

## COLLOQUIUM 4

# THE MEDICAL BACKGROUND OF ARISTOTLE'S THEORY OF NATURE AND SPONTANEITY

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### ABSTRACT

An appreciation of the 'more philosophical' aspects of ancient medical writings casts considerable light on Aristotle's concept of nature, and how he understands nature to differ from art, on the one hand, and spontaneity or luck, on the other. The account of nature and its comparison with art and spontaneity in *Physics* II is developed with continual reference to the medical art. The notion of spontaneous remission of disease (without the aid of the medical art) was a controversial subject in the medical literature, and Aristotle's *aporia* about the notion of spontaneous generation of natural things runs parallel to this controversy. Aristotle's account of spontaneous generation in the *Metaphysics* and in the *Generation of Animals* can also be profitably illuminated by looking at the comparison with medicine in detail. The aim is a clearer and more consistent picture not only of Aristotle's concepts of nature, art, and spontaneity, but also of the influence of medical writings and concepts on his natural philosophy.

Commentators since antiquity have emphasized two groups of predecessors in the background of Aristotle's discussion in *Physics* II: the materialists, e.g., Empedocles and Democritus, who are accused of chalking up the causes of all natural things to luck and spontaneity; and the creationists, e.g., Socrates and Plato, who reject these as primary causes of natural things, championing art or intelligence instead.<sup>1</sup> In his dialectical account of how nature itself is a cause of natural things, Aristotle proceeds, by and large, by comparing and contrasting nature with the other causes and describing how nature differs from art, spontaneity, luck, and necessity. In so doing he engages these materialist and creationist predecessors more or less directly. But when he offers a positive account of what nature is and how it is a cause, Aristotle repeatedly and almost invariably draws a comparison with various aspects of medicine: the physician, the medical art, health, and so forth. This fact strongly suggests that a third group of predecessors, not so often mentioned by commentators, constitute an important influence on

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<sup>1</sup> The dialectical interpenetration of these views in antiquity is researched in detail and synthesized in the extraordinarily important study of Sedley 2007.

Aristotle's concept of nature: the medical writers of the Hippocratic Corpus.<sup>2</sup>

Aristotle's position on the importance and interrelationships between the causes differs in important ways from both the materialists and creationists: he firmly rejects the notion that all natural things are caused by luck or spontaneity, although he does accept that some living things are spontaneously generated. He also rejects the view that natural things have been created by an intelligent designer. Despite various proposals throughout history to assimilate him to one or the other of these opposed camps of his predecessors, Aristotle in the works of the Corpus consistently follows a *via media* between the extremes of "spontaneous generation" materialism on the one hand, and "intelligent design" creationism on the other. His alternative account of natural causes, which remains his most original and most influential contribution to physics and the life sciences, is explained by parallelism with the medical art.

The purpose of the present study is to examine Aristotle's theory of nature and spontaneity in light of the Hippocratic corpus. In section I, I review the *prima facie* reasons for supposing Aristotle's physics to have been influenced by the Hippocratic medical writers. In section II, I discuss how Aristotle's theory of nature as a cause is explained in *Physics* II by analogy to the medical art, and I argue that the context of the *aporia* about spontaneous generation of *Physics* II relates to an important position in the medical literature on how spontaneity is a cause. In section III I discuss how the concepts of nature, art, and spontaneity are understood as causes in some Hippocratic writings. In section IV I show that Aristotle's solution to an *aporia* about spontaneous generation in *Metaphysics* VII reflects a medical perspective on spontaneity. In section V I argue that this background casts light on Aristotle's theory of spontaneous generation in the biological works and its relation to modern theories about spontaneous generation.

By reinterpreting Aristotle's account of how spontaneity is a cause of both human health and of many organisms, but also of the limitations of that kind of cause in natural science (including medicine), I hope to develop a clearer positive interpretation of Aristotle's theory of nature.

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<sup>2</sup> Medical writings were not arranged into what we now call the Hippocratic Corpus until after Aristotle. References to the Hippocratic Corpus in this paper use the abbreviations in H. G. Liddell and R. Scott, *Greek-English Lexicon* (9<sup>th</sup> ed. with suppl., Oxford 1996), xvi-xvii.

### I. Aristotle and Medicine

The prima facie case for thinking that Aristotle's philosophy has been shaped by medicine is really very strong, beginning with well-known biographical facts about Aristotle.<sup>3</sup> Aristotle's father Nicomachus was court physician to the Macedonian king Amyntas, and traced his descent to Asclepius, the hero of medicine; his mother also claimed medical lineage, although the facts on her side are more obscure.<sup>4</sup> From Galen we learn that Asclepiadic physicians trained their sons in dissection and that this kind of primary education had a deep impact on its pupils.<sup>5</sup> There is strong evidence that Aristotle himself carried out dissections, and he defends the close inspection of animal physiology in an exhortation to the life sciences of *Parts of Animals* I 5. Throughout the biological works he refers to a work on dissection or "anatomy," and the ancient lists also attribute to him works on "the medical art."<sup>6</sup> Unfortunately we have lost Aristotle's medical writings, with the exception of those in the *Parva Naturalia*, the *Problems* (especially book I), and *History of Animals* (especially book X). But the discovery of a first century BC papyrus known as the *Anonymus Londinensis* provides substantial evidence that Aristotle had directly entered the fray of Hippocratic medical controversies, and either compiled or had a pupil compile an extensive collection of medical opinions, presumably for the sake of a projected work on health and disease, which was either planned but never finished, or lost.<sup>7</sup>

As for the works that do survive, convincing studies have already demonstrated the importance of medical concepts, models and theories to Aristotle's productive and practical philosophy. Medical theories and analogies pervade the *Ethics*; in particular the doctrine of the mean seems to be mod-

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<sup>3</sup> The most influential twentieth century biographers, Jaeger 1923, Düring 1957, and Chroust 1923, all begin their accounts of Aristotle's intellectual development not with his medical heritage, but with his arrival at Plato's Academy. Natali 1991 provides more evidence about Aristotle's medical heritage, but does not treat this as a factor in his intellectual development. For a discussion in recent medical scholarship see Nutton 2004, 118-121.

<sup>4</sup> Diogenes Laertius V 1. See Düring 1957, 57 and 267.

<sup>5</sup> Galen, *On Anatomical Procedures* 2.1: "they practiced dissection from childhood under parental instruction, as they did reading and writing. . . . One so instructed from his earliest years would no more forget what he had learned from experience than would others the alphabet" (tr. C. Singer).

<sup>6</sup> ἀνατομῶν (Diog. Laer. V 25, title 104); ἐκλογὴ ἀνατομῶν (title 105); ἰατρικὰ (title 111). See Kollesch 1997.

<sup>7</sup> Althoff 1999; Manetti 1999. For text and translation, see Jones 1947. For general background, see: Jouanna 1992; tr. DeBevoise, 59-60; Nutton 2004, 58-60.

eled on a contemporary medical theory.<sup>8</sup> Similarly, the *Politics* utilizes medical theories and analogies, notably the treatment of the polis as an organism, the comparison of the statesman to the physician, and the classification of constitutional types into “correct” versus “defective, perverted, and contrary to nature.”<sup>9</sup> Aristotle in the *Poetics* makes such extensive use of medical notions (such as “crisis” and “catharsis”) that the work as a whole can be understood as a kind of medical text, and has been by a leading scholar of ancient medicine.<sup>10</sup>

But when we turn to Aristotle’s natural philosophy, there are disappointingly few studies of role of medicine.<sup>11</sup> Medical historians, for their part, have tended to offer oversimplified accounts of the relationship between philosophy and medicine by assuming a unidirectional causal influence between one and the other (with some arguing that medical theory was a major influence on natural philosophy, but not vice versa, and others arguing the opposite).<sup>12</sup> Both of these approaches are evidently inadequate for understanding Aristotle’s complex relationship to medicine.

Two passages, one from the beginning and another from the end of the *Parva Naturalia*, show that an account of medicine and the principles of health and disease were thought by Aristotle to be an *end* of his natural philosophy:

The scientist should grasp the first principles of health and disease, for there can be no health or disease in lifeless creatures. Thus, generally speaking, most natural scientists end with a discussion of medicine, and most of the doctors who research their subject more philosophically (φιλοσοφότερος) start on the basis of principles from the study of nature. (*Sens.* 436a17-b1)

Concerning health and disease, not only the physician but also the physicist must, to a certain extent, provide explanations. To what extent they differ and theorize different things must not be neglected, since it is a fact that their objects, at least to a certain extent, are coterminous. For those physicians who are refined and detail-oriented say something about nature, and consider it important to draw their principles from it; while the most accomplished of the

<sup>8</sup> Wehrli 1951, Jaeger 1957, Lloyd 1968, Tracy 1969.

<sup>9</sup> Jouanna 1980.

<sup>10</sup> Craik 2006. See also Janko 1992.

<sup>11</sup> The most important twentieth century work on this topic is Solmsen 1960 and Lloyd 1966. The most notable recent exceptions to the general neglect of the topic are Longrigg 1993, chap. 6, and the work of P. J. van der Eijk, who recently wrote that “the medical background of Aristotle’s biological and physiological theories has long been underestimated by a majority of Aristotle scholars—and if it was considered at all, it tended to be subject to gross simplification . . . the subject of Aristotle’s relationship to medicine is a vast area, and the study of the role of Aristotelianism in the development of ancient medicine is still in its infancy” (2005, 15-16).

<sup>12</sup> Edelstein 1952; Longrigg 1963.

physicists complete their investigations taking them so far as the principles of medicine. (*Resp.* 480b21-30)

Aristotle in these passages argues that both physicians and physicists should discuss the principles both of nature and of medicine. That they did, I think, is borne out by even a cursory examination of the works of the Hippocratic Corpus; and on the other side of the fragments of the early Greek philosophers (especially Parmenides, Empedocles, and Democritus) and Plato's *Timaeus* (which includes a discussion of the principles of both nature and of medicine). Thus there is no room for doubt that Aristotle, as a physicist if not as a physician, was committed from birth to a serious examination of the principles of medicine and their relationship to the principles of nature.

Aristotle saw the value of philosophy for medicine to be a clarification of the principles or starting points of the science. Physicians, then, begin from these principles and proceed to the practical application of their knowledge to specific causes of health and disease.<sup>13</sup> And although Aristotle held that the treatment of health and disease properly come at the end of the physicist's account of nature, and although his own treatment of the causes of health and disease are positioned near the end of his works on nature, we will see in the next section that Aristotle already presupposes substantive views about the medical art in his own discussion of the principles of nature in *Physics* II.

## II. *Medicine in Physics II and in the Background of the Aporia about Spontaneity in Physics II 8*

When defining nature in *Physics* II 1, Aristotle immediately draws a comparison to medicine:

Nature exists as a principle and cause of change and rest in that in which it inheres primarily and intrinsically and not incidentally. I say 'not incidentally' because he who is a physician might himself be a cause of health to himself. Nevertheless, it is not in accordance with being a patient that he has the art of medicine, but coincidentally the same person is both physician and patient. And that is why these attributes are sometimes separate from one another. It is similar with all other products of art. None of them has in itself the principle of

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<sup>13</sup> Lennox 2005, 66-68, points out that the natural philosopher as a zoologist will explore the proper functioning of the animals' parts, and thus the principles of their health. The physician will then take over these principles in order to understand how to restore health, but may look to other sciences (such as meteorology) as well (this is especially evident in medical treatises like *Airs, Waters, and Places*). Lennox also points out that Aristotle is likely to see the relationship between medicine and physics as being similar to the relationship that obtains between, for example, optics and geometry, or harmonics and arithmetic, where the science closer to the phenomena gets its principles from the superordinate and more general science.

its own production. But while in some cases, for example houses and the other products of manual labor, that principle is in something external to the thing, in other cases, those which may cause a change in themselves incidentally—it lies in the things themselves but not intrinsically. (*Phys.* II 1, 192b21-32; cf. *Pol.* III 6, 1279a1-21)

In *Metaphysics* IX 2, Aristotle also defines art in a way that corresponds to this definition: “all arts, and thus all productive kinds of knowledge, are capacities. For they are principles of transformation *in another thing* or in the artist himself considered *as another thing*” (*Metaph.* IX 2, 1046b2-4). What is stressed in these definitions is the mode of causality, whether intrinsic or incidental, and not the regularity or constant conjunction of the cause-effect relation.

The two examples that Aristotle contrasts here, *health* and *a house*, are significant, and are repeatedly paired in the *Metaphysics* VII 7-9 discussion of the causes of spontaneous generation and elsewhere.<sup>14</sup> According to the analysis of how the medical art functions in *Metaphysics* VII 7 (see below), a physician has the formula of health (e.g., a balance of hot and cold) in his own soul and aims by the medical art to produce this form in another, i.e., the patient. Nature, by comparison, has an internal principle of production according to which producer and product are the same. As Aristotle says in *Parts of Animals* I 1: “just as art exists in the products of art, so in the things themselves there is some other similar principle and cause derived like the hot and the cold from the universe” (641b12-15). Consider a patient who just so happens to be a physician, and so, by applying the medical art, determines what interventions are necessary, and acts to bring them about in himself (for example, creating internal warmth by taking a bath, or by rubbing, or consuming a hot liquid). Such a case will have a certain resemblance to natural reproduction, because it looks like the producer and the product are identical, since the formula of health is identical in the producer and the product. That case, Aristotle is cautious to explain, can only happen by coincidence, and remains a case of artificial, not natural production. It is not insofar as he is a physician that he is healed, but insofar as he is a patient. To hold otherwise would be to obliterate the distinction between spontaneous and technical causes of health, because if the patient were healed insofar as she were a doctor and had the cause of health internal to her, this application of the medical art would be indistinguishable from the spontaneous production of health. And yet, while some diseases can be cured spontaneously, only some can, but others require the external agency of the physician.

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<sup>14</sup> The importance of the repetition of these examples in *Physics* II and *Metaphysics* VII is noted by Lloyd 1996, 287.

Aristotle underscores this point in *Physics* II when he makes a second comparison between nature and art, and argues that nature, as a form and end, is not like medicine, but like health:

Nature in the sense of generation proceeds towards nature. For *it is not like medicine*, which is said to be a route not to the medical art, but to health. For it is necessary for those practicing medicine to proceed from the medical art, not to it. But this is not how nature relates to the natural thing; rather the growing thing grows out of something as it grows into something. What, then, grows? Not that out of which it grows, but that into which it grows. The shape, therefore, is a nature. (*Phys.* II 1, 193b12-18)

The earlier point was that nature is not like a physician curing herself, because a physician is the cause of health in another, and in oneself only incidentally. The present point is related but different. Nature is not like medicine, which aims to produce something other than itself, namely health (not the medical art) and in another (not in oneself, except incidentally). Nature by contrast produces itself by exact duplication (univocal reproduction) of the paternal form in the maternal matter. The medical art, on the other hand, produces the form of health in the body of the patient: the physician does not re-produce the medical art in himself, but produces the form of health, by means of the medical art, in another, i.e., the patient.

A third comparison between nature and medicine occurs in *Physics* II 2-3 and later in II 9 where Aristotle argues that natural science, like medicine, deals not only with matter (like bodies and their elements) but also with form (like health):

If we look at the ancients, natural science would seem to be concerned with the matter. Empedocles and Democritus barely mentioned form and what it is to be something. But if art imitates nature, and it is part of the same discipline to know the form and the matter up to a point, then, it would be proper for natural science to know nature in both its senses. For example, the doctor has knowledge of health, but also of bile and phlegm, in which health is generated; and the builder has knowledge both of the form of the house and its matter, specifically that it is bricks and beams, and so forth. (*Phys.* II 2, 194a18-27; cf. 194b11)

Again [nature is a cause], in the sense of end or that for the sake of which, e.g., health is the cause of walking. Why is he walking? By saying 'To be healthy' we think we have stated the cause. The same is true also of all the intermediate steps which are brought about through the action of something else as means towards the end, e.g., of health, reduction of flesh, purging, the drugs, or the surgical instruments. (*Phys.* II 3, 194b32-195a1)

The necessity in nature, then, is plainly what we call by the name of matter, and the changes in it. Both causes must be stated by the student of nature, but especially the end; for that is the cause of the matter, and not vice versa; and the end is that for the sake of which, and the principle starts from the definition or essence: as in all artificial products, since a house is of such-and-such a

kind, certain things must necessarily be generated or be there already, or since health is this, these things must necessarily be generated or be there already, so too if a human being is this, then these; if these, then those. (*Phys.* II 9, 200a30-b4; tr. Hardie and Gaye, mod.)

The examples Aristotle gives to illustrate the point are, again, precisely the same examples he used at the outset of *Physics* II. The physician must understand the body in which by means of art he is going to produce the form of health, just as the builder must understand the bricks out of which, by means of art, he is going to produce the form of a house. But it will not do to know only the matter, as Empedocles and Democritus would supposedly have it, because in all cases a form has been produced out of the matter, and usually the form is very different from the matter. The exceptions, of course, are the spontaneously generated organisms and processes, since their forms are so closely tied to the kind of matter they are produced out of (as Aristotle argues in the *Generation of Animals*—see below). That much, but no more, Aristotle was willing to concede to the materialist predecessors on this issue. In most cases in nature, and in the most important cases in nature, generation does not happen like that, just as most health does not improve spontaneously but requires the assistance of the medical art.

In *Physics* II 4-6, Aristotle gives a direct account of spontaneity and luck. He states that we must determine what kind of cause they are, because “many things are said both to exist and to be generated as a result of luck and spontaneity.” Aristotle believes many things, such as health, plants, and animals, to be generated both spontaneously and not spontaneously. But in reviewing the “materialist” theories of his predecessors, Aristotle makes it clear that he does not believe that *all* things can be generated spontaneously, beginning with the cosmos itself. He describes those “who actually ascribe this heavenly sphere and all the worlds to spontaneity. They say that the vortex arose spontaneously” (196a25-26; tr. Hardie and Gaye). He takes them to task for holding that the causes of plants and animals are not luck but nature or intelligence or something like that (since a natural kind is generated from a natural kind of the same form), but at the same time holding that “the heavenly sphere and the most divine of visible things were generated spontaneously” (196a34). This he argues is absurd “when they see nothing being generated spontaneously in the heavens, but much happening by luck among the things they say are not due to luck, whereas we should have expected exactly the opposite” (196b2-4). Aristotle firmly rejected the position that the universe as a whole, including the planets and stars, could be generated spontaneously.<sup>15</sup> His reasoning for this seems to be that the

<sup>15</sup> *Phys.* II 4, 196a24-b5; *Cael.* II 5, 287b25; *PA* I 1, 641b12-23.



spontaneous is opposed to the regular, or what exists "always or for the most part," but the heavens and nature, by contrast, are perfectly regular.<sup>16</sup> He can see nothing being "generated" among the stars, and so spontaneous generation on a cosmic scale seems out of the question. To some extent these views were theoretical blinders that prevented him, along with other Greeks, from noticing phenomena like supernovae.<sup>17</sup>

Aristotle makes precisely the same argument in both *On the Heavens* and *On the Parts of Animals*.<sup>18</sup> It is thus crucial to his physics that some things are generated spontaneously, but only some, while many things, including the cosmos as a whole, are not. If this is acknowledged, then it arguably follows that since the heavens and the cosmos is more like those things not generated spontaneously than like those things that are, we ought to assume that the cosmos itself and as a whole is not spontaneously generated.

What, then, about things that are generated spontaneously? In *Physics* II 5, Aristotle defines spontaneity (and its subclass, the lucky and unlucky) in terms of incidental cause:

Things that are for the sake of something include whatever may be thought or done as a result of thought or of nature. Things of this kind, then, when they are generated incidentally are said to be by luck. Just as a thing is something either in virtue of itself or incidentally, so may it be a cause. For instance, the house-building capacity is in virtue of itself a cause of a house, whereas the pale or the musical is an incidental cause. . . . When a thing of this kind is generated among events which are for the sake of something, it is said to be spontaneous or lucky. (*Phys.* II 5.196b21-31; tr. Hardie and Gaye, mod.)

For my purposes, the most important thing about this definition is that the spontaneous is not understood as *that which does not come about always or for the most part*, but rather as *that which comes about by an incidental cause*. This shows that Aristotle's primary concern is with the mode of causality and not the regularity of the cause-effect relationship. Later we will see that Aristotle specifies that in the case of spontaneous generations (unlike sexual reproductions) the formal cause is not univocal with its moving and final causes. This is not to deny the regularity of the material, moving, and even final causes of spontaneous generations.

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<sup>16</sup> "Nothing that is spontaneous can be indestructible or ungenerated, since the products of spontaneity or luck are opposed to what exists or is generated always or for the most part, while anything which exists for a time infinite, either absolutely or from a certain point, is in existence either always or for the most part" (*Cael.* I 12, 283a31-b2; tr. Stacks, mod.). "The things which are generated by natural processes all do so either always or for the most part in a given way; while any exceptions—any results that occur neither always or for the most part—are products of luck and spontaneity" (*GC* II 6, 333b4-7; tr. Joachim, mod.).

<sup>17</sup> Lloyd 1996.

<sup>18</sup> *Cael.* I 12, 283a31-b2, 287b25; *PA* I 1, 641b12-23.

To illustrate his point about incidental causation, Aristotle uses the stock example of building, just as in the first definition of nature and the several examples discussed above. For a house, a builder is the intrinsic cause, and the pale or the musical is at most an incidental cause (if the builder happens to be pale or musical). Similarly, a doctor is intrinsically the cause of health. If a pale or musical person should restore health, it is only incidentally; intrinsically the cause of health, unless the cause is spontaneous, is due to the doctor. If the cause is due to an agent that happens to be the same as the patient, the cause is again incidental, for the reasons mentioned above. If the cause were completely internal to the patient, and not due to any external agency, the cause would be spontaneous.

In *Physics* II 6, Aristotle refines his discussion by defining the lucky and unlucky as species of spontaneous effects that happen to fall into the realm of human aims:

The spontaneous is found both in the beasts and in many inanimate objects. We say, for example, that the horse came spontaneously, because, though his coming saved him, he came not for the sake of being saved. Again, the tripod fell spontaneously, because, though it stood on its feet so as to serve for a seat, it did not fall so as to serve for a seat. Hence it is clear that in those things that are generated for the sake of something (without qualification), when they are incidentally not generated for the sake of it because the cause is external, we say that they are generated spontaneously (*ἀπὸ ταῦτομάτου*). And we say that they are generated luckily (*ἀπὸ τύχης*) when things are generated spontaneously among the things being chosen by agents having choice. (*Phys.* II 6, 197b13-22; tr. Hardie and Gaye, mod.)

That Aristotle says “the spontaneous is found both in the beasts and in many inanimate objects” suggests that he is not abandoning, but rather embracing, his position that some animals have spontaneous causes (see below), and may even be referring to animals being generated from inanimate materials. Commentators have, however, expressed justified dissatisfaction with the examples of spontaneity supplied by Aristotle in this chapter: the horse that wanders from camp just before a raid and so is “spontaneously” saved; and the three-legged stool that happens to land upright “for the sake of” being sat upon.<sup>19</sup> The second example should, it is agreed, probably be dropped because, since it is in the realm of human interests (something turns up suitable for a human to sit on), it is an example of what Aristotle stipulates as luck, not chance. But the example of the horse deserves a closer look. Having come back to the camp looking for food, “not for the sake of being saved” (*οὐ τοῦ σωθῆναι ἕνεκα*), the horse nevertheless was saved (*ἔσωθη*), but by an incidental cause. This example of an end is also men-

<sup>19</sup> Charlton 1970, 109-110; Lennox 1982, 234.

tioned in the *Posterior Analytics*: “Among the products of thought, some never occur spontaneously—e.g., a house or a statue—nor from necessity either, but for the sake of something; but others occur also by luck—e.g., *health and safety* (ὑγίεια καὶ σωτηρία)” (*An. Post.* II 11, 95a3-6; tr. Barnes, mod.). Just as the cause of health may be spontaneous (if an agent, not in accordance with the medical art but incidentally, produces the form of health in a patient), so the cause of safety may be (if an agent gets safe but not for the sake of safety but for some incidental reason).

Given that earlier and contemporaneous medical writers so frequently mention the spontaneous recovery from disease as an example of a spontaneous cause (see below), one wonders why Aristotle does not here in *Physics* II 6 use the more natural example of spontaneous production of health, as he does in *Posterior Analytics*, *Parts of Animals*, *Metaphysics*, and elsewhere. The answer is terminological: in the *Physics* passage just quoted Aristotle stipulates that spontaneous results in the domain of human interests are due to luck. The spontaneous production of health or remission of disease is for Aristotle technically an example of luck, and so in the midst of making the terminological distinction between spontaneity and luck he is forced to avoid his own stock example of spontaneous health. But the philosophical point is much clearer if we drop the terminological distinction and consider Aristotle's example of the spontaneous production of health as discussed in the *Metaphysics* and elsewhere (see below). When the materials of the body are moved so as to restore the equilibrium between hot and cold, but not by a doctor for the sake of producing health, the result is spontaneous (which is exactly how certain medical writers would put it). But since it happens among the things that both the doctor and the patient would have produced in accordance with the medical art, it is called lucky.

Thus, spontaneous outcomes are defined with respect to ends that would otherwise be chosen by art or nature. As he puts it in the conclusion of *Physics* II 6, they are “causes of effects which, though they might result from intelligence or nature, have in fact been caused by something incidentally” (198a6-7). Given this conception, he argues that spontaneous outcomes must be posterior to nature and intelligence, since nature is an intrinsic cause of what the spontaneous is incidentally a cause, and luck is incidentally a cause of what art is intrinsically the cause. The terms of the analogy are: nature is to spontaneity as art is to luck. Elsewhere he puts this analogy in even starker terms:

Each substance is generated out of something with the same name. Both the natural substances and the others [i.e., the artificial ones] are generated in this way, for they are generated by art or nature or luck or spontaneity. The principle of art is in another, but the principle of nature is in the thing itself (for a

human gives birth to a human), and the remaining causes are privations of these. (*Metaph.* XII 3, 1070a4-9)

Luck and spontaneity are defined simply as the achievement of an artistic or natural end, but without art or nature being the cause, that is, without the same form being present in the mind of the artist or in the nature of the (sexually reproducing) organism. Thus spontaneity and luck are understood as causes, but only as incidental causes, and in a sense as privations of intrinsic causes. This outcome of *Physics* II is consistent with the original definition in *Physics* II 1 of nature as a source and cause of motion and rest in that in which it intrinsically inheres, and not incidentally.

As we have seen, Aristotle rejects the idea that spontaneity could be the cause of the heavens and the entire cosmos, and that argument is based on views about the causal regularity of the heavens. These views did not stop him, however, from positing the existence of spontaneously generated organisms, or recognizing the phenomenon of spontaneous remission of disease in the terrestrial zone. And yet the assumption that spontaneous things do not happen in the same way “always or for the most part” seems to be in tension with the claim that many organisms, and likewise health, can be generated spontaneously in a perfectly regular and causally determinate way. Some commentators have seen this as a fundamental contradiction between Aristotle’s physical and metaphysical principles and his biology.<sup>20</sup> For example, David Hull has written: “if lower animals can partake in the eternal and divine without the help of efficient, formal, and final causes coinciding, why not all species? . . . if spontaneously generated forms are considered species, there is no need to postulate static essences as the ends toward which all things strive to explain the stability in the organic world. The material cause will do, and the materialists such as Empedocles are right.”<sup>21</sup> The question that Hull and others have raised had already been raised by Aristotle himself in the famous *aporia* of *Physics* II 8:

Why then should it not be the same with the parts in nature, e.g., that our teeth should come up of necessity—the front teeth sharp, suitable for cutting, the molars broad and useful for grinding down the food—since they did not arise for this end, but it was merely a coincidental result; and so with all the other parts in which we suppose that there is a purpose? Wherever they as if happening for the sake of something, these things survived because they fittingly adapted due to spontaneity (ἀπὸ τοῦ αὐτομάτου συστάντα ἐπιτηδείως). But wherever they were not so adapted they perished and are perishing, just as Empedocles says the ‘cow progeny with human faces’ were. So this argument, and others like it if there are any, may present difficulties. Yet it is impossible

<sup>20</sup> See Balme 1962, 96-97; Hull 1967-1968, 247; Lennox 1982, 228-229.

<sup>21</sup> Hull 1967-1968, 247, 249; cf. Lloyd 1996, 118.

that this should be the true view. For these and all the natural things are generated in a certain way (οὕτω) either always or for the most part, but none of them by luck and spontaneity. (*Phys.* II 8, 198b23-36; tr. Hardie and Gaye, mod.)

If the last sentence of this passage is interpreted to mean that no products of spontaneous generation are generated in the same way regularly ("always or for the most part"), then there is a flat-out contradiction between Aristotle's principles in the *Physics* and his conclusions about spontaneously generated organisms in the biological works and about spontaneously produced health in the *Metaphysics* (see below). If the account of spontaneous generation in those other works is correct, then it is not available to Aristotle to resolve the *aporia* of *Physics* II 8 by arguing that nothing that is generated spontaneously is generated regularly. For, as we will see, he gives a complete "four" causal analysis of spontaneously generated organisms, and determines that certain material and moving factors necessitate that a certain form will be generated, forms that are "more or less noble" depending on the complexity of their vital powers. There is no notion whatsoever that these organisms are produced "without a cause," "randomly," "in vain," or "at chance," or that they do not come about through the same causes "always or for the most part."

But does Aristotle really contradict himself? In the rest of *Physics* II, the spontaneous itself is never explicitly denied to occur "always or for the most part." Aristotle seems to apply the "not always or for the most part" restriction only to luck, which is a subset of spontaneous results (those that happen to occur in the realm of human interests).<sup>22</sup> As for the passage in *Physics* II 8 that we are presently considering, the only way I can see to avoid a contradiction is to interpret the words "all the natural things are generated in a certain way (οὕτω) either always or for the most part" as referring to a particular mode of generation, the most natural one, i.e., sexual reproduction. His point is that *for the most part* natural things reproduce sexually (according to the "univocal" principle, with producer-product sameness—see below); this does not exclude the possibility that some things are not generated sexually, but rather spontaneously, and it does not

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<sup>22</sup> Neither of the two passages cited by Hull 1967-1968, 247, support his point: *Phys.* 196b10 talks only about luck, not spontaneity; and 196b29, although it talks about both luck and spontaneity, describes them as incidental causes and says nothing about "always or for the most part." And the same is true of the other passages cited to the same effect by Balme 1962, 96: *APo.* 87b20, *Phys.* 197a32 and 199b24 refer to luck, not spontaneity. That leaves only *Cael.* 283b1 and *GC* 333b5. Aristotle seems to have refined his position in *Phys.* II and allowed that regular results may be produced spontaneously; but in the case of results that happen to coincide with our own purposes, that is lucky results, they cannot be spontaneously produced "always or for the most part."

require that spontaneous generation be irregular. As we will see, spontaneously generated organisms are generated by "equivocal" causes, where the producer is different in form from the product.

Notice that what Aristotle specifically criticizes about Empedocles' theory is his theory of reproduction: the "man-faced cow progeny" is absurd because "a human begets a human," and concomitantly a cow a cow, and that is because in such cases the sexual reproduction of a form is at work. Empedocles has no grounds for reducing cases of univocal sexual reproduction to equivocal spontaneous generation, where the producer and the product are not the same. Aristotle can make this argument even while conceding (and in effect maintaining his own position), that some kinds of organisms, admittedly very lowly ones, can in fact regularly be generated spontaneously. In other words, Aristotle does not, and cannot, argue against Empedocles that no organisms are spontaneously generated; rather he argues that only some can, but most, and the most important, cannot be generated that way but must have some other kind of cause. The question then becomes, what cause? Aristotle's answer is that it is nature itself.

But the absence of an intelligent and deliberate cause acting in nature might be thought to imply the nonexistence of a definite end. To this Aristotle responds in several different ways. One response is to acknowledge that nature does not always reach its end, but sometimes produces freaks or monstrous outcomes. This, he argues, is analogous to a mistake in writing (one is tempted to translate "a transcription error") or to "the doctor who pours out the wrong dose" (*Phys.* 199a34-35). But such cases do not show that nature does not have an end, but rather that there is a natural end which nature sometimes fails to reach. Another response that Aristotle makes is as follows:

It is absurd to deny seeing generation for the sake of something, unless the thing changing is seen to deliberate. Indeed, even art does not deliberate. If the ship-building art were present in the wood, it would produce similarly to nature. The result is that if the cause for the sake of which is present in art, then it is present in nature too. *The point is clearest when a physician treats himself: nature is like that.* Thus that nature is a cause, and a cause in the sense of that for the sake of which, is plain. (*Phys.* II 8, 199b26-33)

In the case of the spontaneous generation of health, and of plants and animals, Aristotle supposes that the matter must somehow be capable of moving or being incidentally moved in such a way that an equilibrium is generated that would otherwise be brought about by the art of medicine or by nature. Aristotle now goes so far as to envision the art being present in the matter: the building art present in the "wood" (literally, the "matter"). This is essentially the case with spontaneous generation: the form that is produced is determined by the matter out of which it comes to be, not a pre-

existent form. Most cases of natural generation are not however like that; rather, the form is determined by an identical form, not the matter. When Aristotle illustrates this by analogy to a physician treating himself, he comes full circle from the point he started—arguing that nature is an intrinsic not incidental cause, where the example of an incidental cause is a physician treating himself. In the next section we will look at the background of this discussion of nature, art, and spontaneity as principles in the context of the medical literature.

### III. *Medical Writers on Spontaneity*

The preceding brief overview of *Physics* II shows that analogies and comparisons between nature and the medical art lie at the heart of Aristotle's understanding of how nature exists as a principle and come at the very beginning of his physical speculations. Aristotle's claim in the *Parva Naturalia* that the "more philosophical" and "refined and detail-oriented"<sup>23</sup> physicians say something about nature, and that the investigations of nature and medicine form a continuum, is evident in many of the surviving works of the Hippocratic Corpus. It has even been argued, convincingly in my opinion, that the concept of nature later employed by sophists and early philosophers originated largely in medical literature.<sup>24</sup>

The author of *On Regimen I*<sup>25</sup> argues that "he who aspires to treat correctly of human regimen must first acquire knowledge and discernment of the entire nature of the human being (παντὸς φύσιν ἀνθρώπου): knowledge of its constitution out of principles, and the discernment of those components by which it is controlled." The basic therapeutic method is to provide a balanced proportion (συμμετρία) of food and exercise relative to a particular kind of constitution: "were it possible to discover for the constitution of each individual a balanced proportion of food to exercise, an exact discovery of health for humans would have been made" (*Vict.* I.2; tr. Jones, Loeb IV, 229, mod.). *On Regimen I* identifies two fundamental principles of nature in general: fire and water, and discusses their properties, primarily the hot and the cold, in many ways parallel to arguments about first principles found throughout the extant fragments of early Greek philosophers. A series of parallels to Heraclitus, Parmenides, Anaxagoras, Democritus, and Pythagoreans are made as the author reasons from observable facts about these

<sup>23</sup> For a useful and thorough discussion of these terms, see Van der Eijk 2005, 194-196.

<sup>24</sup> Heidel 1910, 91-95; Nestle 1938, 8-17.

<sup>25</sup> περὶ διαίτης = *Vict.*; tr. Jones as *On Regimen I* (Loeb IV).

elements and the cosmos to a theory of physiology and nutrition. All change, including generation and destruction, is due to mingling and separation of water and fire. The author argues at length that the activities of arts are all imitations of the nature of the cosmos and the human being; the doctrine that art imitates nature is elaborated in minute detail. *On Regimen I* continues with accounts of: nutrition; the formation of the embryo; the generation of twins; superfetation; differences in human constitutions related to the environment, age, sex, and intelligence.

As even this bare outline suggests, there is much of interest in this work to Aristotle, and in fact many concerns central to his biological works, especially the *Generation of Animals*. Consider the following passage, in which it is argued that nature and the medical art are in certain respects the same:

Cobblers divide wholes into parts and make the parts wholes; cutting and stitching they make sound what is rotten. Man too has the same experience. Wholes are divided into parts, and from the union of the parts wholes are formed. By stitching and cutting, that which is rotten in man is healed by physicians. This too is part of the physician's art: to do away with that which causes pain, and by taking away the cause of his suffering to make him sound. Nature spontaneously knows how to do such things (ἡ φύσις αὐτομάτη ταῦτα ἐπίσταται). When a man is sitting it is a labor to rise; when he is moving it is a labor to come to rest. And in other respects too nature is the same as the medical art (τὰ αὐτὰ ἔχει ἡ φύσις ἰητρικῆ). (*Vict.* I.15; tr. Jones, Loeb IV, mod.)

Two ideas here are fundamental to Aristotle's philosophy. The first is the idea that art imitates nature or helps where it falls short.<sup>26</sup> *On Regimen I* argues in detail that the work of practically all of the arts are similar to the medical art in imitating nature and working to improve it; in addition to cobblers, the author gives as examples ironworkers, fullers, carpenters, builders, musicians, cooks, curriers, basket-weavers, statue-makers, potters, trainers, even prophets and writers.<sup>27</sup> In all cases the artist works with natural materials in order to bring about a result that nature brings about spontaneously. By such an inductive onslaught it is concluded that nature and the medical art are similar. The second idea important to Aristotle (and occasioning much controversy) is that certain things in nature come to be (are generated or produced) spontaneously. The notion that nature spontaneously generates what is otherwise produced by art, and in particular by the

<sup>26</sup> *Phys.* II 2.194a21-22, 2.8.199a15-17; *Meteor.* IV 3.381b6; *PA* I 5.645a10-15; *Metaph.* VII 9.1034a33-34; *Pol.* VII 17.1337a1; *Protr.* IX 49.28-50.1, 50.12; X 54.22-23; cf. [Ar.] *Mund.* 396b1-12.

<sup>27</sup> *Vict.* I.11-24. See Lloyd 1966, 353-354.



medical art, is widespread throughout the medical literature, as I will attempt to show by a rapid review of some of the texts.

That diseases and their symptoms come on spontaneously is a position found as far back as Hesiod's *Works and Days*.<sup>28</sup> Throughout the medical literature, one can read numerous references to spontaneous diseases and symptoms in general,<sup>29</sup> and specifically to spontaneous spasms, bowel movements, bone separations, urination, sweating, swelling, vomiting, purging, bleeding, lacerations, rupturing, expectoration, menstruation, ulceration, abortion, paralysis, and death.<sup>30</sup> On the happier side of things, we read in several works about spontaneous recovery from a multitude of diseases: for example, of spontaneous recovery from eye disease, joint injuries; pain, dysentery-like conditions, strangury, and flatworm infestation.<sup>31</sup> The physician is advised to pay close attention to "symptoms that cease spontaneously" as well as symptoms that benefit the patient even when they arise spontaneously.<sup>32</sup> The physician might intervene on the side of spontaneity, as when by extending the elbow forcibly it is replaced spontaneously.<sup>33</sup>

Very often the descriptions of spontaneously produced effects are explicitly contrasted with effects produced by the medical art. For example, it is said that persons who are attacked by epilepsy in old age, if they do not succumb, recover spontaneously in a short time and are little benefited by a physician; several other comparisons are made in the same work between things that happen spontaneously versus things forced by the physician.<sup>34</sup> In other works we read examples of the same kind of thing, for example of bile breaking out spontaneously without a purgative or emetic,<sup>35</sup> of tuber-

<sup>28</sup> *Op.* 103.

<sup>29</sup> *Acut. (Sp.)* 55 (23.15); *Epid.* 7.1.60.7; *Aph.* 2.5.1.

<sup>30</sup> *Acut.* 19 (6.16), *Acut. (Sp.)* 33 (11.45); *Epid.* 2.5.6.3, 5.1.19.2, 5.1.41.1, 5.1.53.1, 5.1.64.5, 7.1.74.1, 7.1.83.7; *Aph.* 1.2.1, 4.2.2, 4.21.1, 4.78.1, 6.15.1; *Prorrh.* 2.16.2; *Flat.* 10.28-29; *Morb.* 1.8.11, 1.17.7 (cf. 2.28.12, 2.31.6), 2.71.6, 3.16.122; *Ulc.* 8.2, 24.1, 4; *Medic.* 2.19, 10.8; *Int.* 21.8-9 (cf. 42.22, 24); *Mul.* 36.29, 38.21, 40.14, 64.8, 67.7; *Nat. Hom.* 27.24.

<sup>31</sup> *Prorrh.* II.33.3; cf. 20.9 (eye disease); *Art.* 46.27, 46.49 (joints); *Acut.* 14.4.37 (pain, cf. *Acut. (Sp.)* 57.25.24); *Nat. Hom.* 7.33-35 (dysentery); *Mul.* 7.29 (strangury); *Nat. Puer.* 54.55 (flatworms).

<sup>32</sup> *Hum.* 2.1 (cf. 1.6) and 4.16 (cf. 6.16).

<sup>33</sup> *Fract.* 43.5.

<sup>34</sup> *Prorrh.* II.9.18: ὑπὸ τοῦ αὐτομάτου, ὑπὸ δὲ τῶν ἰητρῶν ἥκιστα ὠφελέονται. The same work also mentions diarrhea relieved spontaneously versus by administration of enema (II.23.21); hemorrhages, spontaneous or forced (II.30.5-10); facial paralysis relieved spontaneously or by force (II.38.2).

<sup>35</sup> *Loc. Hom.* 33.13-14: φάρμακον δὲ μήτ' ἰνηθμῶ μητ' ἐμετήριον, χολή δ', ἐπὴν αὐτομάτη ῥαγῆ ἢ κάτω ἢ ἄνω, χαλεπωτέρα παύειν.

cles either incised or broken open spontaneously,<sup>36</sup> of menstrual flow induced spontaneously or by medication,<sup>37</sup> of an abscess breaking “whether by surgery or cautery or spontaneously,”<sup>38</sup> of blood passing not by phlebotomy but spontaneously with sweat,<sup>39</sup> of bone fragments coming up spontaneously not due to trepanning;<sup>40</sup> of spontaneous remission of a disease of the spleen without cauterization or any other treatment;<sup>41</sup> and of spontaneous cleaning (αὐτόματος καθαιρόμενος) that helps a patient suffering from a form of typhus.<sup>42</sup> The curative effect of purging can come about “either spontaneously or by means of drugs”; complications of a disease, too, can happen to a patient either spontaneously or as an “unlucky” result of things administered.<sup>43</sup> The physician must observe symptoms “as many as are artificial, as many as are spontaneous,” and must distinguish between those beneficial and harmful.<sup>44</sup> The physician must be on the lookout for certain symptoms which indicate crisis and is advised: “do not treat any of these with a medication, for that would be dangerous, and your effect would not be to help the patient, but only to deprive his crises of their spontaneity.”<sup>45</sup>

Although it is worth pointing out that there is no univocal notion of spontaneity at work in all these cases, it is nonetheless evident that spontaneity was commonly invoked in early Greek medical parlance (as it was also in other areas of early and classical Greek prose), and fairly early on was conceived of as a cause, either in its own right or in connection with luck, with which the physician must deal. For example, the author of *Diseases* is not alone in treating spontaneity as a general phenomenon and, after giving a list of “things both good and bad that happen to patients spontaneously during their illnesses,” summarizes:

Such things occur and do not occur, not through any ignorance or knowledge of physicians, but spontaneously and by luck (ἀπὸ τοῦ αὐτομάτου καὶ ἀπὸ

<sup>36</sup> *Aff.* 34.6.

<sup>37</sup> *Mul.* 36.38; *Nat. Puer.* 18.35 (cf. 30.28).

<sup>38</sup> *Art.* 12.10: καὶ ἦν τε τμηθῶσιν, ἦν τε καθῶσιν, ἦν τε αὐτόματόν σφιν ἐκτραγῆ, εὔειδέναι χρῆ, ὅτι ταῦτα οὕτως ἔχει.

<sup>39</sup> *Epid.* 2.2.22.4.

<sup>40</sup> *VC* 17.6, 21.9.

<sup>41</sup> *Int.* 19.7, 33.9.

<sup>42</sup> *Int.* 42.10, 22-26.

<sup>43</sup> *VM* XIX (19.23): ἢ αὐτόματοι ἢ ὑπὸ φαρμάκων; XXI (21.3): αἱ μὲν ἀπὸ τῶν αὐτομάτου, αἱ δὲ καὶ ἀπὸ τῶν προσενεχθέντων τῶν τυχόντων. This second passage is especially interesting in that it parallels Aristotle’s distinction between spontaneity and luck.

<sup>44</sup> *Hum.* 5.6: ὅσα αὐτόματα, ὅσα τέχνησιν.

<sup>45</sup> *Acut.* 55 (23.25; tr. Potter in Loeb VI): τῶν τοιῶνδε μηδένα φαρμακεύειν· κίνδυνόν τε γὰρ ἔξει, καὶ οὐδὲν ὀνήσεις, τάς τε ἀπὸ ταῦτομάτου ἀπαλλάξιας καὶ κρίσιας ἀφαιρήσεις.

ἐπιτυχίης); and when they do occur, it may help or harm; likewise, when they do not occur, it may help or harm. (*Morb.* I 7; tr. Potter, Loeb V, mod.)

All of this evidence has been presented in order to show that the medical literature is permeated with the idea of spontaneity, of spontaneous diseases and symptoms, but also of spontaneous recovery of health. Most importantly, medical effects may be accomplished either by deliberate actions in accordance with the medical art, or spontaneously by nature.

Next, I want to strengthen the point by considering some attempts to curtail or minimize the notion of spontaneous recovery from disease, beginning with the work *On Ancient Medicine*.<sup>46</sup> The viewpoint of *On Ancient Medicine* contradicts the viewpoint of *On Regimen I*. The author considers the introduction of philosophical theories about nature into medicine intrusive and otiose: "it is impossible to have any clear knowledge about nature from any other source than medicine."<sup>47</sup> Thus he rejects the reduction of the causes of health and disease to arbitrary and narrow principles such as "hot or cold or wet or dry or anything else they want."<sup>48</sup> Later he identifies Empedocles as an example of this kind of theory; but we can know that theories about the hot and cold as warring opposites were constantly discussed in early Greek literature, including medical literature, through to and beyond Aristotle.<sup>49</sup> According to such theories, the medical writer explains, diseases are associated with an excess or deficiency of one of these principles, such as hot or cold, and remedies are designed to make up for the deficiency for example by supplying heat or cooling to the patient. He rejects this approach entirely, and advocates instead a complex and nuanced dietetic theory. Admitting that medicine is not capable of the "exactitude" or "accuracy" of other sciences, he nonetheless defends its scientific basis, holding "its discoveries as having been made admirably, correctly, and not by luck" (οὐκ ἀπὸ τύχης).<sup>50</sup> This concern to downplay the effects of luck, and to demonstrate that medicine is a real art and that its successes are not due to luck and spontaneity, is voiced in other Hippocratic writings, especially *On the Art* and *Places in Man*.<sup>51</sup>

<sup>46</sup> Περὶ ἀρχαίης ἰητρικῆς = *VM*; tr. Schiefsky.

<sup>47</sup> *VM* 20; tr. Schiefsky.

<sup>48</sup> *VM* 1; tr. Schiefsky.

<sup>49</sup> Lloyd 1966, 34-46, 60-61, 80-82. Schiefsky comments that "the depiction of opposites such as hot and cold as forces engaged in war and struggle with one another is a commonplace of early medical and philosophical thought, and survives even in Aristotle" (comm. on *VM* 16, p. 267). He refers to the useful discussions in Kahn 1960, 126-133; and Solmson 1960, esp. 347-348, 359-360.

<sup>50</sup> *VM* 12; tr. Schiefsky.

<sup>51</sup> *Loc. Hom.* 43: "the whole of medicine has been established, and the excellent principles discovered in it clearly have very little need of good luck. Good luck is arbitrary and

In the service of his critique of philosophical medicine, the author of *On Ancient Medicine* offers numerous examples to show that the philosophical principles of hot and cold should not be thought to be the primary determinates of health and disease. In fact, "of all the powers cold and heat exercise the least power in the body."<sup>52</sup> The presence of hot and cold in the body by itself occasions no problem because, by an unexplained homeostatic mechanism, they temper each other; it is only when they are "separated" that there may arise a problem. But in all such cases, the body itself "spontaneously" generates heat or cold, thus healing the patient without any need of the assistance of the medical art. For example, when the body has been chilled, "hot, coming right from the human being, presents itself in the front line, needing neither assistance nor preparation (οὐδεμιῆς βοηθείης οὐδὲ παρασκευῆς)" (*VM* 16; tr. Schiefsky). The medical writer gives numerous examples, including the effect of spontaneously being warmed up after taking a cold bath, of being spontaneously cooled down after a hot bath, the contradictory effects of fanning, the burning sensation of frostbite, and the presence of fever to counter chills, and of sweats to counter fever. There are countless other examples he might give to illustrate this subject, he writes. He concludes the discussion with the following rhetorical question:

Now how could anything great or terrible come from something that is swiftly met in this way by what is most opposed to it and takes away its power spontaneously (ἀπὸ τῶντομάτου)? Or what need is there for much assistance (βοηθείης) against it? (*VM* 16; tr. Schiefsky)

The medical art is necessary in those cases where nature cannot by itself or spontaneously neutralize dangerous or deleterious forces in the body. Now *On Ancient Medicine* argues that although the body can without the medical art spontaneously make up for deficiencies of hot and cold, many ailments cannot be spontaneously neutralized, and so the art of the physician is a legitimate and necessary one. The assumption, held also by the author of *On Regimen I*, is that the medical art is required exactly to the extent that natural and spontaneous causes fall short and nature needs further assistance or help.

We have now seen an attempt in the medical literature to limit or minimize the importance of spontaneous causes. Next I will consider an attempt to *eliminate* spontaneity as a cause of health and disease. Although the idea of the spontaneous recovery of health without the intervention of medical art was prevalent, it was by no means uncontroversial, as can be seen in the

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cannot be commanded, and even prayer cannot make it come; but understanding can be commanded, and of itself represents good luck, whenever the person who has knowledge employs it" (tr. P. Potter in Loeb VIII).

<sup>52</sup> *VM* 16; tr. Schiefsky.

work *On Nutriment*. The author of this work argues that spontaneous harms and benefits only appear as such "to us," and in fact must have some other more definite cause:

Humors that corrupt both whole and part, both from without and from within, are both spontaneous and not spontaneous: on the one hand, they are spontaneous to us, but on the other hand they are not spontaneous with respect to cause (ἡμῖν μὲν αὐτόματοι, αἰτία δὲ οὐκ αὐτόματοι). And of the cause, part is clear, but part is unclear, and the one is within our power, but the others are not in our power. (*Alim.* 14; tr. Jones, Loeb I, mod.)

The author of *On Nutriment* thus argues that the labeling of something as spontaneous does not designate a positive cause or principle, but rather ignorance of the way that the humors function in the body. Further research may reveal the real mechanism at work, in which case the cause will no longer be considered spontaneous.

The author of the work *On the Art* is even more vehement in his rejection of spontaneous recovery of health.<sup>53</sup> The work opens by criticizing those who make an art of demeaning the arts, and announcing that he will defend medicine against various charges. He asserts that medicine comes from a real form (ἐκ τινος εἶδος), and thus grows out of and is grounded in nature, not in convention or luck.<sup>54</sup> He offers a definition of the art as the elimination or relieving of suffering and disease, and the refusal to treat incurable cases. He begins a defense of the art by answering those who claim that patients are cured not through the art but by luck or spontaneous causes. He argues that spontaneous recovery from disease is in fact impossible, and that cases in which the sick recover without the intervention of the art are due to necessary processes happening incidentally that the physician would have ordered in accordance with the art. Patients are more blameworthy than physicians for fatalities, and even mistakes indicate the existence of an objective cause of health in theory knowable by the medical art.<sup>55</sup> Those who claim that physicians only take on those cases that would be cured by natural causes anyhow demand from the art a power that does not belong to the art, a kind of ignorance or madness similar to demanding from nature something that is not in the power of nature (*de Arte* 8). The art of the phy-

<sup>53</sup> *περὶ τέχνης* = *de Arte*. I have benefited from a draft translation and commentary by J. E. Mann, *Hippocrates: On the Art of Medicine* (forthcoming).

<sup>54</sup> *de Arte* 2: τὰ μὲν γὰρ ὀνόματα νομοθετήματά ἐστι, τὰ δὲ εἶδα οὐ νομοθετήματα, ἀλλὰ βλαστήματα φύσιος (following Gompertz's reading, as in Loeb II, 192).

<sup>55</sup> *de Arte* 7. This is similar to Aristotle's argument in *Physics* II 8 that freaks or monsters in nature testify to the existence of natural ends, just as the possibility of the doctor pouring out the wrong dose does, because in such cases there is agreed to be an end which either nature or the medical art fails to reach.

sician either follows what nature indicates is needed, or forces nature to reveal what is needed by making evident what is obscure.<sup>56</sup> In both cases medicine uses natural causes in order to bring about its benefits by art. The argument against spontaneous recovery is the following:

Nothing is useless for good physicians and by the art of medicine itself, rather inside most of the things that grow naturally and are produced exist the forms (τῶν τε φυομένων καὶ τῶν ποιευμένων ἔνεστι τὰ εἶδεα) of cures and drugs. Thus no patient who recovers without a physician can for a correct account give as the cause spontaneity (τὸ αὐτόματον αἰτιήσασθαι ὀρθῶ λόγῳ). Indeed, upon examination spontaneity disappears; for everything that is generated will be found to do so *because of something* (διὰ τι), and in virtue of this “*because of something*” spontaneity does not appear to be anything real but a mere name (ἐν τῷ διὰ τι τὸ αὐτόματον οὐ φαίνεται οὐσίην ἔχον οὐδεμίην). Medicine, however, because it acts “*because of something*,” and because its results may be known in advance, has substance, as is obvious now and will be always. (*de Arte* 6, my translation)

The Author of *On the Art* thus agrees with the author of *On Nutriment* that spontaneous causes do not in fact exist except in name, that spontaneous recovery is a bogus notion, and that there is always some positive causal principle: “because of something” (διὰ τι) patients recover, whether by the medical art or otherwise. It is remarkable that the author understands this cause to be “forms” that “exist inside” things that are produced or grow naturally. As we will see in the next section, Aristotle’s own account of how health is produced in a patient has to do with the “production” of “form” in the body of the patient.

But before turning to that account, allow me to draw some conclusions based on this rapid survey of spontaneity in the Hippocratic Corpus. We can discern two extreme views about spontaneous causes. One is the view that the medical art produces no health, but all recovery of health is due to spontaneous causes. This position is attacked by those who defend the medical art as a real art, such as the authors of *On Ancient Medicine*, *Places in Man*, and *On the Art*. At the opposite extreme is the position that there is in fact no such thing as spontaneous causes and spontaneous recovery of health; in effect all health either has natural causes or is produced by the medical art. Between these views is the moderate (and perhaps unreflective) position that there are some cases of spontaneous remission of disease, but in many or most cases the medical art is necessary to assist a diseased body for the sake of health. The moderate position will be seen, in the next section, to resemble Aristotle’s considered position that health may in some, but not all cases, be restored spontaneously without the assistance of the medical art.

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<sup>56</sup> *de Arte* 11-12; cf. Lloyd 1966, 353.

IV. *The Aporia about Spontaneity in Metaphysics VII*

In *Metaphysics* VII 7-9, Aristotle directly raises and proposes to resolve the issue of why such things as health, which can also be produced by the medical art, can ever be caused spontaneously. There is a consensus of commentators that this section of what is now *Metaphysics Zeta* originally comprised an independent essay.<sup>57</sup> In it, Aristotle develops a general framework for the analysis of all production and generation (all “coming to be”), whether of natural or artificial things, according to three interrogations: What is it? What is it made out of? What produces it? These correspond to familiar causal discriminations between form, matter, and producer.

Aristotle argues that in all production the producer and the product have the same form and thus the same name. This “univocal principle”<sup>58</sup> is argued to apply to natural reproduction, “for a human begets a human” (1032a25), a doctrine of sexual reproduction that Aristotle develops at length in the biological works and frequently invokes as the paradigm of natural generation throughout the physical works.<sup>59</sup> According to that doctrine the father’s seed contains an inherent “power” or “source of change” for the production of the form of the animal in the matter supplied by the female parent. The seed transmits the heat of its *pneuma* to the female material; this has the effect of “ripening” or “concocting” the growth of the new organism in a way analogous to how the heat of the sun fosters the growth of plants. Somehow the heat works according to a formula that corresponds to the form of the father; this process of heating changes the female’s material into the same form; thus the form of the producer (the father) and the product (the son) are identified and strongly differentiated from the matter (the mother). In this model of sexual reproduction, the causal factors of form and producer naturally coincide, as Aristotle repeatedly emphasizes in discussions of his causes.<sup>60</sup> Later we will see that this is

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<sup>57</sup> The evidence is presented in Burnyeat 2001, 29-38, and my interpretation is heavily indebted to his. See also Ross 1924, 181; Bostock 1994, 119.

<sup>58</sup> They are thus said to be “homonymous” at VII 9, 1034a2-b4, which is later corrected to “synonymous” in the parallel section of *Metaphysics* XII 3, 1070a5. See Burnyeat 2001, 33 and n59.

<sup>59</sup> A concise summary of Aristotle’s account of sexual reproduction and how it relates to spontaneous generation in Lennox 1982, 221-225. I have borrowed and built on Lennox’s arguments throughout this paper.

<sup>60</sup> The most salient passages include these: “Since all knowledge of nature concerns the four causes, it is naturally necessary to prove the reason in all these ways: the matter, the form, the mover, the for the sake of which. Three of these often coincide in one. For ‘what it is’ and ‘what it is for the sake of’ are one, and ‘what first moved it’ is the same in kind as these, as in the case where a human reproduces a human” (*Phys.* II 7, 198a22-27); “The soul

the crucial difference between sexual reproduction and spontaneous generation; in the latter case the form and the producer are not the same, rather the form is closer to the *matter* than to the producer. Aristotle's account of spontaneous generation is nevertheless built upon his account of sexual reproduction, because in both cases it is primarily due to the addition of heat that a certain organic form is produced.

In the case of artistic productions, the producer and product are the same only "in a way" (τρόπον τινά, 1032b11): the doctor or the builder has the same form in his mind—the formula of health, or the blueprint of a house—that they go on to produce, or rather re-produce, out of some matter, either the stones and timbers, or the hot and cold in the body of the patient. But the qualification "in a way" is made in order to acknowledge that the form in the doctor or builder's mind, unlike their actual products, and unlike the father and son, is not itself produced out of matter. And yet in some cases, it turns out that the form is somehow produced out of the matter, namely in those cases in which materials themselves somehow "spontaneously" produce an outcome that would otherwise be produced by art. These are apparently cases of "equivocal" generation, since the producer and product are not at all the same, not even "in a way" as in the case of artistic production. This phenomenon of the "spontaneous" production of certain forms occasions the following *aporia*: "It is a difficulty why some things can be generated both by art and by spontaneity (ἀπὸ ταῦτομάτου), like health, but others not, like a house" (*Metaph.* VII 9, 1034a9-10).

The two examples that Aristotle contrasts here, *health* and *a house*, are repeatedly paired, as we saw in *Physics* II and elsewhere. That health is mentioned should thus be expected, given the medical background discussed in the last section. It is surprising, then, that the background of this dispute is ignored or downplayed by modern commentators, and generally mishandled.<sup>61</sup> Bostock, for example, recommends simply setting the example of health aside and concentrating on the other example, that of a house.<sup>62</sup> The problem with Bostock's procedure is that it ignores not only

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is a cause and principle of the animal body. These causes are said in several ways. Similarly, the soul is a cause according to three of the ways we have determined; for the soul is a cause as the mover from which, and as that for the sake of which, and as the substance of the bodies that have a soul within" (*An.* II 4, 415b7-12); "Nature exists and is spoken of as both matter and as substance, and as substance is both as the mover and as the end" (*PA* I 1, 641a25-7); "It is necessary to regard as almost identical the cause for the sake of which, as an end, and the account of the substance" (*GA* I 1, 715a4-6).

<sup>61</sup> Neither Ross, nor Frede and Patzig, nor Bostock, refer to any parallels in the Hippocratic literature in commenting on *Metaphysics* VII 7-9.

<sup>62</sup> "Since it [sc. health] is the only example he gives of something that may be generated both by skill and spontaneously, one might expect it to be playing an important part in his



the original intellectual background of the *aporia*, but also the fact that Aristotle's solution requires a distinction to be drawn between health and a house, and recognizing how the former could be generated spontaneously but the latter cannot.<sup>63</sup> The centrality of the example of health to Aristotle's thinking on this issue is evident from the fact that in other works, when he makes the exact same point about spontaneity, he invariably refers to the example of health, as in the *Posterior Analytics* and *On the Parts of Animals*:

Among the products of thought, some never occur spontaneously—e.g., a house or a statue—nor from necessity either, but for the sake of something (ἀλλ' ἕνεκά του); but others occur also by luck—e.g., *health and safety* (οἶον ὑγίεια καὶ σωτηρία). (*An. Post.* II 11, 95a3-6; tr. Barnes, mod.)

A human begets a human; and thus it is because the parent is such and such that the generation of the child is thus and so. The same statement holds good also for those which are apparently spontaneous, as also for the products of art. For the same result as is produced by art may occur spontaneously, e.g., *health*. The same producer preexists for those things, such as the statuary's art, that cannot possibly be produced spontaneously. The art indeed consists in the account of the product without its matter. (*PA* I 1, 640a25-32; tr. Ogle, mod.)

It is an important fact that for Aristotle, although they are all theoretical sciences, biology, physics, and metaphysics are autonomous sciences, and one needs to be very careful (more careful than many have been) about using metaphysical passages to illuminate passages of Aristotle's biology (and vice-versa).<sup>64</sup> But the fact that the same *aporia* is raised (about spontaneous generation) and the same models of arts are used to investigate it (building and medicine) in each of the works devoted to these sciences, as well as the *Posterior Analytics*, is an indication that a prior set of problems and concepts must be clarified before any of these sciences can be pursued individually. It has been argued that Aristotle treats the *aporia* differently in the *Physics*, *Generation of Animals*, and *Metaphysics*, but I will endeavor to show in what follows that he in fact treats it consistently in all these works and in the *Posterior Analytics*.

According to Aristotle, in artificial production the product is generated by a producer, such as a sculptor, architect, or doctor, who has in his soul the

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thinking on this topic. But let us begin by simply setting it aside, and supposing that he is concerned with the generation of a material thing such as a house (by skill) or, say, a sand dune (spontaneously). In that case, we can take the 'matter' is spoken of in this paragraph in a straightforward way" (Bostock 1994, 135).

<sup>63</sup> Bostock's example of a "sand dune," which he later admits was suggested "somewhat lamely" (136), cannot possibly capture Aristotle's point, because there is no reason to intentionally generate a sand dune, but there is obviously reason to intentionally generate health.

<sup>64</sup> On this point, see: Bolton 2010, 30-55.

same form of their art: "from art come to be those things of which the form is in the soul" (1032a32-b1). The artist has "the 'what it is' to be something," in their soul: "art indeed consists in the account of the product without its matter" (*PA* I 1, 640a31-32). In the *Metaphysics* he gives as a detailed example the production of health by a doctor.

Health is the formula in the soul and in the science [of medicine]. The healthy, then, comes to be from the diseased in the following way. Since health is such-and-such, if he is going to be healthy, then this will have to exist first. For example, since health is a state of equilibrium (ὁμαλότητα) in the body, if he is going to be healthy, there must be heat, and the doctor goes on thinking like this until he reaches a final thing that he himself is able to produce. The process from this point until it reaches health is called "production." So there is a way in which *health is produced out of health and house out of house*, and that with matter out of that without matter. For the medical art and the building art is the form of health and of the house. By substance without matter I mean "what it is" to be something. Of productions and movements one part is called thinking and the other producing: that which proceeds from the principle and the form is "thinking," and that which proceeds from the final step of the thinking is "producing." And each of the intermediate steps is taken in the same way. I mean, for example, if the patient is to be healthy his bodily state must be put into equilibrium. What then does being put into equilibrium imply? This or that. And this depends on his being made warm. What does this imply? Something else. And this something is present potentially; and what is present potentially is already in the physician's power. The starting point of the production of health, if it is from the art, is the form in the soul. If it is instead from the spontaneous, then it is the thing that at some point starts to be produced by the producer from the art, as when in doctoring the starting point is from the heat, which the doctor produces by rubbing. The heat in the body, then, is either a part of health, or is followed by something (either immediately or through many steps) that is a part of health. And this is the ultimate thing and the producer, this kind of part, in the case of health, and in the case of the house, for example, it is the bricks, and so in the other cases. (*Metaph.* VII 7, 1032b5-30)

The production of health by the medical art is thus explained. The doctor has the formula of health (equilibrium of hot and cold, say) in his soul, and he reasons about how to produce it in another: the patient is cold, and so needs to be warmed up; rubbing can increase the heat of the patient's body. The process, from the physician beginning to rub the body, through the warming of the patient, up to the restoration of the patient to health, is understood as a "production" of the form of health in the patient. What is produced is health, out of the equilibrium of hot and cold in the patient's body, by the agency of the doctor, who has in his soul the medical art, which includes the formula of health, as equilibrium between the hot and the cold.<sup>65</sup>

<sup>65</sup> Bostock writes: "the points that he wishes to make about producing health he applies

This formula is the same, or is synonymous with the form of health that is produced (or rather re-produced) in the patient.

This account makes perfect sense when one considers the background of Aristotle's conception of the medical art. Recall that in *On Regimen I* it is argued that the balance of hot and cold (and their material correlates, fire and water) in the body is the primary cause of health and disease. We find this view about the importance of hot and cold vehemently rejected in *On Ancient Medicine*, which is strong evidence that it was a widespread view. The collection of medical opinions attributed to Aristotle by the author of the *Anonymus Londenensis* is largely organized around a division of medical theories according to the principles of disease and health they posit, and the hot and cold are principles in virtually all of the theories mentioned, beginning with Hippocrates.<sup>66</sup> This view of health and disease is also consistent with the account of health in the *Topics* and the *Problems*.<sup>67</sup> When

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equally to the production of, e.g., a house (b12), but I suspect that he has in fact been misled, in the last two paragraphs of this chapter, by paying insufficient attention to the distinction" (comm. at 1032a26-b14, p. 124). Similarly Ross finds it "difficult to regard the relation of heat (or rubbing) to health as analogous to that of stones to the house that is made of them. ... the heat in the body is naturally conceived not as the material but as the efficient cause of health, and so it seems to be conceived in l. 21. Aristotle has got into difficulties through taking as parallel two things that are not parallel—health and a house (l.11). That which is to the doctor as a house is to the builder is not health but a healthy body. Having thus stated the product abstractly Aristotle also states the cause abstractly, not as 'a body having heat' but as 'heat in the body'; and thus he gets something not really parallel to the stones—which are the material cause of a house—and not really a material cause. There is, however, in his view a real difference between the two cases (1034a9)" (comm. at 1032b28-30, vol. 2, 184). Here I think that understanding the medical background can considerably clarify matters. The form of health is equilibrium of hot and cold in the body, and the material cause of this is equilibrium of the hot and cold (as the author of *On Regimen I* argues). Now an equilibrium of hot and cold in the body can be produced by a physician who has this the formula of this equilibrium in his own mind and reasons about how to produce it in the body of a patient, e.g., by rubbing so as to increase the ratio of hot to cold (i.e., fire to water). Similarly, the builder has the blueprint of a house in his mind and reasons about how to produce it in a stockpile of stones and timbers, e.g., by moving them around so that the timbers are on top of the stones. What is not parallel is that the production of health can happen without the agency of the doctor, for example if the patient is warmed by the weather or a hot drink or rubbing for another reason. The production of a house, on the other hand, cannot happen spontaneously, but requires an agent that has the form of a house in mind.

<sup>66</sup> "On this theory, when residues occur, they give rise to breaths, which rising as vapor cause diseases. *These changes take place in two directions, towards excessive heat or excessive cold.* The nature of the change determines the character of the disease. This is Aristotle's view of Hippocrates" (*Anonymus Londinensis* V.35-42; tr. Jones, 39). The hot and cold occur constantly in the section on the stoicheia, for which see the useful summary in Manetti 1999, 119.

<sup>67</sup> According to the *Topics*, health is a balance of certain opposites, in particular hot and cold (139b21; 145b8; 246b5). Disease, accordingly, is an imbalance of certain opposites (ac-

Aristotle in the *Parts of Animals* writes that “the wet, the dry, the hot, and the cold are the matter of composite bodies,”<sup>68</sup> it is not hard to imagine that he was prepared for this conclusion by the extensive use of these opposites in the medical literature.

Even more to the point is the account of how physicians cause health in *On the Art*, where it is argued of cures and drugs used by the medical art that the forms exist inside (ἔνεστι τὰ εἶδεα) “things that grow or are produced” (τῶν τε φυομένων καὶ τῶν ποιευμένων) and that these forms can be given as the cause (αἰτιήσασθαι) because of which (διὰ τι) patients recover their health. Now that account, so parallel to Aristotle’s account of artistic production of health, is meant to exclude the possibility of spontaneous recovery. But Aristotle, apparently as an empirical matter of fact, accepts that some diseases are cured spontaneously, as is clear from his causal account of how this happens.

The explanation is, thus, that the matter, which is the starting point of the generation of something produced or generated from art (and in which it inheres as a part of the thing), in some cases is such as to be moved by itself, but in other cases is not. And in the former cases, some [material] is such as [to be moved] in the same way [as in the art], but in other cases it is incapable of this. For many things are capable of being set in motion by themselves but not in the same way [as in the art], like dancing. Of those things whose matter is of this kind, some are incapable of being moved in the same way [as the art] except by another [producer], for example stones; but others are—even fire. That is why some things cannot be produced except by someone who has the art, but others can. For the latter can be moved by something that does not have the art, but is capable of being moved itself, either by something else not having the art, or by a part. (*Metaph.* VII 9, 1034a10-21)

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according to *Prob.* I 3, of hot and cold and wet and dry) such that there is an excess of one and a deficiency of its opposite. This is put in quite general terms at the outset of the *Problems*: “Why is it that great excesses cause disease? Is it because they engender excess or defect and it is in these after all that disease consists?” (*Prob.* I 1; tr. Forster). It follows that the doctor, aiming to produce health, must counteract excesses and deficiencies that produce disease when there is an imbalance of the primary qualities. Thus some diseases can only be cured if the patient increases the intake of certain things (e.g., water or fibrous plants) and reduces certain others (e.g., salt or sweets). The prescription or prohibition of foods or beverages associated with the primary qualities is intended to reduce the excesses or deficiencies in the body, which constitutes disease, and thus restore them to a mean, which constitutes health (*Prob.* I 2; XXX 8).

<sup>68</sup> *PA* II 1, 646a16-17. Cf. *GA* II 1: “hot and cold could make hardness, softness, adhesiveness, brittleness and whatever other affections underlie the animate parts” (734b31-33). Solmsen 1960, 347-348, however, writes that “it is hard to gauge the extent to which the pivotal role of the ‘powers’ in medical thought facilitated their rehabilitation in Aristotle’s system” (347).

Thus the general explanation of the spontaneous generation of results normally obtained through a productive art is as follows: in such cases the matter (e.g., hot and cold in the body) can be moved or changed either by a producer who has the form of health in mind, or they can be changed by themselves *in the same way as in the art*, but without a producer that has the formula of health in mind.<sup>69</sup> As the author of *On Ancient Medicine* argues, the body is capable of spontaneously increasing internal heat in response to cold (e.g., a cold bath, frostbite, chills, etc.). In Aristotle's terms, in such cases of spontaneous generation of health the matter moves itself or is incidentally moved in such a way so as to produce the equilibrium of hot and cold in the body of the patient. In other cases, however, the materials cannot move themselves so as to produce the relevant form: some cases of health in human bodies, for example, or all cases of houses out of bricks and timbers.

This seems to be a reasonable point. Clearly not all materials are capable of spontaneously generating something that is normally produced by art. Stones, to use Aristotle's example, cannot move themselves so as to be spontaneously assembled into houses. A builder is required to transform a pile of stones into a house, or to put it in more starkly Aristotelian terms, to re-produce the form of a house out of a pile of stones. We might dispute this, if we were willing to consider a cave a house, since caves to some extent can serve the purpose of a house but come about due to necessary causes totally incidental to this possible use. But surely the space shuttle, or the United Nations, require agents distinct from their materials for their creation; they are things whose parts are not such as to be movable in themselves in the required (i.e., hypothetically necessary) manner. Similarly, even if some diseases can be cured spontaneously, there is no reason to think that all can: some kinds of cancer may spontaneously remit, but not all kinds; type 2 diabetes can sometimes go away if the patient happens to lose enough weight (even if the patient does not intend to lose weight), but type 1 diabetes cannot be treated without insulin. In those cases where

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<sup>69</sup> The italicized clause is essential because, as Joel Mann has pointed out to me, even the materials of a house are capable of being moved by someone or something that does not have the form of a house in mind. The point has to be that in some cases the matter is such that it can be moved by itself in the same way that the artist with the form in mind would move it. Bricks cannot possibly move themselves in such a way that will produce a house, but the hot and cold in the body can be changed by itself in such a way that restores the healthy balance just as a doctor would try to make it do. That is why Aristotle says "many things are capable of being set in motion by themselves but not in the same way" meaning, the same way as the physician would do.

health cannot be generated by spontaneous processes internal to the patient, the outside intervention of the medical art is required.

Insofar as Aristotle is convinced, perhaps on empirical grounds, that some diseases and symptoms spontaneously remit, he agrees with the authors of *On Regimen I* and *On Disease*, and many of those other medical writers who casually refer to spontaneous causes in various contexts. As I have said, not all of these views are consistent and there is certainly no unequivocal notion of spontaneity at work in the Hippocratic Corpus. But Aristotle for his part has tried to determine what all cases of "spontaneity" have in common: that the matter involved (i.e., hot and cold in the body) is such as to be moved in accordance with how the physician would move it in accordance with the medical art so as to produce the form of health in the patient. He thus rejects the extreme position of the authors of *On Nutriment* and *On the Art*, who hold that there are no real spontaneous causes of health. But he agrees with the author of *On Ancient Medicine* that some other cause (i.e., art, the medical art) is necessary when nature falls short and does not spontaneously cause changes that restore the body to health. Of course he disagrees with the same author by holding that the hot and the cold are important determinates of health and disease, but he does agree that these very factors may, in some cases at least, be effected by the body spontaneously, meaning without the aid of the medical art. He thus follows a *via media* between the extreme positions and accepts that spontaneity is a cause of some but not all cases of health. As we will see in the next section, he follows a similar *via media* in his account of the spontaneous generation of animals.

#### V. *The Theory of Spontaneous Generation in Generation of Animals*

Aristotle stays on this *via media* throughout his natural science, although he occasionally veers one way or another, for example in his tendency to see more and more species of living things being spontaneously generated or, in the other direction, in his zeal to exclude spontaneous causes from the stars and the cosmos as a whole. Thus he indeed holds that many living things are spontaneously generated: "some animals spring from parent animals according to their kind, while others grow spontaneously and not from kindred stock."<sup>70</sup> In fact, it has been estimated that fully one fifth of the animals mentioned by Aristotle are exclusively spontaneously generated.<sup>71</sup>

<sup>70</sup> *HA* V 1, 539a21-23; tr. d' A. W. Thompson, mod.

<sup>71</sup> Hull 1967-1968, 246. See also: Louis 1968.

This includes insects, oysters, eels, sea urchins, and many other creatures that Aristotle is keenly interested in.<sup>72</sup>

On the other hand, Aristotle holds that most animals, and the most important of them, cannot be spontaneously generated. Sexually reproduced and spontaneously generated beings constitute the extreme poles of a scale or hierarchy of natural kinds. At the top of the scale are the sexually reproducing organisms, with humans at the apex, being the model species in which the form of the male parent is "always or for the most part" exactly reproduced in the female matter, and the functions of the male and female are as distinct and ordered as possible. Other kinds of animals and living things are understood as degenerate from the model kind in various ways, but their place on the scale of nature is largely determined by their mode of reproduction.<sup>73</sup> Beneath the sexually reproducing organisms are those animals and plants in which the male and female contributions are "mixed," and thus the formal and material causal factors are less differentiated and hierarchically ordered. Lower still are those animals and plants in which there is no formal reproduction whatsoever, but rather generation of the living form out of the matter itself. This is the situation of the spontaneously generated organisms.

As G. E. R. Lloyd has pointed out in his masterful discussion of Aristotle's researches into spontaneous generation and metamorphosis, Aristotle goes to great lengths to assimilate his account of spontaneous generation to his official account of nature and its orderly causes: thus it is possible to give a complete "four" causal analysis for spontaneously generated organisms.<sup>74</sup> Consider two passages in which Aristotle discusses the productive cause of spontaneously generated organisms. The first is from *On the Generation of Animals* II 6 where Aristotle directly compares artificial produc-

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<sup>72</sup> Plants (*HA* 539a18; *GA* 715b27) and animals (*An.* 415a28; *HA* 539a22,b7; *GA* 743a35, 759a7; *Prob.* 898b5); specifically some insects (*HA* 551a1; *GA* 721a2-10, 732b12, 758a30, b7), shellfish as a kind (*HA* 547b19, 548a11; *GA* 761a18, b24-26, 762a1-9, 762b18, 763a25-6), and some fishes (*HA* 539b3, 569a25, 570a16). Also, he frequently invokes the spontaneous in describing reproductive processes even of non-spontaneously generated organisms (*HA* 558a16, 559b1-6, 637b18, *GA* 749a35, 756a19) and deformities (*HA* 587b26, *GA* 773a18).

<sup>73</sup> *GA* I 23, 731a24-b8; II 1, 731b20-732a1; cf. *HA* VIII 1, 588b21-589a5.

<sup>74</sup> Lloyd 1996, 104-125. Lloyd discusses in depth the many scientific virtues of Aristotle's account, such as the frankness about the problems and frequent calls for more investigation, the appeals to detailed observations as evidence, and the robustness of his concept of nature and causes in dealing with the phenomena, many of which are after all genuinely puzzling. His account is all the more interesting because of his detailed account of related phenomena in Chinese writers. Lennox 1982 answers in yet greater detail the charges of inconsistency leveled against Aristotle by Balme 1962 and Hull 1967-1968.

tion, sexual reproduction, and spontaneous generation, holding heat to be the productive cause in all three cases, but in a different way in each.

The heat exists in the seminal residue, and the movement and activity in it is sufficient in kind and in quantity to correspond to each of the parts. Insofar as there is any deficiency or excess, the resulting product is in worse condition or physically defective, in like manner as in the case of external substances which are thickened by boiling that they may be more palatable or for any other purpose. But in the latter case it is we who apply the heat in proportionate balance (συμμετρίαν) for the motion required; in the former it is the male parent that gives it; in the cause of animals spontaneously generated it is the movement and heat imparted by the right season of the year that is the cause. (*GA* II 6, 743a26-36; tr. Platt, mod.)

We have already discussed how spontaneous generation is analogous to sexual reproduction, insofar as both depend on the action of heat on suitable materials that somehow ripens or concocts the matter into a certain form. In the case of sexual reproduction that form is identical with the form of the mover (and the production is thus univocal), but this is not the case with spontaneous generation, since the mover is the heat added by the sun but the form is determined by the matter (and the production is thus equivocal). In all cases, including artificial production, the producer adds heat in order to achieve an equilibrium or proportionate balance. Later, in his discussion of shellfish, Aristotle goes into further detail about this process.

Now all things formed in this way, whether in earth or water, manifestly come into being in connection with putrefaction and an admixture of rain-water. For as the sweet is separated off into the matter which is forming, the residue of the mixture takes such a form. Nothing comes into being by putrefying, but by concocting; putrefaction and the thing putrefied is only a residue of that which is concocted. For nothing comes into being out of the whole of anything, any more than in the products of art; if it did art would have nothing to do, but as it is in the one case art removes the useless material, in the other nature does so. Animals and plants come into being in earth and in liquid because there is water in earth, and air in water, and in all air there is vital heat so that in a sense all things are full of soul. Therefore living things form quickly whenever this air and vital heat are enclosed in anything. When they are so enclosed, the corporeal liquids being heated, there arises as it were a frothy bubble. (*GA* III 11, 762a9-24; tr. Platt, mod.)

Aristotle thus gives an account of the productive cause of spontaneous generation, the heat supplied by the sun, and he describes it as a process of concoction, a phenomenon about which he offers a developed proto-chemical theory in *Meteorology* IV.<sup>75</sup> As for the formal and final causal

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<sup>75</sup> *Meteor.* IV 1-3. Heat produces concoction (πέψις) by which different elements are chemically changed into a homogenous whole.



factors, he says: "whether what is forming is to be more or less honorable in kind depends on the embracing of the psychical principle; this again depends on the medium in which the generation takes place and the material which is included" (*GA* III 11, 762a24-26; tr. Platt). So even among the spontaneously generated organisms there is a graduated scale of vitality and beauty or honor among their forms. Thus they surely have forms. Aristotle holds that everything has a form, although the cause "for the sake of which" those forms exist is less clear the more they are determined by the material principle.<sup>76</sup> Beyond the spontaneously generated organisms the scale of nature forms a continuum with plants (testaceans are directly compared with plants), and then the inanimate "homoeomerous" substances, including stones, metals, minerals, crystals, and so forth.<sup>77</sup> Beyond these are the bare elements themselves, at which point we hit the explanatory bedrock of Aristotle's physical theory. But there is no question that, since even these inanimate substances have forms, surely spontaneously generated organisms have not only forms but even ends. The difference between the forms of spontaneously generated and sexually reproduced animals is that the productive cause and form is identical in the sexual case (and the generation is thus univocal), but in the spontaneous case the heat is the producer, while the form is largely determined by the matter (and the generation is thus equivocal).

Aristotle's discussion of "the medium in which the generation takes place and the material which is included" completes the "four" causal account by referring to the different kinds of matter in which the different kinds of spontaneously generated organisms come to be. Details are provided throughout *History of Animals* V-VI and *Generation of Animals* III: decaying and putrefying matter, mud and excreta, hair and flesh are suitable materials for spontaneous kinds to be formed in. Butterflies, for example, are generated in cabbage, beetles in wood, ticks in grass, caterpillars in fruit trees, gnats in vinegar, and a certain kind of animal that resembles a scorpion in old books. A study of these passages reveals that Aristotle has been convinced on empirical (but not experimental) grounds that some animals have been generated in environments devoid of parents or eggs.<sup>78</sup> He argues

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<sup>76</sup> *Meteor.* IV 12: "the cause for the sake of which is least clear where matter is most. For just as if we also take the extremes: on the one hand, matter is nothing but matter itself; on the other hand the substance is nothing but a formula, and the things in between them are related proportionately by their proximity to each extreme. For each of these are for the sake of something, and is not absolutely water or fire, just as flesh is not, nor are the viscera, and the same is true, a fortiori, for the face and hand" (390a3-9).

<sup>77</sup> *HA* VIII 1, 588b4-18; *PA* IV 4, 681a9-15. See Lloyd 1996, 67-82.

<sup>78</sup> Lloyd 1996, 115-117, discusses and summarizes these examples and several others.

against those who hold that all kinds of mullets spontaneously reproduce: some have parents, he observes; but "there is a species of mullet that grows out of sand and mud" he infers, on the basis of a report about the appearance of these fish after rains in a drained swamp. Similar empirical grounds are invoked to support the spontaneous generation of eels.<sup>79</sup>

Aristotle's theory of spontaneous generation in these cases, like his account of the spontaneous production of health in the *Metaphysics*, involves the idea that certain materials are capable of moving or being moved by themselves in such a way that would otherwise be brought about by natural, i.e., sexual, reproduction. In spontaneous generation the materials involved are ultimately air, earth, and water and the various products of their recombination. When heat is added to suitable materials, balanced proportion (*συμμετρία*) is achieved among the elements and qualities so as to produce a viable form. Just as heat can be responsible for the spontaneous production of health when it is able to create a balanced proportion of elements or qualities in the body, so heat can be responsible for the spontaneous generation of living things when it is able to create a balanced proportion of materials.

The medical background of the problem of spontaneous generation shows why Aristotle would not feel forced to accept the conclusions that Hull and others would urge upon him.<sup>80</sup> To ask why there is any need for formal reproduction since some species can be generated spontaneously is a lot like asking why there is any need of doctors, since some diseases spontaneously remit. It does not follow from the fact that some diseases may be spontaneously cured that all diseases may be. There are some diseases that cannot be cured without the intervention of the doctor, and similarly there seem to be some living things that cannot be generated spontaneously, even if it is conceded that some others can be. That, I think, is how Aristotle will have seen it, and it probably seemed to him most reasonable to stay on the *via media* and avoid either attributing all or none of the natural things to spontaneous causes.

For Aristotle the key difference between natural and spontaneous is causal, whether the producer is formally identical with the product, and thus whether the reproduction is univocal. Where Aristotle determines, whether empirically or otherwise, that there is a seed and a sexual method of reproduction, he thinks he sees a way that nature by itself produces, or rather reproduces, itself, and it does so in a way analogous to the production, or re-

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<sup>79</sup> *HA* VI 15, 569b10-25 (only some mullets spontaneously generated); VI 16, 570a3-10 (eels).

<sup>80</sup> See note 20 above.

production, of the form of health out of the physician's mind into the body of the patient. But where Aristotle cannot find a sexual method of reproduction, he does not speculate that there must be all-pervasive seeds just to salvage his theory of univocal reproduction, but rather directs his speculation at determining the exact causes of non-sexual animal generation. His theory of equivocal generation is paralleled not in modern theories of animal reproduction, but ironically in theories about the origin of life itself out of inanimate materials, now referred to in terms of abiogenesis, biopoesis, self-assembly, and so forth. To his credit, however, Aristotle refrains from holding that the inanimate materials move themselves *for the sake of* producing animals, like insects and oysters. If inanimate materials do happen to combine to produce insects and oysters, they do not do so "for the sake of" producing these kinds of living things. Rather they do so by an incidental cause and spontaneously.

Thus Aristotle stays on his *via media* in accepting that some, but not all, living things may be generated spontaneously. In arguing for at least some spontaneous causes, Aristotle is following a long tradition of attributing the generation of natural things to spontaneous causes that goes back to Homer, Hesiod, Herodotus, and Thucydides, and culminated in the writings of Democritus.<sup>81</sup> Aristotle's pupil Theophrastus continued to accept, but also to skeptically examine, the phenomenon of spontaneous causes for the forms of natural things, including plants and animals.<sup>82</sup> The idea that many animals are generated spontaneously was defended more or less continuously until Louis Pasteur's famous address in 1864.

Of course the verdict is still out on whether the ultimate cause of life on earth was spontaneous generation or something more bizarre, like "directed panspermia."<sup>83</sup> In fact, contemporary theories about the origins of life on earth (and on other planets in the speculative field of astrobiology) suggest that life originates through a process called "abiogenesis" or "biopoesis" whereby organic molecules arise from recombination of inanimate matter.

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<sup>81</sup> I have called attention to the significance of this cause for Democritus and other early natural philosophers in Johnson 2009, 5-52. I discuss Aristotle and the medical writers on pages 36-41.

<sup>82</sup> The *aporia* is explicitly raised in his *Metaphysics*: "In plants and even more in inanimate things . . . the account, that it is by spontaneity and through the rotation of the whole that these things acquire certain forms or differences from one another, seems to have some plausibility" (Theophrastus, *Metaphysics* 10b20-11a1; tr. van Raalte, mod.). In the botanical works, the term "spontaneous" is used to distinguish the natural and wild growths as over against the artificially cultivated (see, e.g., *CP* III 1.1.1-5, I 16.10.8-10). In *HP* II.1.1.1-10). For Theophrastus' doubts about spontaneous generation, see the passages cited in Harris 2002, 3.

<sup>83</sup> Crick and Orgel 1973, 341.

The notion of “self-assembly” in these theories is arguably equivalent to the traditional term “spontaneous.”<sup>84</sup> A recent textbook on the subject opens with these words: “The main assumption held by most scientists about the origin of life on Earth is that life originated through a spontaneous and gradual increase of molecular complexity.”<sup>85</sup>

It is necessary to draw a sharp distinction between the theory of the origins of life on Earth, on the one hand, and the origins of individual organisms and species, on the other. The author of another recent textbook on the topic refers to “a dilemma when discussing the origin of life”: “the insight that organisms always originate from other organisms and never from inanimate matter was a hard one. But in a sense spontaneous generation must have occurred at least once—and so parts of this book deal with spontaneous generation in the past.”<sup>86</sup> Aristotle’s relationship to the history of this position is complex. On the one hand, Aristotle rejected spontaneity (and equivocal generation or abiogenesis) as the origin of all life on Earth, where we are likely to accept it as our best going theory; and Aristotle accepted spontaneity as a cause in the case of certain species of animals where we reject it (and detect univocal generation), such as eels and insects. But at the same time, Aristotle has contributed positively to the contemporary position on spontaneous generation of life in two ways: first, by speculating about how abiogenesis is possible through a recombination of inanimate materials and heat; and, second, by insisting that most forms of life cannot be explained as being due to spontaneous generation but require a deeper account of “univocal” generation.

I see it as a major breakthrough of Aristotle’s biology and physics that he conceived of abiogenesis, although he did not use it as an explanation of the origin of all life (since he did not think that was a phenomenon that needed to be explained), and he was not entirely original here. But it was even more of a breakthrough that he also understood, like modern critics of spontaneous generation, that at least some species must be reproduced univocally by transmission of a form. Would we really think more highly of Aristotle had he agreed with Empedocles and Democritus that all animals are spontaneously generated? Why would we, given that we ourselves reject the idea that most animals are spontaneously generated? The offspring of sexually generated organisms look like their parents “always or for the most part,” but spontaneously generated organisms do not resemble their produc-

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<sup>84</sup> Fox 1968, 235-240.

<sup>85</sup> Luisi 2006, 1. After reviewing the recent scientific history of this conclusion, the author states that the view expressed “is the modern version of a kind of spontaneous generation, although on a sluggish time scale” (1).

<sup>86</sup> Fenchel 2002, 12.

tive causes. There seems to be a phenomenon here to be explained. We still think there is something other than abiogenesis going on in animal reproduction, namely transmission of DNA. That is why we deny that most organisms are spontaneously generated (except in the context of the origin of all life on Earth). And Aristotle's reasons for denying spontaneous generation as having much power in animal reproduction are not entirely dissimilar. If we are so sure that most species are not spontaneously generated, we should thank Aristotle for the impetus he gives to an alternative theory of sexual reproduction. Thus Aristotle has been justly praised by some modern molecular geneticists, if not always by philosophers, for his acute account of biological reproduction that by emphasizing "information" and the agency of an "unmoved mover" in certain important respects resembles the theory of DNA.<sup>87</sup>

Modern biologists use terminology like genetic "code" and "messenger" RNA, which on the surface seem to imply intelligent agents at work. But in the case of Aristotle no less than modern biology, any literal notion of "intelligent design" is excluded from natural inquiry. Unlike health, which is sometimes spontaneously generated and sometimes produced by the medical art, natural things are never generated by art or intelligence according to Aristotle. Thus, by a process of elimination, they must be due either to necessity, or to nature itself as a cause. In the end, Aristotle believes that they are due to a combination of nature and necessity that is worked out in *Physics* II 9 in terms of "hypothetical necessity" (exemplified, as we saw, by reference to the medical art). If *Physics* II 8 has shown that the cause of natural things cannot be necessity by itself, because that would be equivalent to saying that all natural things are spontaneously generated, then not all causes can be necessary and spontaneous or lucky; but since some things can be regularly generated without art (as health can), not all causes can be artistic or intelligent. Nature itself, then, must be the cause of some things, the health of living organisms paradigmatic among them.<sup>88</sup>

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<sup>87</sup> Delbrück 1971, 50-55.

<sup>88</sup> I would like to acknowledge, first of all, the extensive written comments on drafts of this essay by Elizabeth Craik, Joel Mann, and an anonymous reviewer. These have very substantially improved the structure and function of the essay, and in particular have helped shape my interpretation of spontaneity in the Hippocratic Corpus. I would also like to thank for oral feedback audiences at the Boston Area Colloquium in Ancient Philosophy, held at Clark University (especially Ravi Sharma and May Sim), and at the University of California, San Diego (especially Rebecca Wolniewicz and Daniel Goodman). Finally, I would like to thank Shane Ewegen, William Wians, and Gary Gurtler for editorial advice.

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# Proceedings of the Boston Area Colloquium in Ancient Philosophy

Volume XXVII, 2011

*Edited by*

Gary M. Gurtler, S.J.  
William Wians



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2012