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"Form, Cause, and Explanation in Biology: A Neo-Aristotelian Perspective"
Christopher J. Austin

In the aftermath of the Scientific Revolution of the 17th century and the rise of the new mechanistic philosophy, Aristotle's concept of „formal causation" was banished from theoretical biology: its intrinsically teleological activity was explained away as nothing more than the phenomenal residue of the extrinsic forces of selection operating upon the passive participants of evolutionary processes. However, with the advent of the new science of evolutionary developmental biology (evo-devo), organism-centred evolutionary explanations – and with them, non-mechanistic models of development – are again becoming prominent. In this talk, I argue that the scientific paradigm shift of evo-devo has important philosophical implications for our conception of „natural kinds" and the reality of „formal causation".

This talk has three parts. In the first part, I provide an overview of the recent history of evolutionary biology with respect to modelling organismal development, comparing and contrasting the population genetics of the „Modern Synthesis" framework and the new systematics of evo-devo in order to illustrate their respective philosophical implications on the content of our concept of „natural kind". In the second part, I discuss in detail the dynamical models of development employed by evo-devo and argue that their exhibition of the intrinsic, teleologically directed generative potential of organismal morphology correctly captures a characteristically „formal" causal structure. In the last part of the talk, I defend this conception of formal causation from a few common objections by considering its relation to so-called *ontic*, "entities and activities"-based mechanistic models of „efficient causation" and its place within the spectrum of „explanation" and „causation" through the lens of counterfactual dependence.

"Dualisers in Aristotle's Biology"
Nicola Carraro

Aristotle claims that animals like ostriches, bats, seals, dolphins and whales "dualise" (*epamfoterizein*) between two kinds, or (as he sometimes puts it) that they belong "to neither and to both". Accordingly, he explains some of their features based on their membership in one kind, and others based on their membership in the other. For instance, he says that some properties belong to the ostrich "insofar as it is a quadruped", and others "insofar as it is a bird".

This is surprising because, according to the version of essentialism standardly attributed to Aristotle, there cannot be partial overlap between kinds. Therefore, some interpreters suggest that the traditional understanding of his essentialism is incorrect: he has no rigid, overarching taxonomy, and different criteria of classification are appropriate in different contexts. Others distinguish between preliminary, tentative classifications that have a merely heuristic value, and the ultimate essentialist classification that accurately reflects the natural hierarchy of kinds. In their view, Aristotle allows dualisers in the former, but not in the latter. Provisional classifications contain dualisers because the criteria of common-sense taxonomies depend on ambiguous concepts, like "terrestrial" and "aquatic," or "biped" and "quadruped". If we substitute these terms with well-defined scientific ones, dualisers will disappear from our taxonomy.

Against these interpretations, I argue, first, that dualisers do not constitute evidence for a pluralist interpretation of Aristotle's classificatory practice. Secondly, I show that Aristotle regards their ambiguity as an objective phenomenon that is independent from the alleged imperfections of our conceptual apparatus. Namely, he sees them as "deformed" kinds, i.e., kinds that possess features with no teleological explanation. These features do not depend on the animal's form, but on imperfections in the matter from which the animal is produced. Thirdly, I suggest that dualisers are deformed precisely because they exhibit features that essentially belong to two kinds (e.g., the mode of life of a fish and the respiratory system of a mammal) and, therefore, do not work well with each other. Fourthly, I argue that they belong to both and to neither of two kinds because they are deformed members of both, but they are not full members of either.

I conclude by highlighting a surprising feature of Aristotle's brand of essentialism. While many essentialists think that kinds cannot overlap, Aristotle allows for imperfect overlap in exceptional cases. This is possible because his kinds are defined teleologically, and have thus a normative component. The features associated with a kind belong together not because this is absolutely necessary, but because this is necessary in order for the organism to function properly. Since nature is mostly teleological, these correlations are typically respected and, therefore, most animals are not ambiguous. However, ambiguity is possible, as a deviation from the norm, in deformed individuals and deformed species.

"Definition, Existence, and Inquiry in *Posterior Analytics* B 8-10"
Michael T. Ferejohn

My aim in this talk is to explore Aristotle's views, presented mostly in Book B 8-10 of the *Posterior Analytics*, concerning the relations among the topics of definition, demonstration, and scientific inquiry. In so doing I will be discussing in some detail selected parts of the position on this issue defended by David Charles in *Meaning and Essence* and some of his earlier papers. More specifically, I want to raise some questions about Charles' highly influential interpretation of these chapters on which which Aristotle commits himself to the following "three stage" view of how scientific inquiry of any subject should (and indeed must) proceed,

> In Stage 1 the inquirer knows what some kind term Φ signifies, but not whether Φ denotes an existent (i.e., non-empty) kind.
> In Stage 2 the inquirer relies partly on the knowledge acquired in the first stage to discover whether Φ in fact denotes an existent
> In Stage 3, assuming the inquirer has discovered in Stage 2 that Φ does denote an existent kind, she can then go on to determine whether that kind has an essence, and if so, what that essence is.

This talk focuses primarilty on Charles' Stage 2, and on whether it is really distinct from Stages 1 and 3, as Charles maintains. To be precise, I argue that especially in the *most developed* of Aristotle's illustrative examples in *B* 8-10, the completion of Stage 1 (that is, coming to know what a kind-term signifies) already presupposes knowledge of the existence of the kind denoted by that term, which undermines Charles' view that Stage 2 must come after Stage 1. I will then examine Charles' positive account of how knowledge of existence is acquired, and argue that on his own interpretation, knowledge of existence of a kind requires knowledge of its essence, which undermines Charles' view that Stage 3 must come after Stage 2.

"Explanatory Work for Non-Modal Essences"
Kathrin Koslicki

Essentialists hold that at least a certain range of entities can be meaningfully said to have natures, essences, or essential features independently of how these entities are described, conceptualized or otherwise placed with respect to our specifically human interests, purposes or activities. In contemporary metaphysics, essence is still quite commonly understood in modal terms: an essential truth, on this conception, is just a modal truth of a certain kind (viz., one that is both necessary and *de re*, i.e., about a certain object); and an essential property is just a feature an object has necessarily, if it is to exist. The essential truths, according to this modal approach, are thus a subset of the necessary truths; and the essential properties of objects are included among their necessary properties.

But not all essentialists are modal essentialists; a growing number, following Aristotle's lead and Kit Fine's pioneering work on essence since the 1990s, now prefer a non-modal conception of essence. According to this approach, *de re* necessary truths are to be explained in terms of essential truths; and *de re* necessary features of objects, traditionally known as the "propria" or "necessary accidents", similarly are conceived of as in some way derivative from the essential features of objects. Those who embrace a non-modal conception of essence thus face an additional explanatory challenge which is not shared by their modal counterparts: for, according to the non-modal conception, an entity's essence must not only, so to speak, locate the entity in every possible scenario in which it exists; it must also contribute to an explanation of the entity's modal profile. For example, supposing that it is part of the essence of triangles that they have three angles and merely necessary but non-essential to triangles that they have three sides, then we must be given some indication of how the second feature in some way derives from the first.

So far, non-modalists have been slow to take up the challenge to clarify the relevant explanatory connection which can be said to hold between basic facts about essences and derivative facts about an entity's modal profile. Kit Fine's approach to essence and modality assumes, for example, that the relevant consequence relation is that of logical entailment; but a triangle's being three-sided is not *logically* entailed by its being three-angled, unless additional premises are added which take the relationship in question for granted and hence make the derivation in question philosophically uninteresting (e.g., that every closed geometrical figure with three angles also has three sides and that triangles are closed geometrical figures). Aristotle's central idea is that the *explanatory* power of definitions (i.e., statements of the essence), which act as first principles in scientific demonstrations, derives from the *causal* power of essences, viz., their worldly counterparts. Aristotle's approach certainly points towards a promising direction to pursue for those who are in search of an appropriate non-logical asymmetric explanatory connection between basic non-modal facts about essences and derivative facts about an entity's modal profile. But more work remains to be done for non-modalists who wish to incorporate the basic Aristotelian insight into an explanatory framework that is acceptable to contemporary metaphysicians.

"Form, Life Form and Aristotle's Bios"
James G. Lennox

When thinking about the concept of a 'formal cause' in the context of living things, at least from Aristotle's point of view, two philosophical theses are fundamental: the identification of form and activity (*energeia*) in *Metaphysics* VIII and IX, and the related, yet distinct, identification of soul as form and first fulfillment (*protê entelecheia*) in *De anima* II. In recent work I've been puzzling over how these quite abstract theses inform Aristotle's

systematic and richly empirical investigations of animals by asking how this abstract notion of form is related to two concepts that are central both to the way he organizes information about animals in the *Historia animalium* and to the way he explains that information in the *Parts of Animals* and *Generation of Animals*—action (*praxis*) and way of life (*bios*). In this paper, given our conference theme, I want to focus on formal *causation*, and thus on how soul (*psychê*) as formal cause is related to *praxis* and *bios* in their *explanatory* roles in biology. This paper is not, however, a merely historical exploration. I want to make connection with two contemporary philosophical projects which I believe are grappling with questions about the phenomena of life and their explanation that are akin to Aristotle's, the project of Michael Thompson in *Life and Action (2008)* and of Denis Walsh in *Organism, Agency, and Evolution (2015)*.

"A Reconstruction of the Four Causes for Powers Theorists"
Stephen Mumford & Giacomo Giannini

Empiricist philosophy from the Modern period rejected Aristotle's idea that there were four kinds of causes and instead reduced them down only to what he had called efficient causation. Any gain in economy is questionable, however. As much as final causes were derided, it is also clear that without them there are explanatory gaps in our ontology and notions such as law of nature look like an attempt to make up for the lack of directedness. Another way to fill the gap has come to us from the revival of a powers metaphysics. Is the contemporary powers approach consistent with Aristotle's four causes or an alternative to both that and the empiricist view of causation? We can understand Aristotle's causes the following way. The material cause is the bearer of the power, the efficient cause is the stimulus of the power, and the final cause is the manifestation to which the power is directed. That leaves the formal cause. There is some sense in taking the formal cause to be the power itself but it has to be conceded that this is at odds with the way in which Aristotelians traditionally understand formal causes. Nevertheless, I maintain, this account can be seen as a credible contender and will leave us with the explanatory gaps filled once more. Moreover, this discussion reveals that acceptance or rejection of the four causes is the crucial battle ground between the powers metaphysics and the currently very popular Humean view of causation.

"Form as Cause"
David S. Oderberg

Of Aristotle's famous 'four causes', only the efficient cause has survived into contemporary philosophy, the others having been swept aside as so much pre-Enlightenment conceptual detritus. This is especially so in the case of the formal cause. I have argued for the existence of form elsewhere. On the assumption that forms – especially substantial forms – are real beings, I here defend the important Aristotelian-Scholastic thesis that forms are literal causes. After setting out the proper understanding of causality at its most general, I then outline the features of form in virtue of which form can plausibly be held to be a cause. This is followed by analysis of the specific ways in which the form is a cause in respect of both the *nature* and the *agency* of the subject of the form. I examine ways in which the concepts of *grounding* and *explanation* might be thought less contentious proxies for formal causation. Unless literal causation is embedded in such concepts, however, they are incapable of accounting for the relation between form, nature, and agency.

"Forms as Causes in Aristotle's Metaphysics H"
Christof Rapp

While Book Z of the Metaphysics does not seem to come to a positive and definitive conclusion concerning the nature of substance, it is only in the final chapter of the book, Z 17, that Aristotle raises the question again, what substance is and what it is like. I argue that this answer is given in the course of Book H that, however, introduces a quite peculiar understanding of form. On this account, form is a difference applying to the (proximate) matter that makes something an actually existing substance. This account, I argue, completes the causal account of forms introduced in Z 17. This causal account of form has advantages for overcoming problems of any kind of hylomorphism, as concluding glimpse into a contemporary debate will show.

"Formal Causation Regained"
Petter Sandstad & Ludger Jansen

Formal causation, one of Aristotle's 'four becauses', is currently heavily under-researched and has fallen into disrepute. It is at play whenever a thing has a property because it is of a certain kind—or form, or essence. We call these essential properties. For instance, whales have the disposition to breathe with lungs because they are mammals; and a scalene has internal angles equal to 180° because it is a triangle. This type of explanation is found, e.g., in the theories of Lowe, Ellis, Oderberg, and Bird. Our view is independent from disputes over universals, from hylomorphism, from individual forms, and from which kinds are accepted as real kinds. It is applicable to any field that has taxonomic hierarchies. We argue that Aristotle's formal cause is not only an indispensable pattern of explanation, but also that it involves identity dependence and should thus be seen as a proper variety of causation.

"On Finean Feature Dependence and the Aristotelian Alternative"
Wolfgang Sattler

In this paper I identify a so far unnoticed explanatory problem of Fine's (1995) account of ontological dependence, which is intimately connected to Fine's (1994, 2015) account of essence. I clarify this problem with the help of Aristotle's distinction of different kinds of predications, and the corresponding attributes, in his *Posterior Analytics* and *Metaphysics.* For Aristotle, there is accidental predication and two different kinds of *in-itself*-predications. The one kind of in-itself-predication involves essential attributes and is intimately connected with formal causation. The other involves attributes, such as 'propria', that are non-essential, but peculiar to the respective subject, which does not necessarily imply that they are necessary attributes.

According to Fine, an object O depends ontologically on another object Q just if Q figures in the real definition of O, which specifies the essence of O. For instance, the proposition that Socrates is the sole member of {Socrates} is arguably a part of the real definition of {Socrates}. Since Socrates is a constituent of this Russellian 'essential proposition', {Socrates} depends ontologically on Socrates. For Fine this means that *what* {Socrates} is depends on *what* Socrates is. Assuming that Socrates is essentially a human being, it will be essential to {Socrates} to have a member that is a human being. The essence of Socrates is in this way incorporated into the essence of {Socrates}. Relations of ontological

dependence such as these provide an *understanding* of what the dependent entity is, according to Fine.

Fine's account is in principle intended to apply also to cases of what Koslicki (2012) calls 'feature dependence', where for instance a trope or a universal, if one assumes that these entities exist, depends ontologically on their respective bearers. I show that Fine's account renders some problematic results here. For instance, only certain corporeal beings can feel pain and be educated. And it is arguably not just necessary but also essential to all such corporeal beings to have some mass and to be extended on Fine's view. If so, it follows on Fine's account that we understand *what* the features of being educated and of being in pain are in part by being aware of the fact that their respective bearers have some mass and are extended. While this fact is, no doubt, a necessary condition for these dependent features to exist, it is all but clear, that it explains even partially *what* the features of being in pain and being educated are.

The above example shows a certain problem of explanatory relevance with Fine's account of ontological dependence. By contrast, applying Aristotle's distinction of attributes here renders more intuitive and different results than Fine's account. This is so, as I will expound, in particular because Aristotle does not assume that the essence of a feature incorporates the whole essence of its bearer, but only explanatory relevant parts of it. I further explain how this difference between Fine's and Aristotle's views here derives from the different explanatory purposes of their respective forms of essentialism.

"Sparse Essentialism"
Tuomas Tahko

Neo-Aristotelian essentialists typically think that all entities have an essence. My take on this understanding of essence is that the essence of an entity may be expressed in terms of the identity and existence conditions of the entity. But the identity and existence conditions of many entities would seem to be derivative: the existence and identity of water molecules depend on the existence and identity of hydrogen and oxygen atoms, and the existence and identity of hydrogen and oxygen atoms depend on the existence and identity of protons, electrons, and so on. What if we could explain the essences of all entities in terms of the essences of the fundamental entities? This would give rise to what I will call *sparse essentialism*, a view that combines some elements of neo-Aristotelian essentialism with a thought analogous to the Lewisian idea of 'sparse' or 'natural' properties.

Maybe there are only very few genuine, fundamental essences and all the rest 'flows' from these fundamental essences? Moreover, maybe there are no individual essences at all, but rather just fundamental general or kind essences. In other words, why should we think that an individual water molecule has an essence if we can derive the identity and existence conditions of each water molecule from the identity and existence conditions of its fundamental constituents? Note that this view does not have to lead to *atomistic essentialism*, i.e., the view that only mereologically fundamental entities have essences. There is still room for (fundamental) higher-level essences, but only for those that are not derivable from more fundamental essences.

In this paper I will explore the prospects for sparse essentialism and demonstrate that it is a much more parsimonious view than traditional neo-Aristotelian essentialism. The view can also draw some support from contemporary science.

"Essence and Potentiality"
Barbara Vetter

In this paper, I compare two views of modality that anchor modality in actual objects: essentialism, following in the footsteps of Fine (1994), and potentialism, as formulated in Vetter (2015). First, I argue that the two views are not equivalents as it might be thought at first look, but are rather competing views of metaphysical modality. Second, I give methodological reasons to think that the competition between them will not be decided by considerations of extensional adequacy. Third, I argue that general considerations on the role of metaphysical modality favour the potentialist view while explaining the links between essence and necessity.