

The great unifier: form and the unity of the organism

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Abstract

Organisms possess a special unity that biologists have long recognized and that cries out for explanation. Organisms and collectives also have their own related kinds of unity, so what distinguishes the unity of the organism? I argue that only *substantial form*, a central plank of hylemorphic metaphysics, can provide the explanation we need. I set out the idea that whilst organisms *possess* substantial form, organisms *obtain* the substantial form of the organisms they belong to, and collectives *contain* the substantial form of their organismic members. I consider a number of difficult cases, including lichens, biofilms, cellular slime moulds, and plasmodial slime moulds, arguing that none of them pose a serious threat to the threefold distinction between organism, organism, and collective. I conclude by arguing that two prominent, alternative unity principles for organisms do not work, thus giving indirect support to the need for substantial form.

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1. Introduction: the unity problem

In his monumental treatise *On Growth and Form*, the famous mathematical biologist D'Arcy Wentworth Thompson commented as follows: 'The biologist, as well as the philosopher, learns to recognise that the whole is not merely the sum of its parts. It is this, and much more than this. For it is not a bundle of parts but an organisation of parts, of parts in their mutual arrangement, fitting one with another, in what Aristotle calls "a single and indivisible principle of unity"; and this is no merely metaphysical conception, but is in biology [a] fundamental truth...'.¹

The kind of unity to which Thompson is referring – the organisational harmony of interacting parts – is a phenomenon we find both within and without biology. The unity of chemical compounds, of an atom, a molecule, of a

¹ Thompson (1945): 1019.

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lump of iron or uranium, is also a subject of wonder, a phenomenon asking for an explanation. In biology, however, as Thompson makes clear, following

Aristotle before him, there is a special kind of unity. Terence Irwin puts it thus

when commenting on Aristotle's discussion of animal souls:² '...a collection of

flesh and bones constitutes a single living organism insofar as it is teleologically

organized; the activities of the single organism are the final cause of the

movements of the different parts.³

For the many philosophers who reflexively recoil at talk of teleology and

final causes, the idea can be put in a different, yet familiar way: organisms act for

their own sustenance, maintenance, and development. Their parts all serve the

overall goal of the organism: flourishing. The organism, unless it has reason,

does not set itself this goal; and even rational animals such as ourselves do not set

every element of our goal of flourishing as human beings: much of what we do is

no more than what happens to us or consists of the processes we inevitably

undergo for our own sustenance, maintenance, and development. Yet the goal is

there, however we got it and however any organism of any kind got it. Using

more traditional terminology, I claim that organisms display *immanent causation*:

causation that originates with an agent and terminates in that agent for the sake

of its *self-perfection*. By 'self-perfection' I do not mean that there is some *ideal type*

that every organism strives to reach. The idea is far more modest – namely that

every organism aims, whether consciously or not, at the fulfilment of its

potentialities such that it achieves a good state of being, indeed the best state it

² *De Anima* I.5, 411a24-b30, Ross (1931).

³ Irwin (1988): 288.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) can reach given the limitations of its kind and its environment. Immanent

causation is a kind of teleology, but metaphysically distinctive in what it involves.

It is not just action for a purpose, but for the agent's *own* purpose, where 'own purpose' means not merely that the agent acts for a purpose it possesses, but that it acts for a purpose it possesses such that fulfillment of the purpose contributes to the agent's self-perfection.

This unity cries out for explanation. There is, as I have already implied a 'unity problem' for all substances, organic and inorganic:⁴ to put it crudely, what holds their essences together?⁵ This has also been called 'the problem of complex essences', in other words the question of 'the linkage of inherently separable components into a single kind-essence'⁶ – typical example is the electron: it shares its unit negative charge with the tau lepton but not its mass; it shares its

mass with the positron but not its charge. The same applies to organisms: the flying squirrel (tribe *Pteromyini*) and sugar glider (species *Petaurus breviceps*) share a gliding membrane but not a pouch; the latter shares a pouch with the kangaroo (genus *Macropus*) but not a gliding membrane. The properties I have mentioned are all essential:⁷ they are partially definitive of the things to which they belong. Yet they are also really distinct: they are separately instantiated in different kinds of thing yet co-instantiated in others. When they are found together, what holds

⁴ I set out the unity problem in Oderberg (2007), and much of the subsequent defence of hylemorphism is designed to solve it.

⁵ A non-essentialist version is: what holds their natures together? In the latter case, there is no implication about the modal status of a thing's nature. I presume essentialism in what follows, without requiring it as part of my solution to the unity problem.

⁶ Dumsday (2010): 620.

⁷ Strictly, there is a difference between the constituents of a thing's essence and the essential properties ('necessary accidents') that flow from that essence, but for the present discussion I treat the two kinds similarly and call them all 'essential properties'. For more, see Oderberg (2011).

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them together? In the case of organisms the unity problem is even more acute than in the inorganic case, since not only are there distinct yet co-instantiated essential properties, but these properties all subserve the organism's overall flourishing, and the organism itself seeks to bring about its overall flourishing by employing its own parts, powers and other characteristics. In other words the organism, by engaging in immanent causation, displays a further kind of unity beyond the harmony and integration of its parts.

Now the immediate objection one is likely to raise is that there is no unity problem, only a pseudo-problem. What could it mean for essential properties to be 'held' together other than that, in a given case, they are properties belonging to the same essence. This seems to be the view of Jonathan Lowe, for whom the particular but regular combination of powers and liabilities in members of a given kind consists in the fact that, precisely, the objects in question *are* members of a given kind and that kinds are real universals⁸.

Although this account, as Lowe points out, reduces the number of brute facts that must be countenanced compared to nominalism, brutes facts there are nevertheless. It might be thought I am unfair to Lowe here, since he also holds that kinds are governed by laws linking them with their attributes, which adds some depth, as it were, to the bruteness.⁹ But Lowe's official view of laws is that they *consist in* the characterisation of kinds by attributes,¹⁰ so no new information is added to the account. What if one had a different view of laws, say that they involved some sort of metaphysical determination or production; on such a view,

⁸ Lowe (2006): 161.

⁹ Ibid.

¹⁰ Ibid: 141.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) one would hold that the essential behaviour or operation of members of a kind

was governed by the essence of the kind. One might say that kangaroos nurse

their young in a pouch because this is metaphysically necessitated by their

essence. But even so, this cannot account for all essential properties. Since having

a pouch and having a flying member can compare, there cannot be a *law*

uniting them if the law involves necessitation. But if the law is contingent, what

kind of law is it? If it is a law of biology, what law? If metaphysical, how can it be

contingent? Further, kangaroos are essentially mammals, but it is hardly a *law*

that they are mammals in any sense beyond that being a mammal is part of the

essence of being a kangaroo. Similarly, it is not a law that electrons have negative

unit charge; it is just part of what it is to be an electron.¹¹

Attempting to explain unity in terms of laws is bound to fail. Taking it to be a brute fact is also unacceptable. There is a difference, or so it seems, between

an organism and an organ, on the one hand, and on the other between an

organism and a collective of which it is a member, such as a colony.¹² That is why

appealing simply to immanent causation is insufficient to mark out organisms as

a unique category of living thing. Organs, too, work for their own self-perfection:

consider homeostasis within the organism, self-repair, intake of nutrients, and so

on. An organ¹³ has a similar unity to the organism of which it is a part – call it,

for now, *tight*. Yet the organ is *subservient* to the organism in a way that the

organism is not subservient to anything. Again, many collectives – consider ant

¹¹ Here I side with Bird (2007): 208-9 against Lowe (2006):154.

¹² As Clarke (2010): 316 puts it, in the context of the ‘problem of biological individuality’, the task is to focus ‘on what properties separate living individuals from living parts and from living groups, while taking the property of life itself for granted.’

¹³ By which I mean any biologically identifiable part of an organism rather than a random or gerrymandered hunk of tissue or other organic material.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) and bee colonies, among many others – also work for their self-perfection. Unless

we merely stipulate – which seems ad hoc – that immanent causation excludes

this kind of colonial collective agency, we should accept that living collectives,

too, display immanent causation. By contrast with the organ, however, a

collective has a similar unity to the organism that its members of it – as much as

neither are subservient to anything in the way the organ is subservient to the

organism. But the collective's unity is loose. So the organ's unity is tight but

subservient, the collective's is loose but not subservient, and the organism's is

tight but not subservient. What is the metaphysical explanation of these

differences?

In what follows I explore and defend the traditional distinction between organs, organisms, and collectives by utilising Aristotelian conceptual tools that

have, for one reason or another, fallen out of favour. Along the way I will

consider a number (though by no means all) of the hard cases that have been

raised in the literature as a possible threat to this tripartite metaphysical

distinction. The pivotal concept for clarifying and defending it is that of

substantial form, which is where I begin the analysis.

2. Form as unifying principle

The Aristotelian hylemorphist claims that the differences are to be accounted for

in terms of *form*, more precisely *substantial* form. Forms are universal determining

principles whereby things are endowed with substantial natures and accidental

characteristics. Are forms just what we call universals? It depends what one

means by 'universal'. There are a number of things that can be said here, but for

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) my purpose the main point is that there are universal forms, whether of

substance or of accident, but the former should not be thought of as *kinds* along

the lines of, say, Lowe's four-category ontology,¹⁴ except by way of synecdoche,

inasmuch as having a substantial form entails membership of a substantial kind.

There is the form of the Eastern Gray Kangaroo (*Macropus giganteus*), which

determines the animals that have it to be in a corresponding substantial kind.

Being in a substantial kind is, so to speak, part of what it is to have a substantial

form. But the form is not the kind, as seen by the fact that on the hylemorphic

theory there is only one substantial form per substance, the famous doctrine of

the *unicity* of form – whereas every substance instantiates more than one kind.

Boxer the Eastern Gray Kangaroo has the single form of the Eastern Gray Kangaroo

but instantiates numerous kinds such as that of, once again, *Eastern Gray Kangaroo*

but also the kind *marsupial* and the kind *mammal*. Membership in all the higher

metaphysical genera is explained by the substantial form inasmuch as there are

real features possessed by Boxer, in virtue of his form, that are shared by

marsupials and mammals that are not Eastern Gray Kangaroos. But these various

groupings of features are *abstractions* from Boxer's form and from the form of any

other Eastern Gray Kangaroo, among other infima or lowest species, again to use

the hylemorphic terminology. There is no space to defend the unicity of form

here;¹⁵ I raise it only to clarify the difference between form and kind.

As well as substantial forms there are *accidental* forms, such as being cloven-hoofed, and these too are universals. Kinds of substances, being universals,

¹⁴ Lowe (2006).

¹⁵ I defend the doctrine in Oderberg (2007): ch. 4.2.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) have multiple instances – individual substances such as mammals. Accidental

forms have particular accidents as their instances, now called tropes but

traditionally called modes; cases of cloven-hoofedness are an example. These

universals exist both in the mind and in reality, the difference being that in the

mind the universal exists as a single unified idea, whereas outside the mind the

universal exists as *multiplied*: it exists *in* its instances or, to use Lewis's well-known

and apt description, it is 'wholly present wherever and whenever it is

instantiated.'¹⁶ In other words, although the *selfsame* universal is wholly present

in each instance, it is *multiplied* in the sense of having multiple instances.¹⁷ The

same goes for substantial forms: they are grasped *as* unified ideas by the mind,

but in reality they are *multiplied* in their instances, which are *particularised* forms.

The form of Skippy the Eastern Gray Kangaroo is the same as that of Boxer the

Eastern Gray Kangaroo inasmuch as they share the universal form of that species,

which explains their belonging to the correlative universal kind. Whereas

substantial kinds have substances as instances, however, substantial forms have

particular forms as instances. Skippy and Boxer have different *particular forms*

inasmuch as each possesses its own principle of unity, which is also the principle

of its specificity as a certain kind of kangaroo, and this because, and as surely as,

they are each a distinct, individual kangaroo. We can see now that for the

hylemorphist, while in many respects forms – henceforth I mean *substantial forms*

unless otherwise indicated – are on a par with other universals, the former

nevertheless do their own metaphysical work.

¹⁶ Lewis (1986): 202.

¹⁷ For more on this, see Oderberg (2007): ch.4.5.

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Our concern is with form's work as the *unifier* of an organism – an

individual living substance. The first thing that needs to be appreciated is that this is not strictly a scientific but a metaphysical matter. Form is not a scientific postulate but a metaphysical one. One way of thinking of it as an *organising*

principle, where by 'principle' means, as the scholastic philosophers did in this context, a real, objective *cause* of something's being the kind of thing it is, what Aristotelians call a 'formal cause'. Not every cause is efficient, and in the picture of reality: form as organising principle is a cause in the sense of being

metaphysically responsible for something's having a certain nature. As such,

form – the formal cause – is not the sort of thing a biologist or any other natural scientist could ever discover. What they discover are the *kinds* of things there are, to be sure, but they do not discover that form is responsible for the essential

unity of any kind of thing, either as a kind or as an instance of a kind.

Biologists have not and could not discover the existence of form any more than a physicist could discover, or ever did discover, the existence of *matter*. It is through properly philosophical reflection that we know such things must exist.

Without going into detail here, matter is known to us as the metaphysical principle of change and potentiality. What we, either as ordinary observers or scientists, know are the particular material objects that exist. What we know *philosophically* is that that they have something in common that is the permanent substrate, to put it tendentiously, of their change and powers. So matter, as understood in purely metaphysical terms, is not the everyday matter we bump into when we interact with different kinds of thing. It is a metaphysical *posit* without which, claims the Aristotelian, insoluble philosophical problems arise,

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) and which *underlies* the everyday matter of our common experience. The same

goes for form. We know *philosophically* that substances have something in common that is responsible for their unity and specificity, but we know through observation, whether ordinary or scientific, the particular forms of substances

that exist. So on this score the by now total derision of substantial forms that we have inherited from Galileo, Descartes, Spinoza, Hume et al. can be seen to be far less compelling than most philosophers, and in the case of those post-scholastic world views, have thought. Put another way – and quite gesturally, I accept¹⁸ – the early modern rejection of substantial form owes more to anti-scholastic prejudice, in my view, than to irresistible philosophical critique.¹⁹

We should, however, only postulate form as a metaphysical principle if it can do work in explaining the unity that needs explaining. What I want to focus on here is that aspect of unity whereby an organism is clearly neither an organ nor a collective of substances, be they other organisms or anything else. I take this to be intuitively clear even if the boundaries between organs, organisms, and collectives are hard to draw. One might object that we have no pre-theoretical intuition as to the special metaphysical status of the organism; I take it that John Dupré would agree, espousing as he does a pluralistic account of the ways in which cells ‘combine to form integrated biological wholes’.²⁰ Multicellularity, he goes on to say, comes in many varieties, and we should not think of the organism

¹⁸ For the detailed response to sceptical worries about substantial form, and an equally detailed defence, see Oderberg (2007).

¹⁹ The interested reader may also like to consult Oderberg (2012) for a somewhat unorthodox exposure of Hume’s prejudice against the scholastic theory of substance.

²⁰ Dupré (2012): 88.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) in a 'naïve and static way' as a 'living individual'. It is, rather, a 'process' or 'life cycle'.²¹

Yet is the intuition so easy to dismiss? It cannot be a scientific discovery that the intuition does or does not latch onto reality: who made the discovery one way or the other? Biologists have to be sure, discovered all kinds of unicellular entities as well as multicellular organisation, but no biologist discovered – or *could* discover – that there is no difference in kind between organisms as living individual substances, organs that are material parts subservient to organisms, and aggregates of which organisms are members. The difference between parts of substances, substances, and aggregates of which substances are members cuts across the entire ontological realm, it is not special to biology but reflects the way the world in general is organised. And here we have the first philosophical argument in favour of the intuition: that if these categories are instantiated universally outside biology, we should expect them to be found within biology as well. Moreover, given the special teleologically-loaded unity of the living world, we should expect the division to be even more pronounced than in the world of the inorganic. We should be able to identify parts by the *service* they render to the whole, the whole by its integral teleology and hence the service rendered to *it* by its parts, and the aggregate by the service rendered to *it* by its substantial members.

The second philosophical argument for the intuition is very simple: it just *seems*, from both common and scientific observation, that there are many

²¹ Ibid: 99.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) instances of organs, organisms, and collectives or aggregates²² and that the

categories are mutually exclusive for those instances. And, to paraphrase Richard

Swinburne's Principle of Credulity, things usually are the way they appear to

be.²³ Now perhaps the most common way of rejecting the intuition is by appeal

to vagueness, which is effectively what a journalist such as Durre is doing when

he points out, quite correctly, the multifarious ways in which multicellularity

presents itself. The vagueness, to be of any power against the intuition, needs to

be ontic. But assuming it is, there are two responses one might be tempted to

make and yet which I recommend resisting. In the case of the organic world even

if, as I am happy to accept, they can be deployed in the inorganic case. One is to

point out that vagueness is everywhere and appealing to it is often a cheap shot.

We all want to solve the problems of vagueness. We learn nothing special about

biology when we see that we can soritify biological predicates like '...is an

organism' as much as any others. Another response is the Johnsonian one:²⁴ the

existence of twilight does not mean we cannot distinguish between day and

night. If there are clear ontic intermediaries between organs, organisms, and

collectives then to insist upon the importance of these three while ignoring the

in-between cases is to treat the latter as second-class biological citizens - curious

departures from nature's most important paradigms. This is to introduce

²² I will use the terms interchangeably.

²³ Swinburne (2004): 303.

²⁴ Allegedly. Johnson is quoted as having said this by Anscombe (1961): 60 but I have not been able to find it in his works. Edmund Burke made a somewhat similar remark: 'though no man can draw a stroke between the confines of day and night, yet light and darkness are upon the whole tolerably distinguishable' (*Thoughts on the Cause of the Present Discontents*, 1770; thanks to Robert Koons for alerting me to this).

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) unwarranted metaphysical (and perhaps methodological) bias into what should be a dispassionate allocation of ontological status.

Instead, I propose that we resist the idea that any vagueness in this domain is ontic. There is no promise here of an a priori, knockdown argument (which is not to say there might not be one. I prefer to appeal to ignorance, as it were: what *kind* of thing could there *be* lying between the organ, the organism, and/or the collective? What would be its essential features? What kind of teleology would it manifest? Since, however, the goal of this paper is more to justify form rather than to prove the existence of what it explains, the questions will be left hanging, with the burden in my view on the opponent of my threefold taxonomy. Moreover, any knockdown argument, if there is one, should be consistent with what we find in nature, but showing this requires detailed, case-by-case evaluation.

As an example, Dupré cites *lichens* as an case of ‘multispecies organisms...symbiotic associations of photosynthetic algae or bacteria with a fungus’. He notes the anomalousness of such an object from the perspective of the ‘traditional dichotomy between unicellular organisms and monogenomic multicellular organisms’, adding that it is ‘quite unproblematic’ when we approach multicellularity from a more ‘comprehensive’ perspective.²⁵ Now a relatively innocent reading of this passage reflects commitment to the special category of organism, but only a broadening of the category to include multigenomic organisms. A less innocent reading, which I adopt given the entire context of the chapter, is that it downgrades the category itself: after all, if there

²⁵ Dupré (2012): 90.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) are even multispecies organisms, what is so special about the term ‘organism’?

Aren’t lichens an example of the vast heterogeneity we find in living systems?

Even if there are paradigm cases of good old-fashioned organisms such as cats,

and of organs such as hearts and livers, and lichens are quite unlike either of

these, this no more elevates the paradigm above our scientific and other

interests than, recalling the earlier dictum, the existence of twilight brings out

anything *metaphysically* special about day and night. Let us talk about organisms that

be sure; but let us not pretend we are carving nature at a privileged joint.

In reply, lichens are not nearly as worrisome for my view as they might

seem. They are sometimes called ‘dual organisms’ because of the symbiotic

relationship between the mycobiont (fungus) and the photobiont (green algae or

cyanobacterium); but a dual organism is no more an organism than a dual

carriageway is a carriageway. That a lichen behaves differently from its

component organisms does not make it an organism since the same is true of any

collective and it would be question-begging merely to claim that collectives are

all organisms for the same reason lichens are. Although there are still many gaps

in our knowledge, a lichen is usually and best regarded as a ‘miniature

ecosystem’²⁶ consisting of two kinds of individual organism, a fungus and an alga

or colony of bacteria (acting as photosynthesising agents), working in extremely

close symbiosis. As far as we know, most lichen-forming fungi, as too their

photobionts, also occur in a free-living state in nature *or* can be cultivated in a

laboratory (albeit with generally less success than as lichen components, as one

²⁶ Nash (2008b): 7-8; ‘minute ecosystems’ (Tuovinen et al. 2015: 130).

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge would expect).²⁷ The fact that either partner *can* exist free-living distinguishes

them metaphysically from a true *organ*, such as an arm, leg, or eye, that has no free-living state. For an organ to exist separately from its natural body, similar or identical bodily conditions have to be *simulated*.

The other distinguishing feature is that lichen symbionts *both* reproduce. Hence to speak of lichen reproduction without qualification is misleading. There is genuine sexual reproduction wherein the germinating mycobiont (fungal) spores have to find a suitable photobiont in the environment in order for

successful symbiosis to arise again. Here it is the *fungus* that reproduces, not the lichen as a whole. There is also the *propagation* (rather than reproduction) of the lichen as a whole, fungus and photobiont, through the asexual reproduction of the fungus – the breaking off of a part of the fungus (a propagule) but containing

photobionts within it. The fungus and the photobionts continue to grow as did their respective parents once a suitable environment is found. In both the sexual and asexual cases, the mycobiont (fungus) has its own mode of reproduction, and the photobiont continues to reproduce, always asexually as far as we know, in the mycobiont with which it is simultaneously propagated or which captures it following sexual reproduction. Now although many individual organisms have more than one mode of reproduction, none reproduces itself twice over at the same time, or more precisely none engages in two distinct processes of partial

²⁷ Putting together Tuovinen et al. (2015): 130, Friedl and Büdel (2008): 9, Honegger (2008): 29-30, and Nash (2008b): 3, this seems to be the natural inference albeit the evidence is not conclusive. In other words, as far as we know, the majority of lichen photobionts are capable of existing in the free-living state, whether found in nature (even if only rarely) or cultured in the laboratory (even if only with difficulty and limited success).

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) reproduction. I take this not to be a truth of biology but of metaphysics.²⁸

Moreover, there would be something strange going on biologically were it to be that in the sexual case the fungus reproduces, not the lichen, whereas in the asexual case the lichen reproduces, not the fungus. It is far more economical, and less bizarre, to take the asexual case to be one of lichen *propagation* via fungal and photobiont reproduction. Many collectives, such as various kinds of bee or ant colony, propagate by spitting or budding. But if the components are themselves engaging in reproduction, via their own identifiable processes, it is both biologically obfuscatory and metaphysically quite dubious to say that the whole collective is itself reproducing. The very idea of reproduction itself is called into question.

Returning to form, the central idea is that only an organism has a substantial form *simpliciter*: organs and collectives have them only *secundum quid*, or in a manner of speaking. It would be useful to have distinguishing terminology here, so I will stipulate that an organism *has* or *possesses* a substantial form, a collective *contains* one or more substantial forms, and an organ – to use an unfortunate neologism – *obtains* a substantial form. An organism *has* or *possesses* a substantial form inasmuch as this is its unifying principle as an individual substance of its essential kind. The blue whale (*Balaenoptera musculus*) has precisely the substantial form in virtue of which it is a member of that biological species. A collective *contains* one or more substantial forms inasmuch as it consists, inter alia, of one or more individual organisms in some systemic combination.

²⁸ For more on lichen reproduction, see: Paulsrud (2001); Friedl and Büdel (2008); Sarma (2013): 351-2; Australian National Herbarium (2012).

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) Examples include ant colonies, bacterial colonies, forests, obligate colonies such as corals and facultative ones such as carpenter bees (*Xylocopa pubescens*).²⁹

The *obtaining* of a substantial form by an organ is a trickier concept to grasp, but it goes a long way towards showing how substantial form acts as a unifying principle. I now proceed to elaborate the concept of *obtaining*, which will clarify how, ontologically, an organ is to be distinguished from an organism.

3. Organs and organisms

An organ – a term I am, to reiterate using it relatively to denote any biologically identifiable part of an organism that subserves the whole – does not have its *own* substantial form; for if it did it would be a substance. But it is not a substance since substances are ontologically independent. Now there is an important

literature on ontological independence, but I have no space or need to enter into a technical discussion of its definition.³⁰ For present purposes it is enough to say that a substance has existence in itself and by virtue of itself as an ultimate distinct subject of being. This definition encompasses several notions. Substance has existence in itself in the sense that it is not in anything else, not a modification of, a part of, an aspect of, some other thing. It exists by virtue of itself since its continued existence does not require it to be a product or projection of something else. As a distinct and ultimate subject of being, it is the bearer of qualities but nothing bears it or is a subject of it.

²⁹ For carpenter bees' facultative sociality, see Dunn and Richards (2003).

³⁰ See Chisholm (1994); Lowe (1994); Fine (1995); Hoffman and Rosenkrantz (1997).

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An organ is clearly not encompassed by this concept of substance. It is a part that serves the whole, and cannot be constituted as an object with its own identity in a way that is metaphysically independent of that whole. To be more precise, we should say that something is not an organ unless either: (i) it is serving the whole; or (ii) is in some way able to carry out its function as if it were serving a whole, such as when a heart is kept warm, pumping and oxygenated outside the body; or (iii) is kept in a state whereby its powers of serving the whole are preserved, such as when a heart is kept on ice before transplant. The first condition corresponds to Aristotle's *second* actuality – the actual exercise of powers; the second to a *simulated* second actuality; the third to *first* actuality – having powers but not exercising them.³¹ I cannot see how first actuality could be simulated. In all three cases, the identity of the organ is still constituted by the function it performs with respect to the whole organism to which it belongs. As such, following Aristotle's famous homonymy principle,³² an object that fulfils none of the above three conditions is genuinely an organ, no matter how much it resembles one.

With this in view, what it means for the organ to *obtain* the substantial form of the whole is as follows. Although the organ does not have its own substantial form in any condition, when actually subserving an organism the organ is united to the whole *by* the substantial form. Here the organ is in its normal, natural state. It is thoroughly *permeated* by the substantial form in the sense that every part and property of the organ is co-opted to the service of the

³¹ For Aristotle on first and second actuality, see *De Anima* II.5, 417a21-35, Ross (1931).

³² *Metaphysics* Z:10, 1035b23 and elsewhere, Ross (1928).

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) whole (barring damage or disease). The organ has *no life of its own*: it is the

metaphysical slave of the whole, forming just one part, however important, of the organism's total organisation, which is dictated by the substantial form.

We still have to explain, though, what is going on when the organ is in condition (ii) or (iii) above, which we can call *simulation* and *dormancy* respectively.

Hoffman and Rosenkrantz think that both cases demonstrate the existence of 'organic living entities' that are neither organisms nor parts of organisms.³³ This seems to me wrong, for it misconstrues parthood by overemphasizing the

property of being *joined* to the whole. In fact Rosenkrantz, on his own account of whole organisms in suspended animation, allow that opponents of intermittent existence might plausibly construe suspended animation as involving the continued existence of the organism as constituted by the preservation of its

potentiality for metabolic activity in a sense weaker than what he calls

'capability'.³⁴ This looks just like the distinction between Aristotelian first

actuality ('second potentiality') and second actuality referred to above. If he

thinks it can apply to whole organisms, so he should also allow it for organs. Ad

hominem aside, the point is that just as an organism can retain its essential

powers in a state of dormancy or suspended animation, so too can an organ

retain its essential powers in a similar state although detached from the whole. It

is the retention of essential powers that is crucial, not the state of being joined.

This is what unites the dormancy case to the simulation case, the only difference

³³ Hoffman and Rosenkrantz (1999): 87, n.13.

³⁴ Rosenkrantz (2013): 95.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) being that in simulation the organ actually exercises some or all of its powers, albeit in a way that merely simulates subservience to a real organism.

Yet how is retention of power to be reconciled with the organ's essentially subservient nature? Why not count it as a substance in its own right, one that happens in the normal case to reside within another substance, namely a whole organism, but that also may not? Yet this is precisely to reject the organ's essentially subservient nature, not to reconcile it with retention of power. The organ is a dependent entity, its very identity defined by that of which it is an organ. Simulation cannot be understood independently of the genuine case, and there is no a priori reason to consider dormancy a privilege of substances. I claim that the most satisfying, perhaps the only plausible, explanation of retention of power must appeal to the organ's obtaining the substantial form of the whole. It does not have its *own* substantial form, but it does have many forms - accidental forms, as the scholastics put it. The organ is a discrete, identifiable, biologically significant portion of matter possessed of many accidents, the essential ones of which - i.e., the *propria* or properties in the strict sense of which - have a certain *organisation* by which the organ is defined as the kind of organ it is for the kind of species to whose members it normally belongs. What unifies those accidents is the very substantial form of the organism to which it is subservient. But given that the substantial form is *not* present in the organ, the organ must somehow *derive* or *borrow* the unifying power of the substantial form in one of the following ways.

(i) The organ actually *belongs* to its connatural organism, this being the normal case. We might include as a deviant sub-type of (i) the case where an

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organ is grown inside the organism's body using the organism's own tissue, such as when a person's nose is rebuilt and grown on their forehead.³⁵ One might

legitimately wonder, though, whether such an entity fails to satisfy any of the

three necessary conditions for being an organ stated earlier, and hence does not

merit being called a nose at all until it is moved to its proper place. (i) The organ

once *belonged* to its connatural organism at some prior time. An organ removed

from an organism and still satisfying the homogeneity or simulation condition

would be a typical case of (ii). (iii) The organ has come into existence via a causal

process that *began* with a distinct organ satisfying (i) or (ii). Case (iii) covers organs

synthesised from other organs (such as cells – recall my stipulative use of the

term 'organ') belonging or having belonged to a connatural organism. An

example of (iii) would be currently typical organ synthesis, where the organ is

grown outside the organism's body using detached cells from the latter, say a

liver cultured in a lab from the organism's stem cells. In case (iii) the organ still

obtains its unity from the organism, but only indirectly via some other organ that

obtains it directly.

Now to many this way of explaining the difference between an organ and

an organism will seem to partake of the kind of metaphysics that gives

metaphysics a bad name. This is unfortunate and short-sighted. It is unfortunate

because it bespeaks a refusal to engage seriously with hylemorphic metaphysics ,

free of the anti-scholastic prejudices of a bygone age. It is short-sighted because it

reflects a preoccupation with surface illusions rather than the depth of the

³⁵ See <http://www.rhinoplastyinseattle.com/blog/updates-and-analysis/post/can-a-plastic-surgeon-really-grow-a-nose-on-a-forehead>.

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position. On the surface, the idea that an organ might ‘abtain’ a substantial form looks like ‘spooky metaphysics’ involving ‘occult qualities’ akin to the ‘dormitive virtues’ mocked by Molière. Yet one also might wonder how a universal can be

wholly present wherever and whenever it is instantiated, how any parts can

compose a whole, how real causal influence can be transmitted from one thing to

another; and the list goes on. All such things have been wondered about, and

many more. If the former seems insuperable, one adopts the appropriate

position, whether nominalism, or compositional nihilism, or regularity theory,

and so on. Quite why the scholastic framework of any of its key posits should be

treated as of special concern because of its particularly ‘spooky’ nature is itself a

matter for wonder.³⁶

The real focus needs to be on whether a given posit can explain

something that needs to be explained, in a way that is not ad hoc or incoherent. I

don’t see either criticism applying here, but that is where the opponent needs to

concentrate their energy. Substantial form as unifier is clearly a metaphysical

posit: I claim that we must acknowledge its existence if we are to explain the

unity of the organism and its different metaphysical status from the organ and

from the collective. It would be quite mistaken to think of form as a kind of

suprasensible metaphysical ‘glue’ that holds the organism together, something

we need special scholastic spectacles to ‘see’. We do not see substantial form and

we do not ‘see’ it either. On my position, we know that it must exist or we have

no explanation of unity. But to postulate form as no more than *that which unifies*

³⁶ In Oderberg (2007) I give an extensive defence of the same viewpoint in the context of biology (and some physics).

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) would be ad hoc: claiming simply that we need a unifier to explain unity borders

on the tautologous, but this is something no scholastic has ever said. Substantial form not only unifies, it *determines* the identity of a substance, it *actualises* matter, it is a principle of identity and stability in a substance, and more. In other words, it is a key element in an entire metaphysical picture. Needless to say devotees of Quinean ‘desert landscapes’ will have no time for form, but they will have no time for materials, substances, powers, and much else besides. To single out form as having a special mystery about it is the opposite of special pleading, what we might call special prosecution.

Having defended, by appeal to form, the distinction between organs and organisms, I move now to the other part of the tripartite distinction – between organisms and collectives. Here the issues seem to me less subtle, though there are still important empirical challenges to the sharpness of the distinction. Once again, the appeal to form will show that the distinction is both plausible and clear cut.

4. Organisms and collectives

Although collectives come in many kinds, as noted above, what they have in common – at least in biology – is their consisting of one or more organisms in some sort of systemic relation (whether including or excluding non-substances such as an ecological niche or organismically-produced tools or habitats). This, I argued earlier, is how we should understand lichens.

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Yet the idea of a ‘superorganism’ has found its way into the literature,

and as Michael Ghiselin notes it has become a recent fad.³⁷ He himself has done much to counter some of the excesses found in employment of the concept.³⁸

Unreflective comparisons between, say, an organism’s eyes and the combined eyes of an insect colony’s members, or between an organism’s skin and a colony’s nest, do not withstand scrutiny.³⁹ The argument that collectives must be

organisms because natural selection works on organisms as well as on collectives is an elementary fallacy.⁴⁰ As far as the historical debate goes, I am on the side of

those who regard the idea that collectives are literally a kind of organism as ‘bad metaphysics’⁴¹ or as consisting of ‘poetic metaphors in scientific guise’.⁴²

That said, for my purposes the main idea to keep in focus is that collectives *contain* substantial forms but do not *possess* them. It is not that we can appeal to substantial forms to *demonstrate* that there is a difference between organisms and collectives, but that given the distinction, only forms can explain it. Pointing to a list of disanalogies will not do the job: superorganism theory has long had a ‘magnetic appeal’⁴³ precisely because of the many *analogies* that can be found between the two kinds, in terms of such phenomena as selection (at individual and group level) and division of labour. Even if the disanalogies overwhelmed the analogies, we would still not have arrived at an *explanation*. For, we should ask, why the disanalogies? Disanalogies point to a significant

³⁷ Ghiselin (2011).

³⁸ Such as in Hölldobler and Wilson (2009).

³⁹ Ghiselin (2011): 163.

⁴⁰ I agree with Ghiselin (2011): 153 that this is the ‘basic thrust’ of the complex argument of Wilson and Sober (1989).

⁴¹ Ghiselin (2011): 153.

⁴² Wilson and Sober (1989): 338, speaking of many versions of the superorganism theory.

⁴³ *Ibid*: 338.

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metaphysically: organisms are unified by a single substantial form that constitutes them as an individual substance. An ant colony's behaviour, for all its beguiling resemblances to multicellular co-operation in an organism, does not reflect the existence of a unifying form, since the colony *contains* substantial forms already – those found in the individual ants. But if the ants have their own substantial forms, this *excludes* a further, superorganismal form. Why? Couldn't one object that the superorganismal form can be superimposed on the individual ant forms, such that the ants each have their own form and the *plurality itself* has a colonial substantial form?

The objection fails. For assume the existence of the individual form and the superorganismal, colonial substantial form. The colony would itself be a substance and the ants would be its parts. But the parts of an organism – the organs, as I am calling them – are, as set out earlier, essentially subservient, ontologically dependent entities whose very *identity* is defined by the organism of which they are parts. Putting it loosely, there is no such thing as a *heart simpliciter*, only the heart of a lion, of a man, or of a reptile. Organs are defined by the organisms they subserve. So the ants would be defined by the superorganism they subserve. But they cannot be, since – ex hypothesi – they already have their own substantial forms as ants; and they are defined by these. They certainly don't have an *extra* substantial form, namely the colonial form, since this would absurdly imply that each ant was a colony. The colonial form is supposed to be the form of the plurality of ants yet also function so as to *define* each individual ant as an organ of the colony. In other words, the individual ant

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) is supposed both to possess its own substantial form *and* obtain another

substantial form. It is, then, supposed to be both ontologically independent and ontologically dependent; and this is a contradiction.

So, on the substantial forms view, we either have to deny that the ant is a substance or deny that the colony is a substance. It is clear what we must do.

Denying that the ant is an individual substance is a non-starter, unless we deny that there are any individual substances at all – not a position I am questioning here.

If anything is an individual substance an ant is, since it displays all the hallmarks of ontological independence. *What* it is, its *quiddity*, is in no way defined by reference to colonies in general or any colony in particular. An account of how ants *behave*, of course, must make reference to necessary colony formation (albeit, note, not for facultatively colonial organisms⁴⁴), but this is not

the same as defining an ant as a kind of organism with its distinctive and independent physiology, anatomy, developmental processes, and so on – all of which constitute its immanent causal behaviour, and none of which require defining it in terms of its colonial behaviour, whatever the causal connections between the two.

We are faced, then, with the obvious and only remaining move, which is to deny that the colony is a substance. It is ontologically dependent inasmuch as the kind of thing it is depends, metaphysically, on the kinds of organism that belong to it, each having its own independent physiology, anatomy,

⁴⁴ Should the superorganism theorist say that facultative colonies are not superorganisms whereas obligate colonies are? Why? After all, the colonial behaviour is the same, yet in facultative colonies the organisms are quite liable to disperse and live their own *substantial* lives. To maintain in the face of this that the obligate colonies are still superorganisms looks like a manoeuvre with no independent motivation.

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developmental processes, and so on. This is quite different from the substantial members of the aggregate, whose identities as the kinds of thing they are do not depend metaphysically on their membership of the aggregate. This is so even if it is essential to a given substance to *be* a member of an aggregate. Now it is not for the metaphysician to say what aggregates there are any more than what substances there are: this is for the biologist, and hence is a wholly a posteriori matter. What the metaphysician can say, however, is that we should expect there to be a sharp division between substances and aggregates because they are distinct metaphysical categories; so-called borderline cases should reflect our investigative limitations rather than a blurriness of the categories.

We see this sharpness, I submit, in the supposed borderline cases of biofilms and slime moulds. A biofilm, at its most general, is a colony of bacteria adhering to a surface and often to each other, producing an extracellular polymeric substance (EPS) that acts as a matrix holding the colony together, protecting it against predators and toxins, helping to digest and pass on nutrients to the colonists, and facilitating communication between them.⁴⁵ Slime moulds, on the other hand, are a paraphyletic class of protists that form masses of protoplasm containing one or more nuclei and reproduce by means of spores emanating from sporangia, much like plants and many fungi.⁴⁶ There is much that we do not know about biofilms and slime moulds, making interpretation of their natures a difficult matter. One might wonder, however, whether they give credence to the idea of a superorganism constituted by other organisms. There is

⁴⁵ For the details, see Romeo (ed.) (2008)

⁴⁶ For more on slime moulds, see Stephenson and Stempen (1994) [plasmodial] and Bonner (2009) [cellular].

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) far too much to be said about slime moulds and biofilms to be anything other than cursory here, but a few remarks are in order.

It is difficult to see biofilms as anything but extraordinarily close-knit colonies of individual organisms. All biologists, as far as I can tell, refer to them as such⁴⁷ or as ‘communities’⁴⁸ with their nomenclature. Virtually all bacteria can form biofilms,⁴⁹ and yet all live quite happily in the planktonic state unless either stressed by lack of nutrients or the presence of toxins, or attracted by a suitable surface. The bacteria within the biofilm maintain their cellular integrity. The biofilm forms precisely through the colonization of a surface by free-living bacteria. It grows by the reproduction of the bacteria themselves and the addition of new bacteria. The biofilm does not itself reproduce, it *disperses* by the detachment of the bacteria from the colony, their movement to a new location, and reattachment to a new substrate. The bacteria themselves produce enzymes that degrade the EPS or the substrate. Some biofilms undergo ‘seeding dispersal’, whereby hollow cavities in the matrix fill with planktonic bacteria that then breach the colony wall and emerge to form new colonies.⁵⁰

Nevertheless, Ereshefsky and Pedroso argue that biofilms are ‘individuals and not merely communities’, by which they mean individual organisms.⁵¹ Without going into the detail of their own account, note for example their contrast between biofilms and ‘symbiotic complexes, such as the symbiotic relation between ants and acacias...Bacteria in a biofilm exchange genetic

⁴⁷ E.g. Romeo (ed.) (2008) *passim*, Karatan and Watnick (2009).

⁴⁸ Kaplan (2010).

⁴⁹ Karatan and Watnick (2009).

⁵⁰ See Kaplan (2010) for the details.

⁵¹ Ereshefsky and Pedroso (2016).

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) content; ant/acacia symbionts do not.⁵² This lateral gene transfer is taken by

them to be one of many markers of individuality since it facilitates

communication between the bacteria and hence development of the colony,

especially the EPS as a boundary between the colony and its environment. Yet

although they make the claim with a lack of LGT in ant/acacia symbiosis they

also refer to a supposed lack of LGT in aphid/bacteria symbionts. In support of the

latter, they cite a paper in which the authors find no evidence of LGT between

the pea aphid (*Acyrtosiphon pisum*) and its obligate mutualist

Gammaproteobacteria (*Buchnera aphidicola*). Yet these same authors *do* explicitly

suggest that there is evidence of functional gene transfer to *A. pisum* from *prior*

rickettsial endosymbionts, given that Rickettsiales symbionts are found in some

aphids. (Albeit the evidence is consistent also with transfer by bacterial infection

rather than endosymbiosis.)⁵³ So the claim that biofilms are ‘better candidates for

biological individuals than aphid-symbiont combinations’⁵⁴ in virtue of lack of

LGT is not warranted by the evidence.

Again, getting less technical, Ereshefsky and Pedroso are impressed by the way the biofilm EPS defends the bacteria, digests nutrients and passes them on to the bacteria, and facilitates communication between them. Yet a bee hive is not far away from this: it protects the bees, facilitates communication, and although it doesn’t digest nutrients it stores them (which is just as important as digestion). I am not denying the EPS is perhaps more complex than a bee hive (how do we measure complexity?), but what I am suggesting is that being

⁵² Ibid: 109.

⁵³ Nikoh et al. (2010).

⁵⁴ Ereshefsky and Pedroso (2016): 108.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) impressed by this or that marker or group of markers can cause one to lose the

wood for the trees. A hylemorphist will look at all the characteristics of the entity under consideration, forming a holistic judgment as to whether the unity provided by substantial form is present. Anything less is bound to risk being skewed or arbitrary.

The same, I submit, applies to slime moulds. In fact they come in two quite different kinds, the plasmodial or 'true' slime moulds and the cellular slime moulds. The cellular slime moulds have been described by the world's expert on them as 'no more than a bag of amoebae enclosed in a thin slime sheath', albeit capable of the most remarkable behaviour 'equal to those of animals who possess muscles and nerves with ganglia, that is, simple brains'.⁵⁵ The amoebae in a cellular slime mould retain their cell membranes. They feed and reproduce

normally as individual amoebae as long as food is plentiful. When they begin to starve, they aggregate into pseudoplasmodia that produce fruiting bodies inside which are spores that germinate as free-living amoeba that drift to other locations and will remain free-living as long as conditions are favourable. Cellular slime moulds, then, do not strictly reproduce: they have a fungus-like property of sporulation that produces yet more free-living amoebae, but fungal spores are juvenile fungal parts that germinate into the vegetative mycelium or fungal body.

For all their amazing behaviour, cellular slime moulds are rightly designated as not true slime moulds. They are, in my view, tightly integrated colonies, much like biofilms. Their motility, chemotaxis, direction-finding

⁵⁵ Bonner (2009, Kindle edition): ch.5, 'Behavior of Multicellular Slugs'.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) behaviour, and the like, can all be found in colonies and swarms constituted by birds, bees, fish and other animals.

Plasmodial slime moulds, the *true* slime moulds (*Myxomycetes*), do by contrast appear to be genuine individual organisms. The constituent amoebae do not retain their individual membranes but instead pass into a single-celled, multinucleate plasmodium. Reproduction is also typically by sporulation, but here the spores are either haploid gametes that later fuse with suitable gamete partners to form the juvenile plasmodium via a zygote, or (less commonly) the diploid zygotes themselves. The zygotes grow into plasmodia through repeated nuclear (but not cellular) division. The entire life cycle seems to instantiate the growth and reproductive pattern of an individual organism, with numerous entities within the single-celled plasmodium that correspond to potential free-living amoebae.

There is much more to say, and much more to be known, about the various kinds of entity that might challenge the idea of a sharp boundary between organisms, organs, and collectives. So far I have made out a positive case for the distinction's plausibility, utilising substantial form. I want, however, to return to more foundational issues by means of a negative argument. If we grant that the unity of the organism is what marks it out from the organ on one side and the collective on the other, why must we go so far as to posit substantial form? Mightn't a lesser principle of unity be sufficient for the task? If some of the leading candidates for such a principle are not successful we will have further, indirect reason at least to think that only a principle as strong as substantial form can do the required work.

4. Lesser unity principles will not work

An objection to substantial form that no doubt arises in many minds is that they seem redundant. Why couldn't I say everything I have about organs and collectives, contrasting them with organisms, without even mentioning substantial forms? Why not simply talk about substances and non-substances? Aren't substantial forms an ontological spare wheel. In reply, as I have already argued, there must be a principle of unity for substances – that which unifies otherwise disparate elements into a whole. If a principle is to have ontological reality, it must be either a substantial form or something else. So to underscore the reality of form we should consider alternative unity principles to see if they can do the required work. I want to look briefly at two alternatives, and will argue that both are found wanting. The first is that of Hoffman and Rosenkrantz,⁵⁶ who have a complex account of organismic unity in terms of functional organization, one which also requires the existence of a 'master part' that controls the processes of all the other parts. Details of their specific account of functional organisation aside, their basic, quite Aristotelian idea is that organisms are functionally united in such a way that their parts subserve or contribute to the typical life processes of growth, metabolism, development, and/or reproduction. As such, however, there is no distinction between organs, organisms, and collectives, given especially that they do not propose these basic life processes to be necessary and sufficient for any living thing. Hence organisms cannot be singled out by some privileged set of life processes.

⁵⁶ Hoffman and Rosenkrantz (1997), (1999); Rosenkrantz (2013).

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What does single out organisms, according to Hoffman and Rosenkrantz, is that they must have a ‘master part’ that controls and regulates their processes. They, like I do, take it as a datum that organisms are not proper parts of other living things whereas organs are parts of organisms, but they seek to explain this terms of the organism’s processes’ being controlled by its master part, which excludes the organism’s being functionally subordinate to another living entity. A part of an organism, such as a liver cell, is functionally subordinate to the organism and its life processes are controlled by the organism’s master part, either directly or indirectly. Hence the nucleus of the liver cell is not its master part.

The implied argument for the master part thesis is precisely that anything less won’t make the right distinctions: mere functional unity, however complex, is too coarse grained to do the work they require.⁵⁷ Although they don’t put it this way, it would be a miracle were there to be a special kind of functional unity that applied to all and only organisms. The explicit argument, however, is one by induction from observed cases of paradigmatic organisms. Eukaryotic single-celled organisms seem to have the nucleus as a ‘highly centralised regulatory system’ and prokaryotes have the system of their DNA and mRNA molecules. If a proteinoid microsphere were an organism, its protein chains would constitute its master part.⁵⁸ The (central) nervous system of an ‘adult vertebrate’ is its master part, as are the roots, stem and leaves of a ‘typical mature

⁵⁷ As Clarke (2010): 316 perceptively puts it in the context of ‘functional integration’ accounts of individuality: ‘The trouble is that pretty much everything is organized, in some sense. ... [T]here are many respects and degrees to which functional integration is evident in systems we clearly don’t want to describe as biological individuals.’

⁵⁸ Hoffman and Rosenkrantz (1997): 126-7.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) plant',⁵⁹ as well as the nerve net of a jellyfish, the nucleoid of a bacterium, and the 'nuclear system' of a plasmodial slime mould.⁶⁰

This approach seems to me wrongheaded, for it leads to Rosenkrantz's view that the master part of a plant is all of the plant minus its sap, since the sap appears to be the only part that does not control the plant's life functions. He calls the plant minus its sap a 'decentralized' master part without showing how to distinguish between centralized and decentralized master parts. But I think this is to abuse the term 'part', since for biological purposes the plant minus its sap is no more a proper part of the plant than a Tobbles minus his tail. Moreover, before a vertebrate embryo gastrulates⁶¹ there is nothing resembling a nervous system to serve as master part, yet there is still an organism. Furthermore, what on their master-part theory of organisms is to be said about non-vascular plants such as algae and bryophytes, all of which lack sap? Are we to say that they are their own master parts? After all, if we want to justify the idea that, say, the 'nuclear system' of a plasmodial slime mould is a master part simply because it is a proper part according to extensional mereology (not that Rosenkrantz and Hoffman say that, but it is an obvious move), why not hold that non-vascular plants are their own improper master parts? All in all, it seems that the master-part theory is unacceptably hostage to empirical fortune when it comes to defining the organism.

⁵⁹ Hoffman and Rosenkrantz (1999): 96.

⁶⁰ Rosenkrantz (2013): 97-8. Gratifyingly, they come to the same view as I do about slime moulds, namely that plasmodial slime moulds are organisms but cellular slime moulds are 'a collective of "social" unicellular organisms'.

⁶¹ Gastrulation is the reorganisation of the hollow sphere of cells (blastula) to a three-layered gastrula. In human embryos this occurs at around sixteen days.

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The other unity principle I briefly want to mention is *structure*, as

exemplified in the work of Kathrin Koslicki.⁶² She holds that we need something *like* substantial form to act as a scientifically respectable analogue of a metaphysically discreditable idea. So she proposes structure – a perfectly natural and understandable thought. Moreover, instead of the prime matter that accompanies substantial form on the hylemorphic theory, she proposed *content* as that on which structure operates to produce a structured whole. I have criticized her view elsewhere,⁶³ primarily on the ground of its being subject to what I call the ‘content-fixing problem’, which concerns the impossibility in principle of choosing any particular content as *the* content on which structure is imposed to constitute a substance. What, for instance, is *the* content on which structure operates to constitute a horse? For different contents, whether it be flesh and bones, cells, atoms, quarks, there will be a different structure, and yet there is no reason in principle to choose one over the other.

There is, however, another problem for structure-based hylemorphism, which I call the ‘qualitative problem’. Related to the content-fixing problem, and in a way more fundamental and also explanatory of why the first problem arises, the qualitative problem is that most if not all the candidate contents for a structural account come *too late* in the metaphysical analysis to be viable partners for any given structure. Certainly, if we restrict ourselves to *biological* contents, whether flesh and bones, organs, biological systems, genes, or DNA itself, they are all *already* defined by the organism to which they belong *before* structure even

⁶² Koslicki (2008).

⁶³ Oderberg (2013).

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) comes on the scene to organise them into a substantial whole. No structure

imposed on, say, equine organs can explain any unity beyond the unity of those specific organs. The unity *within* each organ is left unexplained: and yet each organ is already defined as an equine organ *before*⁶⁴ the proposed equine structure does any work. The unity problem, however, is a problem concerning the *whole* substance, including *all* of its biological parts: in virtue of what are they all united into an organic substantial whole? Structural hylemorphism cannot answer this question.

5. Conclusion

For traditional hylemorphism, only substantial form penetrates, in its unifying power, to every element of the organic substantial whole. It leaves no aspect of unity in need of further explanation. This is why the traditional hylemorphist holds, for example, that there is as much of the substantial form of humanity in my little finger as there is in me as an individual human being. The difference, however, is that as an organ my little finger *obtains* my substantial form, whereas I *possess* it. The unifying power of the form nevertheless descends to my finger as much as it does to any other part of me and as much as it determines me, as a whole, as the kind of thing that I am.

To reiterate, substantial form is a metaphysical posit, not the subject of an empirical hypothesis. It is not ‘something we know not what’ that is vacuously postulated to explain unity. It is what we *must* have if unity is to be explained. If this is hard for biologists and/or philosophers to swallow, it is because both have

⁶⁴ In the metaphysical sense of ‘before’, of course, not the temporal.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) abandoned the quest for a genuine *philosophy of nature* that combines scientifically-

informed metaphysics with metaphysically-informed science. An adequate

philosophy of nature will resist the wild flights of fancy found in superorganism

theory, which undermines organismic unity from both ends – blurring the

boundaries both between organism and environment, and between organisms and

their parts. If D'Arcy Wentworth Thompson was right that the unity of the

organism's fundamental truth requiring explanation, then only substantial

form can claim to be the 'great unifier' that does the work that needs to be done.

With this, I can cite the agreement of another Thompson – William R. Thompson

(1887-1972), one-time research scientist at the Imperial Institute of Entomology

and Fellow of the Royal Society – who said:

In the unification of a multiplicity, with reference to a specific end, the

organism resembles a machine; but it is not, like the machine, unified by

the participated activity of a separate mover. It moves itself, and what we

call "physico- chemical properties" or "cytological activities" are simply

the living unit envisaged in abstracto at various levels. They are not true

nonliving or nonorganismal agglomerates unified and moved by

something higher. There is nothing to move them but the thing they

constitute; in other words, nothing to move them but themselves.⁶⁵

By this, Thompson means that the unity of an organism's parts does not derive

from anything external to the organism. The organism moves its parts, but only

because it moves itself. And it moves itself because of its unity as a single

⁶⁵ Thompson (1947): 154.

© David S. Oderberg. Not for citation. Not for circulation. Draft only. No reproduction in whole or in part without permission. Forthcoming in Simpson, Koons, and Teh (eds) *Neo-Aristotelian Perspectives on Contemporary Science* (Routledge) substance. I happily side with both Thompsons in regarding *form* as the only thing that can make this possible.⁶⁶

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⁶⁶ I am grateful for comments and feedback on a version of this paper to colleagues and graduate students at the University of Reading, and to participants in the conference on Biological Identity organised by Anne Sophie Meincke and John Dupré at Senate House, London, in June 2016.

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