

FOUR-EIGHTHS HEPHAISTOS: ARTIFACTS AND LIVING THINGS IN ARISTOTLE

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I. INTRODUCTION

There is considerable dispute in the literature as to how much, in Aristotle's universe, artifacts and living things really have in common.¹ To what extent is the relation between form and matter in living things comparable to the relation between form and matter in artifacts? Aristotle no doubt employs artifact-analogies rather frequently in describing the workings of living things. But where does the usefulness of these analogies reach its limits? Spheres, to use one of Aristotle's favorite examples, can be made of bronze, wood, stone, or any other kind of matter, as long as it is suitable for the purpose at hand. Is the same true for plants and animals?

The view that artifacts are crucially different from living things has a long tradition. For instance, when Alexander of Aphrodisias considers the relation between form and matter in *De Anima Mantissa*, he draws a sharp distinction between natural forms (the forms of living things) and artifact-forms. With the help of Aristotle's distinction between being-in-a-subject and being-said-of-a-subject from the *Categories*, Alexander contrasts living things and artifacts in the following way:

That's why natural forms could not be in matter as in a subject. For a form which comes to be through art is in a subject which is already a *tode ti* and which already has a form, as the craftsman imposes and bestows the relevant form upon [the matter]. But natural forms can in no way be said to be in matter in this way. For matter by itself is not a *tode ti* and a subject in actuality.²

Alexander suggests in this passage that artifact-forms are in matter as in a subject, while natural forms are in matter in some completely

different way. This puts the form of a sphere, for example, on much the same level as the sphere's color, weight, texture, and so forth. The form of a living thing, on the other hand, is supposed to have a very different status: the form of a living thing, to put it in contemporary terms, is not supposed to be just another one of its properties.³

This long tradition has recently been called into question by the so-called functionalist interpretation of Aristotle's "philosophy of mind," initially proposed by Hilary Putnam and Martha Nussbaum.⁴ It is central to the Putnam/Nussbaum interpretation of Aristotle that the relation between form and matter, for living things as well as artifacts, be spelled out in rather liberal terms. The relation between matter and form, on their view, is merely *contingent*: two "systems" with the same functional properties can have various material makeups.⁵ This thesis is commonly referred to as "*Multiple Realizability*."

The functionalist interpretation of Aristotle extends Aristotle's artifact-analogies beyond their limits. There are crucial differences between artifacts and living things, particularly in how matter and form are related. According to the reading of Aristotle presented here, every living thing must be made of a *particular* kind of matter. The particular kind of matter of which a living thing is made is the *only* kind of matter suitable to fulfilling its characteristic functions. Human beings, for instance, cannot be made of anything other than flesh and bones (and whatever else goes into the making of a human being). More strongly, the reason why, in Aristotle's view, there is a particular kind of matter in each case is not simply because he lacked the necessary resources. Rather, he explicitly decided against allowing any degree of variation in the material composition of living things. In short, Multiple Realizability does not apply to living things.

The case of artifacts, on the other hand, is very different. Here, matter and form are related much more loosely. Whether spheres are made of wood or bronze does not make any difference to their being a sphere. Even in the case of things that are designed to perform a more narrowly defined function, e.g. axes or saws, the particular kind of matter of which they are made is relatively unimportant, as long as it is suitable for the task at hand. For example, the axe or saw must be made of something that is hard enough for it to manipulate wood.⁶

This suggests that we must be careful in how we evaluate Aristotle's artifact-analogies. They are no doubt quite useful for some of his purposes, among them most prominently the following

two. First, they illustrate nicely why the question of the *unity* of form and matter should not arise in our minds. In the case of the bronze sphere, we can distinguish between the sphere's form (sphericity?) and its matter (bronze), but there is no question that the individual bronze sphere is still *one* thing. There is no danger of its falling apart, as it were, into its formal and material aspects.

Secondly, Aristotle's artifact-analogies are useful in the context of *explanation*. In the case of artifacts, it is typically easy to make out the four kinds of causes Aristotle wants us to distinguish. The house is built *by* the craftsman (efficient cause); *for the purposes* of shelter (final cause); it is *made of* bricks and wood (material cause); and its *form* is the form in the mind of the craftsman (formal cause).

Despite their usefulness, however, Aristotle's artifact-analogies can also be misleading. Living things and artifacts may be comparable when it comes to explanation and the unity of form and matter. But the relation between form and matter is still crucially different in the two cases. Aristotle's artifact-analogies tell us very little about how form and matter are related in living things.

Now, the denial of Multiple Realizability for living things can be read in at least two ways. First, there is what will be called the "*Weaker Thesis*":

WEAKER THESIS:

As a matter of contingent fact, living things of kind K can only be made of a particular kind of matter, M.

The Weaker Thesis suggests a kind of *contingent uniqueness* of material composition. For example, the world might be such that, as a matter of contingent fact, human beings are only to be found in flesh and bones. However, the Weaker Thesis, as such, is not incompatible with a functionalist reading of Aristotle, though it would lead to a funny kind of functionalism. The Weaker Thesis does not exclude the possibility that what it means to be a human being can be specified in purely functional terms; that is, without even mentioning material composition. In other words, one might agree to the Weaker Thesis and still hold that "X satisfies certain functional properties characteristic of human beings" is *sufficient* for "X is a human being." It just turns out, for whatever reasons, that there is only one way in which these functional properties can be realized.

Second, there is what may be called the "*Stronger Thesis*":

STRONGER THESIS:

It is *essential* to living things of kind K that Ks can only be made of a particular kind of matter, M.⁷

The Stronger Thesis suggests a kind of *non-contingent uniqueness* of material composition. If human beings are only to be found in flesh and bones, then this is because being realized in flesh and bones is part of what it means to be human. The Stronger Thesis is clearly incompatible with a functionalist reading of Aristotle. For it asserts that "X satisfies certain functional properties characteristic of human beings" is *not* sufficient for "X is a human being." Something more concerning X's material composition would need to be added.

Although Aristotle held the Stronger Thesis, the aim of this paper will be to provide arguments for the Weaker Thesis.⁸ This more modest project should be of some interest. For what is the point of insisting that function is all that matters, if Aristotle's world is one in which living things are *in fact* only ever realized in one particular kind of matter? This seems to be a funny kind of functionalism.

Section II of this paper presents the relation between matter and form in living things as necessary, in the sense specifically of *hypothetical* necessity. How the notion of hypothetical necessity applies to the material constitution of living things is illustrated by means of a few examples from the biological works, in particular from *Parts of Animals*. We shall see that lips and tongues, for instance, require a particular kind of flesh — the softest flesh available — in order to perform their characteristic functions. Section III goes on to argue that whatever flesh is best suited to the task at hand will have to be made of a particular ratio of elements. There cannot be two types of flesh that are functionally equivalent but materially distinct: any difference in material makeup will entail a difference in functional characteristics. But, then, by hypothetical necessity, one of the two types of flesh will be better suited to the task at hand. This is enough to support the Weaker Thesis: all natural forms require a particular kind of matter; and they are related to it via hypothetical necessity.

II. HYPOTHETICAL NECESSITY

What does Aristotle mean by saying, as he frequently does, that a given form or composite requires "*such-and-such materials*" or "*matter of such-and-such a kind*"? Take *DA* II.2, for instance, a

passage in which Aristotle criticizes his predecessors for failing to specify the *kind* of body in which a soul can be found:

For [the soul] is not a body, but something which belongs to a body, and for this reason exists in a body, and in a body of *such-and-such a kind* [en sōmati toioutō]. Not as our predecessors supposed, when they fitted it to a body without any further determination of what body and of what kind, although it is clear that one chance thing does not receive another. In our way it happens just as reason demands. For the actuality of each thing comes about in that which is already such potentially and in its *appropriate matter* [tē oikeia hylē].⁹

If the notion of "proper (appropriate) matter" or "matter of such-and-such a kind" is to exclude Multiple Realizability, it must be interpreted in a fairly restricted way. That is, when human beings are said to be made of flesh and bones (where flesh and bones are the proper matter for the human soul), Aristotle must be taken as saying that *there is no possible other matter* of which human beings can be made.

Aristotle often pictures the body as an instrument — on analogy with the artifact-model — whose material constitution seems to be restricted solely by its ability to perform certain characteristic functions. It is passages of this sort that seem to point in a direction that is much more sympathetic to a functionalist reading. What must thus be shown is that only the *particular* kind of matter of which a given living thing is made, and no other kind, will be able to perform its characteristic tasks. That way, the instrument-metaphor can be made sense of without drifting too far into the realm of artifacts.

Matter, in living things, is most naturally understood as being *necessarily* related to form, where the notion of necessity involved is specifically that of "*hypothetical necessity*" [anagkē ex hypotheseōs].¹⁰ To illustrate, consider the following passage from *Parts of Animals*, I.1:

The *absolutely necessary* is present in what is eternal, but it is the *hypothetically necessary* that is present in everything that comes to be, as it is in the artefacts such as a house and anything else of that sort. It is necessary that such-and-such matter be present if there is to be a house or some other end; and first this thing must come to be and be moved, then this, and so on successively as far as the end and that for the sake of which each thing comes to be and is. It is the same with things that come to be naturally.¹¹

Something is hypothetically necessary if it is required for the achievement of a certain outcome, where that outcome at the same

time represents the fulfillment of some kind of goal. The kinds of outcomes Aristotle has in mind are (i) the *existence* or *coming-to-be* of a given substance; and (ii) the performance of certain *functions* that are somehow characteristic of the substance in question.¹² For example, the coming-to-be or existence of a house hypothetically necessitates bricks and wood. An axe or saw hypothetically necessitates certain hard materials, e.g. iron or bronze, which will enable it to perform its characteristic functions, i.e. to split and saw wood. A living organism hypothetically necessitates a body of a certain specific kind.

One might argue that the two different usages of hypothetical necessity really only mark a difference in emphasis, though an important one. We could certainly imagine an axe-like entity which comes-to-be or exists without being made of hard stuff. The one characteristic with respect to which this entity would then *differ* from an axe is the axe's woodcutting capabilities. Yet the ability to cut wood is so much part of what it is to be an axe that we (along with Aristotle) most certainly would not want to call this axe-like entity an axe, except in an extended use of the term (viz. when we apply the term "axe" to toy-axes that are made of plastic or wood). The question of existence or coming-into-being and that of performing certain functions are thus inseparable: when we ask what is required for a given substance to be what it is or to come-into-being, we cannot neglect its characteristic tasks.

Hypothetical necessity is a relative notion. If something Φ is "merely" hypothetically necessary (as opposed to necessary, in the absolute sense), then we cannot call Φ necessary *simpliciter*. Instead, we can only say " Φ is necessary *relative to some outcome* Ψ ." We might put this by saying that Φ is *necessitated by outcome* Ψ . What is necessary is the whole conditional: if Ψ , then Φ . For example, it is necessary that if John is to be healthy he must take daily walks. But for John to take daily walks is not necessary *simpliciter*. It is only necessitated by the desired outcome of John's being healthy.

Having briefly considered the concept of hypothetical necessity in general, let me now turn to its application to the specific case of body and soul. Consider the following illustration from *PA* I.1:

For just as there is a necessity that the axe be hard, since one must cut with it, and, if hard, that it be of bronze or iron, so too since the body is an instrument (for each of its parts is for the sake of something, and so is the body as a whole), therefore there is a necessity that it be *such* a thing and made of *such* things if that end is to be.¹³

At first sight, Aristotle might be taken as suggesting that there is room for different kinds of matter even in the case of the body. Like the axe, the body is after all just an instrument, hypothetically necessitated by that for the sake of which it exists. And what, so the functionalist might ask, is so absurd about supposing that some other suitable kind of matter could take the place of flesh, bones, and the like? In fact, Putnam & Nussbaum, in "Changing Aristotle's Mind," endorse a position very much like this:

We hold that while embodiment in some sort of suitable matter is essential to animals and their life-activities, the particular material realization is contingent. . . . For Aristotle, the organic parts of animals — the heart, the eye, the hand, etc. — are *functionally defined*: the heart is whatever performs such-and-such functions in the animal. . . .¹⁴

Upon consulting *On Generation and Corruption* and the biological works, however, one cannot fail to recognize how inherently un-Aristotelian this view is. Consider the following two examples from *Parts of Animals*.

With respect to tongues and lips, for instance, Aristotle informs us in *PA* II.16 that, in order to satisfy certain conditions, human tongues and lips *must* be made, not only of flesh, but of *soft* flesh.¹⁵ The conditions that are to be satisfied contain a whole chain of hypothetical necessities. In order for the human sense of touch to be as delicate as it is, it is necessary that human flesh be softer than that of any other creature. Furthermore, human tongues must be able to perceive tastes and make speech possible. Lips, which have this second task in common with tongues, serve the further purpose of protecting the teeth. Anything that is to perform these tasks must of necessity be made of flesh. And, given the delicate nature of the human sense of touch, the kind of flesh in which they are realized must be of the softest possible kind.¹⁶

Equally telling is the example of eyes and eyelids from *PA* II.13:

The reason for the existence of these protective coverings [eyelids] is that the eye is fluid in order to ensure keenness of vision. If the eye had been constructed with a hard skin it would of course have been less liable to injury by impact from without, but its vision would have been duller. For this cause the skin round the pupil is left thin and fine, and the safety of the eye is ensured by the addition of eyelids.¹⁷

Again, we encounter a fairly complex chain of dependencies. The starting-point this time is keenness of vision, which itself may be hypothetically necessitated by some other unspecified end. Keenness of vision places the following two demands on the material

composition of the eye: (i) that the skin surrounding the eye be sufficiently thin and fine; (ii) that eye-matter be fluid. By "fluid," as stated elsewhere, Aristotle means specifically *water*.¹⁸ One might think that there is some contingency in the composition of the eye, since both air and water are equipped with the property of transparency essential for vision. However, certain other characteristics of air (e.g. its being less easily confined) prevent it from playing that role.¹⁹ So, given all the previous requirements, we know that the eye *must* be composed of water. Considering the fragility of eye-matter, we furthermore know that the eye needs protection, in the form of the eyelid. (Even the material composition of the eyelid is hypothetically necessitated. It *must* be made of skin; for if it were to contain any flesh, the two partitions of the eyelid would grow together.²⁰)

III. THE ELEMENTS

The two examples considered above illustrate what can be found throughout the biological works: the bodily composition of living things is, on Aristotle's view, thoroughly necessitated (hypothetically) by their respective natures. Neglecting the occasional disformity, every body-part *has* to be exactly the way it is. And in order to be the way it is, it can only be composed of a single type of matter, whatever proves to be the most suitable in each circumstance.²¹

There are a few exceptions, some of which are discussed in Sorabji (1980). Certain body-parts, for instance, do not neatly fall under the concept of hypothetical necessity, at least in the way in which it has been spelled out here. These body-parts are not directly required for the existence of the organism in question or for the performance of its characteristic functions. According to Sorabji, their presence is to be explained with reference to "a teleological rule regarding the beneficial character of organs:"²²

There is . . . a more interesting group of organs and arrangements which exist for the sake of the good. Aristotle believes that the function of the testicles is to loop the seminal canals, so that seed is emitted less frequently, and similarly, the function of the convolutions in our gut is to delay excretion, so that replenishment is needed less soon. The second idea is taken from Plato, and if Aristotle is faithful to him, his thought will be that the arrangement gives us more time for the characteristic higher human activities. Similarly, the kidney's job of cleaning the bladder, and the ball and socket's job of increasing the flexibility, promote our *comfort*, but are not considered by Aristotle necessary for *existence*.²³

These "comfort-organs," however, can hardly be considered a counter-example in favor of the functionalist view. The material composition of testicles, gut-convolutions and ball-and-socket joints may not be (hypothetically) necessary for the existence of an organism or its performance of certain vital functions. But there will still be a similar chain of necessitations starting from the good they are to promote, all the way down to the organ's material composition.

More serious difficulties for the view presented here are raised in the following passage from "Changing Aristotle's Mind:"

We hold that while embodiment in some sort of suitable matter is essential to animals and their life-activities, the particular material realization is contingent. But caution is in order here. For Aristotle, the organic parts of animals — the heart, the eye, the hand, etc. — are *functionally defined*; the heart is whatever performs such-and-such functions in the animal, and a disconnected heart or hand is not, he repeatedly insists, really a heart or a hand except in name. This means that we could perfectly well say that the life-activities of animal A are necessarily and not contingently realized in a heart, and eye, and so forth, *without ever leaving the (formal) functional level*. What would then be contingent would be the material realization of that organic function at a lower level.²⁴

In this spirit, the functionalist might respond to our previous examples involving eyes, eyelids, lips and tongues that nothing has yet been said that would require "leaving the functional level." Eye-, eyelid-, tongue- and lip-matter *is* just whatever satisfies the functional requirements imposed on eyes, eyelids, tongues and lips. Call it "water," "skin" and "flesh," if you like.

This passage raises *two* important issues, taken up, respectively, in the Weaker and the Stronger Theses introduced in Section I. First, there is the issue of whether we are ever required to leave the level of purely functional description. This is addressed by the Stronger Thesis. The Stronger Thesis entails that "X satisfies certain functional properties characteristic of living things of kind K" is *not* sufficient for "X is a living thing of kind K." According to the Stronger Thesis, then, there will be *some* point at which, in characterizing a given living thing, we must leave the purely functional level.²⁵

But Putnam and Nussbaum's talk of "contingency" also raises the issue addressed by the Weaker Thesis: as a matter of fact, given Aristotle's cosmos, can there ever be more than one candidate for, say, lip-flesh? Is there contingency in the material makeup of living things, in the sense that there is no *unique combination*

of elements that results in a given substance? The Weaker Thesis asserts that, in each case, a set of characteristic functions can *only* be fulfilled by whatever *actually* fulfils it. There are no other candidates. So, if (via hypothetical necessity) a given body-part *must* be composed of a certain kind of flesh, then there will be only one combination of elements that satisfies the functional properties in question. Though the functionalist may still insist on functional descriptions "all the way down," Aristotle's world is one in which we never actually come across multiple realizations.

To substantiate this claim, we must briefly turn to *On Generation and Corruption*, where Aristotle is more specific about the lower-level material composition of living things. The universe, according to Aristotle, exhibits four different levels of material constitution:

- (i) *prime matter*²⁶
- (ii) *the four elements*: fire, water, earth, air
- (iii) *homoiomerous parts* (e.g. flesh, bone, sinew, skin, etc.)
- (iv) *anhomoiomerous parts* (e.g. hands, lips, tongue, etc.)

Each higher level is made of the level immediately below it, e.g. anhomoiomerous (or nonuniform) parts are made of homoiomerous (or uniform) parts. The lower levels exist *for the sake of* the higher levels;²⁷ each higher level thus hypothetically necessitates the lower level. That is, in order for anhomoiomerous parts to come about and perform their characteristic functions, homoiomerous parts are necessary; and so on down.

On Generation and Corruption II.3 characterizes the four elements as being made of prime matter and pairs of qualities:

Fire: hot (dry)

Air: (hot) moist

Water: cold (moist)

Earth: (cold) dry

Even though one member of the pair is always more characteristic of the element in question, both qualities have to be present in order to account for the fact that all elements can change into one another. Associated with the four primary qualities (and thus the elements) are the following characteristic "powers."

Hot/Fire: Associating the like

Cold/Water: Associating the like as well as the different

Moist/Air: Easy to adapt, hard to confine

Dry/Earth: Hard to adapt, easy to confine²⁸

Hot, cold, moist and dry are basic among the tangible qualities: heavy, light, hard, soft, viscous, brittle, rough, smooth, coarse, fine, etc. can all be reduced to them. Hard and soft, for instance, come from the moist and the dry.²⁹ But hot, cold, moist and dry are also basic in a more general sense. Everything in Aristotle's universe is ultimately made of fire, water, earth and air. Thus, since hot, cold, moist and dry are the principles of the elements, everything is in some way governed by these basic qualities and their properties.³⁰

Aristotle never states the exact ratio [logos] of elements that go into a given compound. But when he says in *DA* I.4, for instance, that "the mixture of elements which go to make the flesh has not the same ratio as that which makes the bone,"³¹ what else could he mean than that there is a *particular* ratio for both flesh and bone and that the two differ? What Aristotle had in mind were most likely ratios of the sort given by his presocratic predecessors, such as the Empedoclean ratio for bone given in *DA* I.5 (two-eighths water, four-eighths fire, plus the two-eighths that are left unspecified).³²

Comparing Aristotle's ratios with Empedoclean ratios, however, can be dangerous. To say that both Aristotle and Empedocles employ ratios of elements in describing the material makeup of an entity may in no way be taken to imply that they meant the same thing by them. On the contrary, for somebody with Empedocles' general world-view (or at least what Aristotle took it to be), two-eighths water and four-eighths fire is presumably all there is to the compound bone (plus the additional two-eighths that are left unspecified). The ingredients will not even have to be put together in some special manner, so that the whole would be in any way different from the sum of its parts. Rather, if we could cut up an Empedoclean bone into small enough pieces, we should be able to find minute water and fire-"particles" there.

Not so for Aristotle. On Aristotle's view, the ratio given barely describes bone-matter. A satisfactory description of the compound bone would be required to state, among other things, that the elements specified are not just *combined* [synthesis] in any old way but *mixed* [misis] into a homoiomerous whole. It would furthermore have to talk about the specific *kind* of whole that is to result from the mixis of elements. The process of mixis has the consequence that the whole is in certain crucial respects different

from the sum of its component-parts. When elements are unified into a whole in this way, the "new" entity that comes about marks the fulfillment of a *goal* of some kind, such as the performance of certain characteristic tasks.³³ This is, of course, nothing more than the familiar distinction between form and matter, only it is less obvious in the case of homoiomerous substances. Nevertheless, as Aristotle maintains, there is a formal as well as a material aspect even to such substances as flesh and bone and an adequate account of the compound will have to refer to both.³⁴

Now, considering the specificity with which the properties and dynamis of different kinds of matter are stated, can a certain set of characteristic functions be fulfilled by anything other than whatever *actually* fulfills it? Let's consider the examples of tongues again. The human sense of touch and our ability to speak require a particular kind of tongue-matter: the softest kind of flesh available. Could there be two types of flesh that can do the job equally well?

Everything, in Aristotle's universe, is ultimately made of the four elements. If there were a homoiomerous substance, call it "flesh*," just like flesh except in its material constitution, the two would have to differ with respect to some one or more elements. In other words, flesh* would have to be made of more earth, fire, water or air. Let's suppose, for the sake of the argument, that flesh* is made of slightly more earth than flesh. But then flesh* will be functionally different from flesh. The argument runs as follows.

On Generation and Corruption tells us that earth is dry and cold. We furthermore know that the dry is hard to adapt and easy to confine, while the cold associates the like as well as the different. Since flesh*, by hypothesis, is made of more earth than flesh, it will be drier and colder and thus harder to adapt, easier to confine and better at associating like and unlike. But this difference will also cause a difference in its tangible qualities. *GC* II.2 argues that the hard, the brittle and the coarse, for instance, are reducible to the dry, specifically because of the "powers" the dry has. So, flesh*, in being drier than flesh, will also be harder, coarser and more brittle. How, then, can flesh* be exactly like flesh in its functional properties if it is harder, coarser and more brittle than flesh? If flesh* is in fact harder, coarser and more brittle than flesh, even to the slightest extent, one of them will necessarily be better suited to perform the tasks tongues must perform. For brittleness, hardness and coarseness would surely be properties that are *relevant* to how well a tongue can perform its

characteristic functions. In our present scenario, flesh would be better suited, since it is softer than flesh* and we know that tongues are to be made of the softest flesh available. Thus, only flesh, and not flesh*, can serve as matter for tongues. Indeed, flesh and flesh* are mutually exclusive.

It might seem as though this argument depended for its success on the superlative in "the softest kind of flesh." Is the material composition of flesh less contingent than that of other body-parts, because it acts as the medium for the sense of touch? What about things like bone? Are there equally good reasons why bone could not be made of different materials?

In general, there will at least be the requirement that the part in question interact with the rest of the organic system in the right sort of way. To interact with an organic system in the right sort of way presumably entails participating in such vital functions as growth, nourishment, digestion, perception, and the like. We know through the Homonymy Principle that Aristotle is extremely picky in this respect. He is so picky, in fact, that, after Socrates' death, in a matter of seconds, Socrates' body ceases to count as Socrates' body, or even a *human* body. It is hard to believe that Aristotle thought the ratio of elements would change radically within those first few seconds. What has changed radically is that Socrates' body is no longer interacting with its form in the right sort of way.

But, given that Socrates' dead body immediately ceases to count as a human body, it is hard to see how, for instance, a metal bone which is not in any way organically connected to the rest of the system could count as a bone. Metal bones do not participate in growth or other such bodily functions. Presumably, a metal bone would be treated as on a par with Socrates' dead body or an eye made of stone, and so would other such artificial substitutes, e.g. wooden legs. Wooden legs and metal bones can no doubt perform some of the crucial tasks legs and bones must be able to perform. However, unless one is willing to go far beyond Aristotle's fire-water-earth-air based universe, there will be some function with respect to which the artificial substitute differs from its natural counterpart. Growth or food-processing immediately come to mind. The generalization reached earlier, according to which a difference in material makeup entails a difference in functional properties, can therefore be upheld even in the case of less demanding body-parts than flesh.

It is tempting, at this point, to suppose that Aristotle would have taken a different stance had he only known about silicon,

robots, Martians, and computers. Perhaps he would have gladly allowed for the possibility of flesh* and flesh being functionally alike, but materially different, had he only known that there is more to the world than earth, fire, water and air.

Of course, it is hard to know what Aristotle would have said had he known what we now know. However, what we do know is that, for whatever complicated reasons, he explicitly rejected those options that were available to him. Had he wished to allow for more variation in the material composition of living things (while keeping function constant), he could have taken at least the following two routes.

First, he could have chosen to make the list of elements and their characteristic qualities an open one; open, that is, to possible future discoveries and revisions. But he chose not to do so. When Aristotle says that everything in the sublunary world is made of the four elements and governed by their four characteristic qualities, he sounds like someone who is advancing a metaphysical, and not a tentative empirical, claim.

Secondly, he had the option of allowing for another (actual) level below the level of the four elements. This option was available to him, most notably through atomism. According to the atomists, the four elements and their characteristic qualities were reducible to various geometrical qualities such as position, shape and order.³⁵ But, for whatever complicated reasons, Aristotle rejected atomism and, along with it, the option of reducing the four elements and their characteristic qualities to some set of more basic qualities.

IV. CONCLUSION

A brief summary is in order. Our starting-point was the observation that Aristotle's artifact-analogies are frequently overextended in such a way that important asymmetries between living things and artifacts are lost in the process. One such asymmetry of crucial importance is the relation between form and matter. Although form and matter in living organisms and artifacts alike are related via hypothetical necessity, it does not apply to both in the same way. In section II, we considered certain body-parts and argued that, in each case, a particular kind of matter is picked out by hypothetical necessity. In the case of lips and tongues, it was the softest possible flesh; in the case of eyes, it was water. The contrast to artifacts was already visible: since saws merely require sufficiently hard matter, both iron and bronze will work. Artifact-forms are related via hypothetical necessity to a whole disjunction

of materials. Each member of the disjunction, however, is related to the form in question contingently. It is only the whole disjunction (e.g. iron or bronze or . . ., in the case of the saw) that is hypothetically necessary. In the case of living things, on the other hand, there is no disjunction of appropriate materials. In each case, only a single kind of matter is selected by the various complex requirements Aristotle places on the functioning of the organism and its interaction with the rest of the world.

The results of section II, however, were not yet sufficient to establish that a given form could not also be realized in a different kind of matter, as long as the two are functionally equivalent. Thus, one might suppose that there could be two different kinds of flesh, flesh and flesh*, both of which can serve equally well as tongue or lip-matter. Section III proceeded to argue for the absurdity of this claim via a brief excursion into *On Generation and Corruption*. We saw that, given the properties of the elements, flesh and flesh* could not be (functionally) alike. Depending on which one of them will be more suited for the task, either flesh or flesh* will be selected as lip and tongue-matter, but not both.

We may thus conclude that, as a matter of exegetical fact, Aristotle did not believe in Multiple Realizability, as far as living things are concerned. He did believe that artifact-forms are multiply realizable. But this is precisely where artifacts and living things part ways.

More strongly, though, we may also conclude that he did not reject Multiple Realizability for living things merely because he lacked sufficient resources to entertain the relevant counterfactuals. Given Aristotle's assumptions about the natural world, one *could not* have believed in Multiple Realizability for living things. He had sufficient resources to allow for more variation in the material composition of living things (while keeping function constant). But, by rejecting the reductionism of his presocratic predecessors, he explicitly decided against this option.

Aristotelian explanations, as Myles Burnyeat would put it, are "top-down." His views concerning the natural world are not only inseparable from his metaphysics: they are *determined* by his metaphysics. That is why we cannot view Aristotle as advancing a tentative empirical conjecture when he suggests that all living things and their parts have their proper earth-air-fire-water based matter.

The aim in this paper was only to argue for the Weaker Thesis. The Weaker Thesis does not exclude the possibility that the workings of living things can be described in purely functional terms;

that is, without even mentioning material composition. The Weaker Thesis only shows that the result would be a funny kind of functionalism: given Aristotle's cosmos, the characteristic functional properties can only ever be realized in a single way.

But the idea of staying on the functional level, in describing the workings of living things, is quite un-Aristotelian. Imagine an artifact that is so specialized that it can only be made of a *single* kind of matter, e.g. a special kind of knife, especially designed to cut diamonds, that can only be made of a particular kind of high-quality silver, or something along those lines. It still seems that there are crucial differences between the diamond-knife and the tongue of a living organism. To be sure, in both cases, the functional requirements are strict enough to narrow down the selection of materials to a single one. Still, the tongue-flesh is *alive*, while the high-quality silver is not. One of the ways in which this difference makes itself felt is that the high-quality silver, as Alexander puts it, is already a *tode ti* and a subject in actuality: the craftsman takes a quantity of silver and bestows upon it the form of the diamond-knife. He *could* conceivably bestow another form on it, if he chose to do so, e.g. he might decide to manufacture the quantity of silver into a piece of jewelry instead. The quantity of silver may survive the knife into which it is manufactured and have several different artifact-forms bestowed upon it, throughout its career. There is no such freedom in the case of living things: tongue-flesh is not already a *tode ti* and a subject in actuality, waiting to have some form bestowed upon it.

Though these last few remarks are only meant to be gestures in the direction of the Stronger Thesis, still the uniqueness in the material composition of living things is not only created from the top down, through very specific functional requirements, but also from the bottom up, through a receptiveness on the part of living matter that is directed only towards a single natural form.

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Received January 30, 1996

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NOTES

1. The first ancestor of this paper was conceived during a seminar on Aristotle's *De Anima* taught by Myles Burnyeat at Harvard University in the fall of 1991. My principal thanks are therefore due to him. I would also like to thank my audiences at MIT, Kansas State University, and the Louisiana State Philosophy Convention, where I delivered versions of this paper between the fall of 1994 and 1995. Over the years, I have received excellent comments from many people. I would like to thank in particular Ned Block, Richard Cartwright, Edward Johnson, Mitzi Lee, Robert Stalnaker, Jason Stanley, Mary Sirridge, Jim Stone, Gisela Striker and Judith Thomson. Finally, at an earlier stage, this paper benefitted greatly from the comments of an anonymous referee.

2. Alexander, *De Anima Mantissa*, Question IV, p. 120, 1.4-9 [my translation].

3. Much the same view can also be found in Aquinas (cf. his distinction between substantial and accidental forms: *ST I*, 76, 4, c.; *ST I*, 77, 6, c.; *Spiritu I*, ad 9; et al.).

4. Putnam and Nussbaum first referred to Aristotle as a functionalist independently of each other in Putnam (1975) and Nussbaum (1978).

When under attack from Burnyeat (1992), they then coauthored Putnam & Nussbaum (1992).

5. Cf. Putnam (1975).

6. Thus, "contingent" will obviously never mean "entirely without constraints," even in the case of artifacts. The axe or saw must at least be hard and this requirement will already narrow down the selection quite a bit. An axe cannot be made of wood, fabric or clay, for example. For more on Aristotelian definitions, see G. E. R. Lloyd (1992), Balme (1987); et al.

7. I do not mean to suggest that matter must therefore be part of the definition of "living thing of kind K." It could, for instance, be something that *follows* from the definition. There are at least the following two senses of the term "essential." First, there is Aristotle's sense of "essential" as "part of the essence." For something to be essential, in this sense, it has to occur explicitly in the definition, which is, as Aristotle puts it, the "formula of the essence." Secondly, there is the contemporary sense, according to which a property is essential to a thing if the thing cannot exist without the property (while still counting as the same thing). As will become clear below, the contemporary sense of "essential" can be identified with one of Aristotle's senses of "necessary" ("absolute necessity"). Aristotle's use of the term "essential" is much stricter than the contemporary sense. For example, the property of having three sides is *not* essential to a triangle, according to Aristotle's use of "essential," though it is necessary. We, of course, would say that the property of having three sides *is* essential (in our sense) to a triangle, because no triangle could be a triangle and not have three sides. The property of having three *angles*, on the other hand, is essential to a triangle, according to both Aristotle's and the contemporary use. It is essential, in Aristotle's sense, because it is explicitly part of the definition of triangle. The property of having three *sides*, on the other hand, merely *follows* from the definition.

8. When I speak of the denial of Multiple Realizability, unless I explicitly indicate otherwise. I shall henceforth have the Weaker Thesis in mind.

9. *DA II.2*, 414^a 20-27, D. W. Hamlyn's translation (as all future quotations from *De Anima*) but my italics.

10. In my use of the concept of hypothetical necessity, I shall rely rather heavily on Cooper (1987) as well as on chapters 9 and 10 of Sorabji (1980).

"Necessity" is also used in the sense of "that which cannot be otherwise," i.e. *primary*, *simple* or *absolute necessity* [to haploun anagkaion] (*Met. A.5*; *Met. A.7*, 1072^b 11-13; *GC II.11*, et al.); as well as in the sense of "*coercion*" [bia] (*Met. A.5*, et al.). What is absolutely necessary is thought to follow directly from the essence. Necessity, in this sense of the term, mainly applies to the realm of eternal substances and their movements (including the unmovable mover itself). Among things that come-to-be and pass-away, absolute necessity is also attributed

to certain cyclical movements and regular occurrences. "Necessity" in the sense of "coercion" [bia] is used in such contexts as, for instance, when a stone is (by coercion) thrown upwards, even though its natural tendency points downwards.

11. PA I.1, 639^b 24-640^a 6, D. M. Balme's translation. For other passages explicitly mentioning the concept of hypothetical necessity, see also *Phy.* II.9; PA I.1, 642^a 1-13; PA I.1, 642^a 31-^b 4; *GC* II.11, 337^b 9-338^a 3; *De Somno* 455^b 25-27.

The passage from *Parts of Animals* I.1 quoted above seems to imply that the concept of absolute necessity exclusively applies to the realm of eternal things, while that of hypothetical necessity is characteristic of things that come-to-be, both by nature and by art. Whether or not Aristotle in fact obeys this restriction is still debated. Several authors, including Sorabji and Cooper (op. cit.), have advanced the thesis that the notion of absolute necessity is used repeatedly in describing the properties of non-eternal entities. In particular, certain properties are said to follow from a thing's "necessary nature." Iron, for instance, is thought to be hard by its necessary nature (*Phy.* II.9). If this line of interpretation turns out to be correct, absolute necessity might well apply to both matter and form *separately*, without applying to the relation between them. In this vein, flesh and bones might be said to have certain properties by absolute necessity, e.g. to be soft and sensitive or hard and stabilizing. But the kind of necessity that is involved in saying that the soul or human being requires a body of a certain kind is nevertheless hypothetical necessity (unless, of course, matter turned out to be part of the essence).

12. There is a third way in which the term "hypothetical necessity" is used. In some examples, food, sleep, and the like, are listed as hypothetically necessary. This must surely mean something like "hypothetically necessary for the sustenance of a living thing" (once it has come-into-existence). This third use is therefore closely related to the first two, in that — once a living being has come-into-existence — it must sustain its existence, before it does anything else.

13. PA I.1, 642^a 10-14.

14. Putnam & Nussbaum (1992), p. 35, ftn. 17.

15. PA II.16, 660^a 9-14.

16. That the human sense of touch is to be the most delicate might itself be hypothetically necessitated by some other function characteristic to man. Or it might follow from the essence of man directly. Everything else, however, follows from the hypothesis that the human sense of touch is the most delicate.

17. PA II.13, 657^a 30-35, A. L. Peck's translation. (Cf. also Cooper (1987), p. 244 and p. 255 for a discussion of the eye/eyelid-example.)

18. See, for instance, *De Sensu* II, 438^a 13-17, where Aristotle makes the following remark in the context of criticizing Democritus:

It is true that the eye consists of water, but it has the power of vision not because it is water, but because it is transparent; an

attribute which it shares with air. But water is more easily controlled and confined than air; hence the pupil or eye proper is composed of water.

19. One might wonder, in this context, why air is not considered a likely candidate for eye-matter, even though it can, as we are told in *De Anima* II.8, be confined in the ear, where it acts as the medium for the sense of hearing.

20. PA II.13, 657^b 3-4.

21. Although this characterization of living things and their constitution might sound as if it implied that everything is necessarily *perfect* the way it is, it is important to realize that that is not the case. (By this, I do not mean to refer to situations in which, say, a human child is born with only one arm. Situations of this nature are covered in Aristotle's system in a more obvious manner, through the notion of a chance-occurrence; for he admits that things do not *always* work out the way they should, although they do for the most part.) Aristotle imposes certain restrictions on the workings of nature, according to which every creature can, for instance, possess only a certain amount of each element. Thus, sometimes there is simply no more earth left to form a certain part that might otherwise be useful. Such is the answer to the question why birds do not have ears: given their overall constitution, the right material to form ears is no longer available [PA II.12, 657^a 18-21]. Consider, in this context, also the discussion of horns in PA III.2.

22. Sorabji (1980), p. 159

23. *Ib.* p. 158. The references given by Sorabji are *GA* 717^a 15-31; 787^b 19-788^a 16; *PA* 675^a 19; ^b 23; 654^b 22; 670^b 23; Plato's *Timaeus* 73A, *Gorgias* 494B.

24. Putnam & Nussbaum (1992), p. 35 ftn. 17. (The first few sentences of this passage were already quoted earlier.)

25. Cf. *ib.* p. 35 ftn. 17; see also Whiting (1992) for a discussion of similar issues, particularly her distinction between "*causally*" and "*quantitatively*" characterized matter (p. 81, ftn. 20).

26. The status of prime matter in Aristotle's system is highly controversial. For discussions, see the appendix on prime matter in W. Charlton's edition of *Physics* I & II and C. J. F. Williams' edition of *De Gen. and Corr.*; et al. In what follows, I shall speak as though Aristotle was committed to the (potential but not actual) existence of prime matter. However, nothing that is of interest in the present context hangs on this assumption.

27. Aristotle seems to be committed to this dictum even with respect to the lower levels. However, as soon as one leaves the level of anhomioimerous parts, it becomes difficult to discern the final cause and, in general, to distinguish form from matter. (Cf. *PA* II.1, 646^a 13ff; *Mete.* IV.12, 389^b 28-390^b 2; *GC* I.5, 321^b 20-22; et al.)

28. *GC* II.2, 329^b 27-33; et al.

29. *GC* II.2.

30. Cf. *Mete.* IV.1; *PA* II.2, 648^b 3-11 also provides a good illustration of this point:

It is surely sufficiently established that these four principles (and not to any appreciable extent roughness, smoothness, heaviness, lightness, or any such things) are practically the causes controlling life and death, not to mention sleep and waking, prime and age, disease and health. And this, after all, is but reasonable, because [. . .] these four – hot, cold, solid, fluid – are the principles of the physical elements.

Aristotle often (misleadingly) speaks of things being made up of just one or more of the elements. However, *GC* II.8 explicitly states that all compounds, in some way or other, contain all the elements. When Aristotle speaks of bone, for instance, as being composed of earth, I take him to mean that bone is primarily composed of earth and that earth is, therefore, its most characteristic component. But all the other elements must nevertheless be present as well, albeit in comparatively small quantities.

31. 408^a 14-15 (translation by W. S. Hett).

32. *DA* I.4, 410^a 4-6.

33. In the case of homoiomerous substances, the result of the mixis is “new” in the sense that we have passed from the realm of inorganic substances (the elements) into that of organic substances (flesh, bones, etc.). At the same time, homoiomerous substances are, according to the Homonymy Principle, only organic as long as they are part of a living organism.

34. Aristotle points out that there is a problem in distinguishing the form from the matter in homoiomerous substances (*Mete.* IV.12). In *GC* I.5, we are told that flesh and the like have a kind of “double nature:” homoiomerous substances “have their form in their matter [tōn en hylē eidos echontōn]” and both matter and form are called “flesh” (321^b 20-23).

35. See, for instance, Democritus, DK fr. B 125.