, we could say that, even though a horse does not generate a horse but a mule, still a beast of burden generates a beast of burden.⁴⁰

Gloria Frost rightly notes that a certain level of dissimilitude between a cause and its effect can be the outcome of the fact that many effects are caused by joined operation of a number of agents that have various active powers. She claims that according to Aquinas “In these cases, the effect will bear some similarity to each agent which produced it, and thus, it will resemble none of the individual agents perfectly.”⁴¹

Eduction of New Substantial Forms

In my analysis so far, I have referred several times to the notion of the eduction of SSFF from the potentiality of PM. This idea (based on Latin *educere*) is found in Aquinas and seems to be his answer to one of the most challenging questions faced by classical metaphysics, that is, the one concerning the source of new SSFF. Aquinas rejects the suggestion that agents literally hand-over or pass the same numerical forms that actualize them to the substances they instantiate (act upon):

[A] hot body is not said to give off heat in this sense, that numerically the same heat which is in the heating body passes over into the heated body. Rather, by the power of the heat which is in the heating body, a numerically different heat is made actual in the heated body, a heat which was previously in it in potency. For a natural agent does not hand over its own form to another subject, but it reduces the passive subject from potency to act. (SCG III, 69, no. 28)⁴²

Trying to clarify his position on the source of SSFF, Aquinas states that “it is not correct to say that the form is made in matter, rather should we say that it is educed from the potentiality of matter [*de materiae potentia educatur*]” (*Q. de pot.*, 3, 8, co.)⁴³ This is important as it

⁴⁰ Note that in Aquinas’s example, the parental organisms belong to two different species. I believe it is legitimate to think that the interpretation of the principle “like produces like” that he suggests extends also to the cases of parental organisms that belong to one species. Nevertheless, evolutionary theory requires stretching it even more, as it assumes the reality of transitions at the level of genera and higher biological taxa.

⁴¹ Frost, *Aquinas*, 101.

⁴² In *ST III*, 77, 1, co. Aquinas offers a general formulation of the same argument, this time in reference to AAF: “[A]ccidents do not pass from subject to subject, so that the same identical accident which was first in one subject be afterwards in another; because an accident is individuated by the subject; hence it cannot come to pass for an accident remaining identically the same to be at one time in one subject, and at another time in another.”

⁴³ See also *Q. de pot.* 3, 4, ad 7, ad 14. In *SCG III*, 69, no. 2 Aquinas adds: “forms and accidents cannot come into being from matter, since they do not have matter as one of

reminds us that SF is not merely a combination, structure, or dynamic codependency of parts (secondary matter). Rather, matter can exist and function in different ways, and eduction of SF means actualization of one of these options. Because the principle corresponding with SF is PM, we are dealing here with a substantial change and not merely an accidental regrouping or reorganizing of atomic parts.

The language of eduction is an attempt by Aquinas to find a middle ground between treating SF as external and coming to form things “from the outside,” on the one hand, and describing it as preexistent in a primitively actualized state in PM, on the other. Hence, he says that “motion is nothing else than the eduction of something from potentiality to actuality [*educere aliquid de potentia in actum*]” (ST I, 2, 3, co.).⁴⁴

At the same time, we must be careful not to conceive of SSFF as somehow present or dormant in PM. This would compromise the notion of PM as pure potentiality. If we can say that form preexists in PM, it does so as entirely unactualized: “Every actuality of matter is educed from the potentiality of that matter [*educi de potentia materiae*]; for since matter is in potentiality to act, any act pre-exists in matter potentially” (ST I, 90, 2, ob. 2; see also ad 2). “Every form brought into being through the transmutation of matter is educed from the potentiality of matter [*formaeducta de potentia materiae*]” (SCG II, 86, no. 6). Consequently, insofar, as the effective cause brings out the form which it realizes in the potentiality of matter, it is said to induce (*inducere*) or introduce (*introducere*) form.⁴⁵

Speaking of the eduction of SSFF from the potentiality of PM, we must take into account efficient causes. Due to their active powers (dispositions), they are capable of actualizing PM in a particular way. They may

their parts.” At the same time, in *Q. de pot.* 3, 8, ad 10 we find him saying that “form is not perfected by adding to the matter something extraneous that was not already in the matter potentially.” Rather, “every form brought into being [*educitur in esse*] through the transmutation of matter is educed from the potentiality of matter, for the transmutation of matter is its reduction from potentiality to act” (SCG II, 86, no. 6).

⁴⁴ A similar argument can be found in *In Meta.* VII, lect. 6 (§ 1430–31): “[S]ome men were compelled to say that all forms are created; for while they held that forms come to be, they could not hold that they come from matter since matter is not a part of form; and therefore they concluded that forms come from nothing, and, consequently, that they are created. But because of this difficulty, on the other hand, some men claimed that forms actually pre-exist in matter, and this is to suppose that forms are hidden, as Anaxagoras maintained. Now the view of Aristotle, who claimed that forms are not generated but only composite things, excludes both of these other opinions. For it is not necessary to say that forms are caused by some external agent, or that they will always be present in matter actually, but only potentially, and that in the generation of the composite they are brought from potentiality to actuality.”

⁴⁵ See *Quod.* 7, 4, 9, ad 4. See also ST I, 2, 3, co.; ST I, 4, 1, ad 2; ST I, 84, 3, co.; ST III, 8, 3, co.; SCG II, 45, no. 3.

operate individually or in groups, entering substantial changes themselves or initiating such changes in other entities. Hence, SSFF do not preexist in any way; they are not passed from one entity to the next, and they are not copied or generated (even if their origin accompanies generation of new entities). They are educed by proper efficient causes from the potency of PM, as ways of being or existence of things, making them to be what they are, at all levels of their complexity and in all quantitative and qualitative aspects of their natures. As notes Lawrence Dewan:

The Platonists and Avicenna did not posit that forms are educed from the potency of matter, and so they were forced to say that natural agents merely *dispose matter*: the introduction of forms was from an incorporeal principle. If we say (as Thomas *does* say) with Aristotle, that substantial forms are educed from the potency of matter, then natural agents will not be merely the causes of the dispositions of matter, but even *the causes of the substantial forms*.⁴⁶

Most importantly, this analysis tells us that the origin of SSFF should be classified as a natural occurrence, which does not require any direct supernatural causal influence.⁴⁷ The same applies to evolutionary transitions and the emergence of the first exemplars of a new species. The first SF of a given type is educed from the potency of PM. Since it is pure potentiality, all logically plausible SSFF can be educed from it by secondary efficient causes.⁴⁸ However, the proposed metaphysical foundation of evolutionary transitions and its notion of the source of new SSFF face a major challenge. Some think that it violates the principle of proportionate causation. I will address this issue in the remaining part of this chapter.

THE PRINCIPLE OF PROPORTIONATE CAUSATION AND EVOLUTION

The principle of proportionate causation (PPC) seems to be commonly accepted among classical philosophers and theologians. This becomes

⁴⁶ Lawrence Dewan, “The Importance of Substance,” <https://maritain.nd.edu/jmc/ti/dewan.htm> (retrieved 19 August 2022). However, Thomas qualifies this assertion as follows: “... but just so far and no farther, viz that the forms are educed from potency into act. Consequently, the natural agents are principles of being as regards beginning to be [*essendi principia quantum ad inchoationem ad esse*], and not as regards being, absolutely [*et non quantum ad ipsum esse absolute*]” (*Q. de pot.* 5, 1, ad 5). I will say more on this topic in the section dedicated to the importance of *esse* in Aquinas’s theology of creation in Chapter 4.

⁴⁷ One exception from this rule is human soul, which on the Thomistic scheme is created by God *ex nihilo* at the moment of conception.

⁴⁸ Once again, with the exception of the human soul.

obvious when we take into account the variety and frequency of its formulations in Aristotle and especially in Aquinas:

[T]he begetter is of the same kind as the begotten (*Meta.* VII, 8 [1033b 30]). [W]hatever perfection exists in an effect must be found in the effective cause (*ST* I, 4, 2, co.). [N]o effect exceeds its cause (*ST* II-II, 32, 4, obj. 1).⁴⁹ [E]very agent produces its like (*SCG* II, 21, no. 9). [N]othing acts beyond its species (*Super II Sent.* 18, 2, 3).⁵⁰ [T]he order of causes necessarily corresponds to the order of effects, since effects are commensurate with their causes (*SCG* II, 15, no. 4). [E]very agent acts according as it is in act (*SCG* II, 6, no. 4). No effect can be more powerful than its agent cause (*Super II Sent.* 18, 2, 3, obj. 3).⁵¹

It is worth noting that Descartes forms a similar principle (often called the Causal Adequacy Principle) when he says in the “Third Meditation” that “there must be at least as much reality in the efficient and total cause as in the effect of that cause.”⁵²

Adequacy versus Perfection

Before referring the PPC to the proposed metaphysics of evolutionary transitions, we need to ask about its general meaning in the wider context of possible changes and causal relationships in nature. Here, Stephen Boulter rightly notes that the core intuition of the PPC is that every effect has an “adequate” (i.e., proportional or commensurate) cause. But what constitutes adequacy? A rough yet common interpretation of the PPC is that a cause cannot give what it does not have. However, such delineation of PPC is deficient as it rules out the emergence of new active and passive powers (dispositions) from a causal base that does not possess them – basically in virtue of their being in a way “new.”⁵³

Interpreted this way, the PPC renders implausible not only explanation provided by evolutionary biology but also a vast number, if not the

⁴⁹ See also *SCG* I, 67; *ST* II, 24, 6, s.c.; *Q. de pot.* 3, 16, ad 8.

⁵⁰ See also *Q. de ver.* 24, 14; *Quod.* 9, 5, 1; *SCG* III, 84; *Q. de pot.* 3, 9; *ST* I-II, 112, 1.

⁵¹ See also *Q. de pot.* 3, 8, obj. 13; *ST* I-II, 112, 1; *Comp. theo.* 1, 93.

⁵² René Descartes, *The Philosophical Writings of Descartes: Volume 2*, trans. John Cottingham, Robert Stoothoff, and Dugald Murdoch (Cambridge: Cambridge University Press, 1984), 28.

⁵³ See Stephen Boulter, “Evolution and the Principle of Proportionality,” in *Neo-Aristotelian Metaphysics and the Theology of Nature*, ed. William M. R. Simpson, Robert C. Koons, and James Orr (New York: Routledge, 2021), 126.

majority of substantial changes observed in nature and analyzed in physics, chemistry, biology, and other sciences. These are the changes where we observe new substance(s) coming into existence, which have new properties and perfections that are not observed in the substances they originated from (the reagents that entered the reaction, which effected a given substantial change). Think about the reaction in which hydrogen and oxygen react forming water. The outcome of the process is a new substance, which has properties radically different from those of the reagents.⁵⁴

Hence, Boulter is right when he says that what is at stake and what defines adequacy in PPC is perfection (see *ST I*, 4, 2, co. above). In other words, what PPC rules out are cases where something less perfect causes the more “perfect” or cases of an effect “exceeding” its cause or of an effect “being more powerful” than its cause (see *ST I*, 95, 1; *ST I-II*, 66, 1; *ST I-II*, 63, 2, obj. 3; *ST II-II*, 24, 6; *SCG I*, 67; *SCG I*, 41; *SCG III*, 120). Following Coffey, he traces back primary intuitions that led scholastics to formulate the PPC:

- (1) The principle of causation – whatever begins to be, has a cause; whatever is contingent has a cause; nothing occurs without a cause.
- (2) *Operari sequitur esse* – operational powers depend on what a given entity is.
- (3) *Omnes agens agit in quantum est in actu* – all agents act insofar as they are in act. Hence, the higher an agent is on the scale of being, the more perfect its act of being, the higher its operations and effects.
- (4) From a known effect, we can argue with certainty to the existence of an adequate efficient cause, which is available to our cognition (we can obtain knowledge of its nature).
- (5) The principle of proportionality – an adequate efficient cause is sufficiently perfect and high on the scale of being to produce the

⁵⁴ Paying attention to the same problem of the popular interpretation of PPC Peter Coffey states: “The mediaeval scholastics embodied this truth in the formula: *Nemo dat quod non habet* – a formula which we must not interpret in the more restricted and literal sense of the words giving and having, lest we be met with the obvious objection that it is by no means necessary for a boy to have a black eye himself in order to give one to his neighbour!” (Peter Coffey, *Ontology or The Theory of Being: An Introduction to General Metaphysics* [Gloucester, MA: Peter Smith, 1970], 60). Brian Carl adds that “Like the claim that ‘there is nothing in the intellect that is not first in the sense’, the formulation that ‘nothing gives what it does not have’ only explicitly appears in Thomas’s writings in objections,” which shows that he prefers other (more precise) formulations of the PPC. See Brian T. Carl, “Thomas Aquinas on the Proportionate Causes of Living Species,” *Scientia et Fides* 8, no. 2 (2020), 226.

effect in question (otherwise the effect would be partly uncaused – which contradicts (1)).

- (6) An effect cannot as such be ontologically more perfect than its adequate (created) cause, which further specifies (5).
- (7) *Nihil agit ultra suam speciem; omne agens agit simile sibi* – nothing acts in a manner above its own kind; (since) everything produces its like.⁵⁵

Delineated in this way, PPC might be considered as a real challenge for evolutionary theory, where we observe a number of fundamental transitions, including those from abiotic to biotic; from replicating molecules to populations of molecules in protocells; from independent replicators to chromosomes; from RNA to DNA; from asexual clones to sexual populations; from single-celled forms to multicell and organic forms; from individual organisms to colonies; and from primates to humans.⁵⁶ The difficulty seems to be all the more acute in reference to the metaphysical account of evolutionary transitions I delineated in this chapter.⁵⁷

Different Notions of Perfection

The first line of response engages in an attempt at providing a metaphysically precise definition of perfection. Here, following Boulter, we need to distinguish two principal notions of what it means to be perfect.⁵⁸ The first goes back to Aristotle and ties perfection with completion, that is, the notion of *ἐντελέχεια* (*entelecheia*), which relates formal to final causation (anticipating my analysis of it in Chapter 3) and denotes the form as actualized in the highest state of perfection of a given entity. Within this paradigm, an entity is perfect when “in respect of excellence and goodness [it] cannot be excelled in its kind” (*Meta.* V, 16 [1021b14]). Perfection completes an entity, making it lack nothing that is proper to it, in reference to the natural kind it belongs to. Embracing this notion

⁵⁵ See Boulter, “Evolution,” 128–31.

⁵⁶ See John Maynard Smith and Eors Szathmary, *The Origins of Life: From the Birth of Life to the Origin of Language* (Oxford: Oxford University Press, 2000), 17.

⁵⁷ Chaberek has pointed to the principles that “no being can convey more act than it possesses,” that “no effect can exceed the power of its cause” and that “the perfection of the cause cannot be lesser than the perfection of the effect” as incompatible with the evolutionary emergence of novel genera of living things. See his *Aquinas and Evolution* (Lexington: The Chartwell Press, 2019), 48; “Classical Metaphysics,” 56.

⁵⁸ See Boulter, “Evolution,” 131–34.

of perfection Aquinas says: “That is perfect which lacks nothing of the mode of its perfection” (*ST I*, 4, 1, co.)

The second notion of perfection goes back to Plato and Plotinus as it is grounded in the concept of the Great Chain of Being. Boulter refers it to Anselm and his version of the Ontological Argument. On this scheme, a perfection is any property the possession of which moves one up the Chain. Yet, it is not easy to decide what all such properties have in common. Apart from rather imprecise suggestions made by scholastics, we might think about defining the common denominator of such properties in terms of rising (1) the degree of act *versus* potency; (2) the degree of immateriality; (3) immanence of action; (4) range and depth of operation and causal influence; (5) freedom from substantial change; (6) unity and simplicity of structure; or (7) natural control of other things.⁵⁹

Most importantly, notes Boulter, even though both accounts of perfection contain the notion of completion (*entelecheia* and God’s *esse*, respectively), they differ rather substantially:

According to the Aristotelian account, a perfection is a property that makes an entity better than other entities *of the same kind*, while on the Anselmian account a perfection is a property that makes an entity “better” or more “noble” than another entity, whether that entity is of the same kind or not. Anselmian perfections are thus absolute in a way Aristotelian perfections are not.⁶⁰

Consequently, since all cases of the first (Aristotelian) notion of perfection are species and kind relative, they are inadequate in comparing and ranking entities and organisms that belong to different natural kinds. To give an example, on this notion of perfection, a fly is as perfect as an elephant, as long as both organisms lack nothing that is proper for their natural kind (i.e., they reach their kind specific state of *entelecheia*). Biologically speaking, this kind of perfection might be defined in terms of the dominance of an ecological niche and producing fertile offspring. Thus, under this notion of perfection, there can be no question of a less perfect kind of entity bringing about a more perfect kind of entity, as there is no ground for the alleged comparison.

The case of the Anselmian hierarchical notion of perfection is more nuanced. Boulter suggests, after Scotus, that we should distinguish at least two main types of hierarchy here: (1) the order of ontological dependence (based on “what depends on what”) and (2) the order of

⁵⁹ See Bernard Wuellner, *Summary of Scholastic Principles* (Chicago: Loyola University Press, 1956), 226.

⁶⁰ Boulter, “Evolution,” 133.

eminence (“nobility” or “dignity”) of entities.⁶¹ Concerning (1) he states that the fundamental transitions in the history of life do not violate the PPC, as they do not generate effects on which they themselves depend ontologically. To the contrary, new types of being usually incorporate the old kinds of entities from which they originate as their constituent parts and thus may be said to be, to some extent, dependent on them. Even the origin of rationality from purely material causes follows the PPC, as human active intellect is only relatively independent from sense organs. With reference to (2), one might argue that the hierarchy of eminence is an anthropocentric projection or an outdated residue of Neo-Platonism, and all perfections listed in it are, in fact, Aristotelian perfections (just as life is not a perfection in a stone, sentience is not a perfection in a rose, nor rationality in an elephant). Hence, the PPC is not violated here either.⁶²

However, might such a dismissive response with regards to the hierarchy of eminence be too hasty? What if Anselmian perfections are metaphysically respectable properties? What if it is metaphysically relevant to compare perfections (proper dispositions) of neighboring species on the tree of life? Would not it violate the PPC? We might think about several possible answers to this question.

Virtual and Eminent Presence of Perfections

One possible response to the observation that, in the course of evolutionary transitions, less perfect causes bring about more perfect effects is to refer to the medieval concept of dispositions and properties present in things potentially (or virtually) and not actually (or formally).⁶³

⁶¹ A more general account of the hierarchy of ontological dependence rules out the following relations: (1) the nonexistent being the efficient cause of any type of being; (2) a being of reason effecting a real being; (3) a potential being effecting an actual one; (4) compound entity being the efficient cause of a simple being; (5) accident efficiently causing a substance; or (6) contingent entity efficiently causing the emergence of a necessary one. In each of these relations a cause seems to depend on the effect, which violates the PPC. In other words, as notes Aquinas “effects correspond proportionally to their causes, so that we attribute actual effects to actual causes, potential effects to potential causes, and, similarly, particular effects to particular causes and universal effects to universal causes” (SCG II, 21, no. 4). See Boulter, “Evolution,” 135.

⁶² See, *ibid.*, 137.

⁶³ Boulter mentions this idea as one of the intuitions that led scholastics to formulate the PPC (in addition to those listed above, in the section juxtaposing adequacy and perfection). He claims that they believed “The actuality of the effect need not be in its adequate created cause actually and formally, but merely *potentially* or *virtually*” (Boulter, “Evolution,” 130).

Applying this argument in the contemporary context, Edward Feser reformulates the classical version of the PPC saying that what it means is that “whatever is in an effect must be in its *total* cause in *some* way or other, whether *formally*, *virtually*, or *eminently*.”⁶⁴ In reference to this distinction, he gives an example of the \$20 bill:

Suppose I give you a twenty dollar bill. Your having it is the effect. One way in which I could cause you to have it is by virtue of having a twenty dollar bill in my wallet and handing it to you. I have the “form” of *possessing a twenty dollar bill* and I cause you to have the same form. That would be a case of what is in the effect being in the cause “formally.” But it might be that I do not have a twenty dollar bill on hand ready to give you, but I do have at least twenty dollars in the bank, and I can wire the money from my account to yours so that you can withdraw it from an ATM. In that case what is in the effect was in the total cause – me plus my bank account, etc. – “virtually” rather than formally. Or it might be that I do not have even twenty dollars in my account, but I do somehow have access to a U.S. Federal Reserve Bank printing press and can get a genuine twenty dollar bill printed off for you on demand. In that case what is in the effect is in the total cause – me, the printing press, etc. – “eminently.” For while in this case I don’t have an actual twenty dollar bill or even twenty dollars in the bank, I would have something even more fundamental, causally speaking, namely the power to *make* twenty dollar bills.⁶⁵

Although reasonable, this proposal needs clarification. In what way is a perfection proper for amphibians present in fish? My intuition is that the notion of virtual presence in this context differs from the one discussed above, in reference to parts present in a substantial whole through their dispositions and powers – that is, intrinsically. Here, virtual presence may be interpreted as extrinsic presence of a given perfection or its “parts” (“aspects”) in what Feser calls a “*total* cause” of a given entity. Indeed, one of the major faults of the debate on metaphysical aspects of evolutionary transitions and the PPC as applied to them is a blatant oversimplification of their causal analysis. What is being taken into account is usually the last step (usually an act of fertilization or conception) of a causal process that is extremely complex, multifaceted, and extended in time. We might speak here about an evolutionary causal matrix (or causal polygeny), where relevant contributors to speciation are incredibly many. Their number might be, in fact, virtually impossible to estimate.⁶⁶

⁶⁴ Edward Feser, *Scholastic Metaphysics: A Contemporary Introduction* (Heusenstamm: Editiones Scholasticae, 2014), 155.

⁶⁵ *Ibid.*

⁶⁶ The idea of causal polygeny of events was introduced in analytic philosophy of biology by John Dupré, who, in turn, takes it from genetics, which acknowledges that many

In addition to genetic mutations, we may name a number of other accidental changes that are relevant to speciation, such as genetic recombination, gene transfer, genetic drift, and changes classified as epigenetic (i.e., permanent, nongenetic, yet heritable changes that affect DNA expression). Moreover, as already mentioned in the introduction, we currently learn more about the synergy of evolution and development (evo-devo), as well as the importance of cultural, behavioral, physiological, and ecological inheritance (biological niche construction). Among additional factors, having causal influence on speciation, we find geographic, ecological, and reproductive barriers, as well as natural selection, which – strictly speaking – is not so much a cause but rather an explanation (a descriptive principle), turning our attention toward the fact of greater reproductive success of organisms that are better adapted to the environment in which the principle of struggle for existence applies.⁶⁷ All these factors have an influence on living organisms which, by nature, seek to preserve life (maintain homeostasis) and produce offspring (reproduce). Furthermore, organisms in question are closely linked in ancestral-descendant relations within populations in a given evolutionary lineage, which extends over extremely long periods of time, counted in hundreds of thousands or millions of years.

Hence, the proportionate cause of the emergence of a new species is not a single law or force but a concurrence of many causal influences constitutive for a speciation event or rather a history of an evolutionary transition. Causal contribution of such a multiplicity of causes is stored and transmitted from generation to generation, up to the point in which a given organism is able to educe a new kind of SF from the potentiality of PM. This does not contradict the PPC. This view was expressed already by Benedict Ashley:

The proportionate cause of the emergence of new types or organisms of increasingly complex organization and independence of the environment is not any single law or force but a concurrence of many causes in an evolutionary event,

genes typically contribute to the production of one trait. Following Dupré, George Molnar notes not only that events are polygenic but also that causal powers, conversely, are pleiotropic and flexible, and can make a contribution to many different effects. See John Dupré, *The Disorder of Things: Metaphysical Foundations of the Disunity of Science* (Cambridge, Mass: Harvard University Press, 1993), 123–24; George Molnar, *Powers: A Study in Metaphysics*, edited by Stephen Mumford (New York: Oxford University Press, 2003), 195.

⁶⁷ I will address this issue in greater detail in Chapter 3, in a section asking whether natural selection should be regarded as teleological.

or better, a history. A population of interbreeding organisms interacts with the ecosystem of which it is a part so as to evolve and differentiate into new reproductively isolated species, each of which develops an integrated type adapted to a special environmental niche, clearly distinguished from other populations for many generations.⁶⁸

Relating my argument to the notion of biological information, we may suggest that in a case of speciation, the quantity of information rises and its quality changes with respect to the first representative(s) of a new species. However, in our assessment of those differences, we must take into account not only the preceding generation, that is, the parents of the first exemplar of a new species, but also numerous causes contributing to the entire evolutionary transition. Their information input accounts for the net result and balance of the quantity of information that changes (or is being exchanged?) in this process.⁶⁹ Hence, Ashley concludes by saying:

Thus nuclear, chemical, and biological evolution, although involving very different kinds of events, have this in common: atom, molecule, and organism are products of historical events no less complex and sequentially ordered than the entities which they produce. The new species is not a “greater emerging from the less,” because the amount of information it contains in integrated form is no greater than the amount of information present in the historical evolutionary process. What is spread out in history is condensed, as it were, in the emerging new species.⁷⁰

Interestingly, this view finds a firm grounding in the thought of Aquinas who, following Avicenna, distinguishes the following four

⁶⁸ Benedict Ashley, “Causality and Evolution,” *The Thomist* 36, (April 1972), 215. See also Norbert Luyten, “Philosophical Implications of Evolution,” *New Scholasticism* 25 (July, 1951), 300–2; Leo J. Elders, “The Philosophical and Religious Background of Charles Darwin’s Theory of Evolution,” *Doctor Communis* 37 (1984), 56.

⁶⁹ The information input in evolutionary transitions is most likely much higher than the amount of information written and expressed in representatives of neighboring species. Much of it is possibly lost and scattered “on the way” of these highly complex and multilayered processes.

⁷⁰ Benedict Ashley, “Causality and Evolution,” *The Thomist* 36, (April 1972), 215. The notion of biological information – which is notoriously difficult to define and quantify – is one of the vexing topics in philosophy of biology. See Peter Godfrey-Smith and Kim Sterelny, “Biological Information,” in *The Stanford Encyclopedia of Philosophy*, ed. Edward N. Zalta, Summer 2016 (Metaphysics Research Lab, Stanford University, 2016), <https://plato.stanford.edu/archives/sum2016/entries/information-biological/> (retrieved 20 July 2022); Peter Godfrey-Smith and Kim Sterelny, “Information in Biology,” in *The Cambridge Companion to the Philosophy of Biology*, ed. David L. Hull and Michael Ruse (Cambridge; New York: Cambridge University Press, 2007), 103–19; Stefan Artmann, “Biological Information,” in *A Companion to the Philosophy of Biology*, ed. Sahotra Sarkar and Anya Plutynski (Chichester: Wiley-Blackwell, 2010), 22–39.

types of efficient causation: perfecting, preparing, assisting, and advising.⁷¹ While all four categories might be attributed to natural agents, the most interesting for us are perfecting and preparing efficient causes. Aquinas's notion of the former defined as "the one which causes the ultimate perfection of a thing" (*In Meta.* V, lect. 2 [§ 766]) might be referred to the cause that brings about (directly) the final step of an evolutionary transformation. His reflection on the latter – preparing (indirect) efficient causes – can be extended to numerous causal agents contributing to the same complex evolutionary transition. He writes: "The cause disposing anything ... does not induce the final perfecting form, but rather only prepares matter for that form" (*In Meta.* V, lect. 2 [§ 767]). Hence, Aquinas is aware that natural efficient causes may be (and usually are) plugged into a network of other efficient causes and that the effect of one of them might be also attributed to others.⁷² Moreover, he sometimes uses the term "order" to characterize the interconnection between many causes contributing to a joint effect (see e.g., *ST I*, 116, 2, ad 1).

Another possible answer to this query, mentioned by Feser, introduces the notion of the "eminent" presence of perfections in causes. The idea goes back to the medieval concept of a passive obediencial capacity (*potentia obediencialis*) whereby the nature of a given cause can be "elevated" such that it is capable to give what by nature it does not have.⁷³ Naturally, just as in Feser's example, the access to a US Federal Reserve Bank printing press, which gives an eminent "power" of issuing dollar bills, is not something that lies within the capacities of a regular citizen, the "eminent" presence of perfections in contingent causes goes beyond their natural dispositions. Hence, the "elevation" of such agents is caused by the supernatural concursus of the First Cause, which enables

⁷¹ See *In Meta.* V, lect. 2 (§ 766–69); *In Phys.* II, lect. 5 (§ 766–69); Frost, *Aquinas*, 192–98.

⁷² Frost notes that Aquinas is concerned with positing limits to the number and scope of efficient causes potentially contributing to a given change. She says that for him "Disposing causes are those which act toward the production of that which can be immediately transformed (i.e., by a single action) into the final effect" (Frost, *Aquinas*, 196).

⁷³ Boulter sees it as yet another idea that motivated the formulation of the PPC in the Middle Ages. He claims the scholastics believed that "Created causes have a passive obediencial capacity (*potentia obediencialis*) whereby their nature can be so elevated by the First Cause that they can produce, with His special supernatural concursus, effects of an entirely higher order than those within the ambit of their natural powers" (Boulter, "Evolution," 130). The question remains to what extent this idea, as well as the one referring to virtual presence – see note 63 above – motivated the formulation or rather explained the difficulties stemming from the PPC.

them to bring about effects of an entirely higher order than those within the ambit of their natural powers.

Although one could argue that divine “elevation” of contingent causes is not so much a miracle but an expression of God’s agency in the universe through the instrumental causation of creatures (I will say more on this topic in Chapter 5), the argument based on *potentia obediens* might be less favored by the naturalistically oriented mind of a contemporary researcher and theoretician of evolutionary biology.⁷⁴ If they are not convinced by this nor by any of the preceding arguments, one could refer them to another possible response to the difficulty related to the PPC in evolutionary transitions.

Conservation of the Overall Perfection of the Universe

In reference to a growing awareness of the complexity of the notion of perfection among biologists and philosophers of biology, Boulter develops an intriguing observation that throughout the fundamental transitions in the history of life, the net “amount” of perfection of the universe remains stable. He challenges our tendency to pay attention only to increases in operation or power found in new kinds of entities. What is less immediately obvious, and for the most part neglected, is that new powers and dispositions are usually accompanied by new difficulties, problems, and defects. Hence, the balanced notion of evolution reveals that each transition in the history of life involves both increase and decrease in perfection. This allows us to postulate a principle of an overall conservation of perfection in an evolving universe.

Think about the loss of operational control – says Boulter – which we normally perceive as a decrease in perfection. Apply this rule to

⁷⁴ See, for example, Daniel De Haan’s strong argument in favor of the naturalistic explanation of evolution from the Thomistic perspective in his “*Nihil dat quod non habet*: Thomist Naturalism Contra Supernaturalism on the Origin of Species,” in *A Catholic View on Evolution: New Perspectives in Thomistic Philosophy and Theology*, ed. by Nicanor Austriaco (Washington, DC: Catholic University of America Press, 2023). In the course of his argumentation, he states: “According to Thomist naturalism, the Cosmos is endowed with all of the secondary causal potentialities required qua interacting secondary causes to eventually bring about, via adornment (*opus ornatus*), the generative eduction of all fundamental particles, atoms, molecules, galactic, stellar, and planetary systems, along with the abiogenesis and evolution of all living organisms, including the emergence of sentient conscious animals. The principled exception is the immaterial rational soul of humans that cannot be educed from any totality of hylomorphic secondary causes, because there is no material potentiality for a per se subsisting immaterial form or rational soul” (*ibid.*).

prokaryotes entering the first eucaryotic cell, to cells of higher organisms, which depend for their activities on being part of a multicellular organism, or to individuals of sexually reproducing species that depend on populations of interbreeding organisms. He concludes that the general pattern of counterbalancing perfections continues as we mount the scale of being (*scala naturae*). In reference to John Maynard Smith and Eors Szathmary, he then offers an original reflection on this topic:

[E]ach of the transitions involves an increase in the internal complexity of the relevant entities. Yet simplicity is traditionally seen as a perfection. So whatever is gained in operational powers after a transition is offset by the increase in complexity.

Moreover, the transition from abiotic to biotic involves the emergence for the first time of *mistakes*. No doubt this is in part due to the greater internal complexity of the relevant entities. However that may be, life cannot be seen as an unqualified advance against the background of a mistake-free inanimate order, given that these mistakes are often nontrivial and introduce the very possibility of suffering for the first time.

Again, living things, animals in particular, need to be equipped to deal with their precarious form of existence in a way abiotic entities do not. In particular there is a need for forms of perception to guide movement to secure resource requirements and avoid predation. From this perspective sentience is seen to be *both* a perfection *and* a compensation for a handicap due to a need not present amongst abiotic entities and plants.

Similar remarks apply to rationality in humans. Our intellectual capacities are *both* a perfection *and* a necessary compensation for a handicap not present in the other higher animals, namely, the lack of natural weapons or defences against both predators and the elements. The lesson here is that nature provides what is *needful*; nobility is not a consideration.

Moreover, the “advance” from the sensory experiences of the sensitive soul to the abstract concepts of the intellective soul is *not* a move up from a material sensory organ to an immaterial intellect, but a *sideways* move from informationally rich to informationally impoverished but useful representations. This is because concept formation via abstraction involves *ignoring information* available in perception. But if information – truth – is a good, then this transition involves sacrificing *quantity* of information for *quality*.

Finally, voluntary action is one of the benefits associated with rationality because it involves an increase in control over behaviour; but it also introduces the possibility, not to say inevitability, of moral mistakes and suffering of a kind and intensity not known to animal, plant or inanimate entities.⁷⁵

Boulter thus confronts us with the image of a universe that was perfect to begin with, with the emergence of life and its subsequent history

⁷⁵ Boulter, “Evolution,” 140–41. He refers to John Maynard Smith and Eors Szathmary, *The Origins of Life*, 19.

revealing different but equally perfect states of the universe. If he is right, then evolutionary transitions themselves do not involve violations of the PPC, with respect to hypothetical negative perfections.

Evolution and Aquinas's Hierarchy of Causes

One last attempt at answering the challenge of the PPC applied to evolution, offered by Brian Carl, takes us back to Aquinas. He draws our attention to the complexity of causal hierarchy in Aquinas, which is often ignored by many who concentrate merely on proximate causes in their analysis of causal dependencies. For Thomas, all causal relationships in the mundane reality happen within God's providence, where God is conceived as the first and principal cause, working in nature through secondary and instrumental causes. However, between God and mundane creatures, Aquinas sees the causality of angels and celestial spheres, especially the Sun, which is the source of heat.⁷⁶ Concerning generation of animals, gametes (egg and sperm – as we know today) are instrumental causes in relation to parental organisms, which are secondary (or instrumental) causes in relation to celestial spheres (in particular, the Sun), which are secondary (or instrumental) causes in relation to angels, who are secondary (or instrumental) causes in relation to God.

Based on this observation, Carl notes that

Thomas does not in fact hold that any individual animal “has” its own nature in such a way that it is sufficient to “give” that nature to something else, for on his view an individual animal is an instrumental cause in the generation of another individual of the same species.⁷⁷

In other words, each individual living creature does not “have” its own nature in a way that enables it to pass it on its offspring. It “has” its nature in such a manner that it can be used instrumentally by a

⁷⁶ It is important to remember, in this context, that the ancient and medieval idea of causation of celestial bodies is not just a relic of an outdated cosmology. It is not entirely implausible to see the energy emitted by the sun, forces of gravitation, and other universal cosmological causal principles as contributing to educing particular forms from PM in processes of substantial changes occurring in nature. At the same time, this general supposition must be distinguished from the outdated science. The ancient and medieval scientists thought that it was through heat that matter was qualitatively disposed to enter a substantial change in which its underlying PM was informed by a soul of a given type. They thought semen was a thoroughly concocted blood endowed with powers similar to blood producing flesh and organs, yet directed to do so in the conception of a new organism from the matter provided by the female (see *De gen. an.* II, 4 [74ob 24]).

⁷⁷ Carl, “Thomas Aquinas,” 226.

superior cause.⁷⁸ Moreover, all changes (including all cases of generation and corruption) engage the entire hierarchy of causes, since – paradoxically – higher causes (separated substances) may not be able to bring changes in mundane (physical) reality directly:

Just as the baker cannot produce the form of bread except through fire, for St. Thomas created separate substances are unable to directly cause any formal transmutation of bodily substances; they are limited to causing changes of place. If a separate substance wishes to cause any transmutation of a bodily substance, it must use a mediating body, “just as a man can heat something through fire” (*Q. de malo* 16, 9).⁷⁹

Carl further develops this idea in reference to Aquinas who asserts that “the power of a heavenly body suffices for generating certain less perfect animals from disposed matter, for it is obvious that more [things] are required for the production of a perfect thing than for the production of an imperfect thing” (*ST I*, 91, 2, ad 2).⁸⁰ He comes to the original conclusion that:

... the only general metaphysical principle that St. Thomas invokes in order to argue for the need for the instrumental contribution of a univocal generator is not the principle of proportionate causality, but instead the principle that a remote created universal cause needs the instrumental contribution of mediating instruments to produce more powerful effects. This principle seems reconcilable with evolution as well—although to articulate this reconciliation would require much further work.⁸¹

This suggestion certainly remains in line with previously discussed solutions based on the notion of virtual and eminent presence of perfections and paying attention to the complexity of the evolutionary matrix of causes engaged in speciation events.

CONCLUSION

Despite an ever-present skepticism toward classical philosophy, the long-standing legacy of the Aristotelian – Thomistic tradition remains not only coherent and consistent but also vigorous, flexible, and open to the

⁷⁸ See *ibid.*, 235. As Thomas elsewhere puts it, endorsing what he takes to be Aristotle’s view, “whatever causes generation in these lower [bodies] moves [its patient] to a species as the instrument of a heavenly body” (*ST I*, 115, 3, ad 2). See also *SCG III*, 69; *ST I*, 45, 8, ad 3.

⁷⁹ Carl, “Thomas Aquinas,” 243.

⁸⁰ See also *Super II Sent.* 18, 2, 3, ad 5; *Q. de pot.* 3, 11, ad 12; *In Meta.* VII, lect. 6 (§ 1401).

⁸¹ Carl, “Thomas Aquinas,” 244–45.

new data and current ways of understanding the universe, its structures, and processes. When introduced to the evolution debate in particular, it presents itself not as an aged doctrine that is limited to humble listening and adjusting of its principles to the new scientific theories. Quite to the contrary, its fundamental principles enable us to develop a constructive proposal of the metaphysics of evolutionary transitions.

However, as promising as this perspective may seem, there are a number of queries that remain. They refer to various aspects of evolutionary theory that are widely discussed among both biologists and philosophers of biology. One of the most important issues that need to be addressed takes us back to the controversy concerning biological species. Is the classical essentialist notion of species (assumed by the proposed metaphysical notion of speciation) defensible in the context of contemporary evolutionary biology? The next chapter will provide an answer to this question.