【論　文】

Aristotle and Ancient Greek Physicians in the Debate about the Generation of a Human Being

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With Aristotle, general or comparative biology came into its own. That almost inexhaustible profusion of living shapes which had not attracted the attention of the earlier Ionian and Italo-Sicilian philosophers, which had been passed over silently by Socrates and Plato, ... was now for the first time exhaustively studied and reduced to some sort of order. ... It was Aristotle who was the first curator of the animal world, and this comparative outlook colours his embryology, giving it, on the whole, a morphological rather than a physiological character.

Joseph Needham（1900–1995）, *A History of Embryology*（1959）[2], p. 38.

Introduction

In what follows, I shall discuss the question how Aristotle（384–322 BC）was historically related to ancient Greek physicians in the development of his theory of the generation of animals, including a human being, with a focus on his arguments against the Pangenetic theory in his treatise *On the Generation of Animals*（*GA*）.[1] Through a conceptual analysis of some of Aristotle's physiological and biological ideas and doctrines for his arguments against it and for his own hylomorphic theory of the generation of animals, which I think might have been given by the philosopher as a critical response to the advocates of the Pangenetic theory, I want to shed new light on aspects of the history of the debate about the reproduction and generation of a human being in the field of ancient Greek biology and embryology of the fifth and fourth centuries BC.

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[1] References to medical writings in the Hippocratic Corpus as well as to the treatises in Corpus Aristotelicum will be made in this article with English titles and the abbreviations of Latin titles in round brackets.

[Hippocratic Corpus]

On the Sacred Disease = De Morbo Sacro（*Morb. Sacr.*）| *Airs, Waters, Places = De Aeribus, Aquis, Locis*（*Aer.*）| *On the Nature of Man = De Natura Hominis*（*Nat. Hom.*）| *On Generation = De Genitura*（*Genit.*）| *On the Nature of Child = De Natura Pueri*（*Nat. Puer.*）| *On Diseases IV = De Morbis IV*（*Morb. IV*）

［Corpus Aristotelicum］

History of Animals = Historia Animalium（*HA*）

On the Generation of Animals = De Generatione Animalium（*GA*）

Aristotle and the Pangenetic Theory: An Overview

Before I begin my discussion, I will make some preliminary remarks on the Pangenetic theory and its historical backgrounds, which I would think will be most useful for us to consider the relationship between Aristotle and ancient Greek physicians as authors of some medical writings in the Hippocratic Corpus.

In the history of modern biology and embryology, the Pangenetic theory is generally known as a hypothetical doctrine advocated by Charles Darwin（1809–1882）concerning the system of reproduction and generation of animals and plants. Darwin was most interested in the question how characteristic features of ancestors are transmitted to their descendants. His doctrine of Pangenesis was intended to give a scientific explanation of this phenomenon in terms of self-reproductive particles called *gemmules* contained in cells of each part of animal and plant bodies, which, collected through their vascular system into their generative cells, will be dispersed in the bodies of their descendants, thus functioning as a medium for transmitting their characteristic features to their descendants.[2]

We find the Pangenetic theory in the field of ancient Greek biology and embryology of the fifth and fourth centuries BC as the so-called prototype of the Darwinian doctrine of Pangenesis to the effect that sperm（σπέρμα）comes from all the body of both parents. The main sources of information about it are some of Greek medical writings in the Hippocratic Corpus, which are classified into two categories, i.e.（a）the two treatises *On the Sacred Disease*（*Morb. Sacr.*）and *On Airs, Waters, Places*（*Aer.*）and（b）a set of treatises *On Generation*（*Genit.*）, *On the Nature of Child*（*Nat. Puer.*）*and On Diseases IV*（*Morb. IV*）, which seem to have constituted one and the same work in its original form, written by the same author. There are also some references to the theory in the extant fragments attributed to Democritus of Abdera（c.460–c.380 / 70 BC）.[3]

It would seem to be conceivable that the Pangenetic theory might have had the origin of its theoretical form in the tradition of ancient Greek medicine, and then came to have drawn attention of philosophers in their increasing interest in biological and embryological issues, especially because the main sources of information about the theory are these medical writings, where the authors of the treatises mentioned above share it as one of the theoretical frameworks of their discussions, when discussing the most important issues for them from a pathological as well as physiological point of view, such as the inheritance of particular physical constitutions（*e.g.* bilious or phlegmatic ones）from parents to their children, and, more generally, that of some characteristic features from parents and their ancestors to their children and their descendants. On the other hand, there are some people in modern scholarship on the Pangenetic theory, who claim that

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[2] Charles Darwin, *The Variation of Animals and Plants under Domestication*（London, 1868）.

[3] Hermann Diels und Walter Kranz（Hgg.）, *Die Fragmente der Vorsokratiker*, 3 Bde., 6 Aufl.（Berlin, 1951–1952）［=DK］68 B32, B124.

Democritus played a decisive role in the formation and development of it. In 1950, Erna Lesky published a monumental thesis on the theories of generation and heredity in classical antiquity.[4] She strongly insists that Democritus was the originator of the Pangenetic theory, which was then taken over by ancient Greek physicians in their attempt to give systematic accounts of some of the most important genetic issues mentioned above.[5] In 1981, I. M. Lonie published an English translation of the Hippocratic treatises *On Generation*（*Genit.*）, *On the Nature of Child*（*Nat. Puer.*）and *On Diseases IV*（*Morb. IV*）with a detailed commentary and discussion of these treatises.[6] Although he has reservations to agree with Lesky to the opinion that Democritus was the originator of the Pangenetic theory, Lonie maintains that the author of the set of treatises relied on the theory, which he had taken over from the philosopher, when giving his answer to the question which one of parents their children resemble in their characteristic features by referring to the amount of sperm coming from each part of their bodies.[7]

In order to argue against their opinions, I would insist on the fact that ancient Greek physicians shared a view of a particular kind of fluids called humours（χυμοί）with their own inherent powers（δυνάμεις）as the essential constituents of a human body, which may well be regarded as being fundamentally different from the atomistic doctrine of Democritus. We cannot discern any traces of Democritean atomism at all in the discussions on the basis of the Pangenetic theory by the authors of（a）about the inheritance of particular physical constitutions and characteristic features of parents from them to their children, as Max Pohlenz has already pointed out in his criticism of Lesky's thesis.[8] And further, it is obvious that the author of（b）gives his answer to the question mentioned above, by referring to the Pangenetic theory presupposing his own doctrine of four humours（i.e. blood, bile, water and phlegm）, which could not be reduced to Democritean atomistic doctrine. It should also be noted that in the history of ancient Greek biology and embryology in genaral, a view of living things as having some primordial matter or stuff as their generative origin seems to have been older than the corpuscular theory, according to which living things and their parts are structured by a particular kind of particles, such as atoms, as their components. These facts would lead us to conclude that ancient Greek physicians seem to have originated and developed the Pangenetic theory in their own right, independently of the atomistic doctrine of Democritus, starting from their own interest in a large variety of

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4 E. Lesky, *Die Zeugungs-und Vererbungslehren der Antike und ihr Nachwirken*, Akademie der Wissenschaften und der Literatur（Mainz, 1950）.

5 Lesky（1950）, SS.1294–1300.

6 I. M. Lonie, *The Hippocratic Treatises On Generation, On the Nature of Child, On Diseases IV*, Walter de Gruyter（Berlin, New York, 1981）.

7 Lonie（1981）, pp.115–117.

8 M. Pohlenz, 'Nomos und Physis', Anhang I. Der Ursprung der pangenetischen Zeugungslehre, *Hermes*, Vol.81（1953）, SS.436–437.

empirical facts connected with the reproduction and generation of a human being.[9]

Whatever its origin and its historical backgrounds might have been, the Pangenetic theory had been one of the most influential doctrines in the field of ancient Greek biology and embryology until the first half of the fourth century BC, since Aristotle draws most specific attention to the theory, with his long and most detailed arguments against it, in his treatise *On the Generation of Animals* (*GA*), Book I. When he begins his discussion in ch.17 of the treatise *On the Generation of Animals* (*GA*), Book I, about the essential nature of sperm as the so-called generative matter of a human being, Aristotle refers to those who insist that sperm comes from all the body (721 b12), with four pieces of evidence which might be adduced to prove it, including the most crucial point that the children resemble their parents in their whole bodies or in particular parts of their bodies. What characterizes most the Pangenetic theory is, in fact, that it may be regarded as being persuasive enough to give a theoretical account of physical resemblances between parents and their children. According to the advocates of the Pangenetic theory, a daughter resembles her father in particular parts of her body, because her father has provided more amount of sperm coming from these parts of his body than the sperm coming from the same parts of her mother's body.

It is clear from this line of thinking that the Pangenetic theory may presuppose that sperm is provided by both of the parents from every part of their whole bodies, as indicated by Aristotle, who explains that it is part of the same argument whether both male and female emit sperm or one only, and whether it comes from all the body or not from all.[10] It turns out that the Pangenetic theory is in opposition to Aristotle's own hylomorphic theory of the generation of animals, including a human being. Aristotle insists, in fact, that only male emits sperm, thus providing the principle of movement (ἀρχὴ τῆς κινήσεως) for generation, by which the menstrual fluid provided by the female as the material (ὕλη) for the body of the embryo will be formed into an animal. It is probably because the Pangenetic theory is incompatible with the theory of the reproduction and generation of a human being of his own that the philosopher may have developed long and most detailed arguments against it.

A question may arise here as to the sources for the Pangenetic theory, from which Aristotle might have got information about it, when he develops his long and detailed arguments against it. To answer this question, I would draw specific attention to the authors of the medical treatises mentioned above as the most promising candidates for Aristotle's own principal sources for the theory. We should note, however, that, when he refers to the advocates of the Pangenetic theory, Aristotle usually does not refer to them with their names, but with more general words such as 'some people' (τινες) and 'the ancients' (οἱ ἀρχαῖοι), whereas he

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[9] See my article 'The Pangenetic Theory in the Tradition of Greek Medical Science' (in Japanese), *Kagakusi Kenkyu: Journal of History of Science, Japan*, Vol.48 (No.249), pp.22–33.

[10] *GA I*, ch.17, 721b7–11. See text to n.13 below.

almost always refers to Presocratic philosophers, such as Anaxagoras of Clazomenae (c.500–c.428 BC), Empedocles of Acragas (c.495–c.435 BC) and Democritus, with their names.[11] This would seem to be an indication of the fact that Aristotle could not or did not think it necessary to specify the advocates of the theory, because medical writings of the fifth and fourth centuries BC might possibly have been circulated without authorship, as it was exactly the case with almost all the medical writings in the Hippocratic Corpus.[12]

Thus, in my discussion below, I will first examine the scope and contents of his arguments against the Pangenetic theory with a view to explore the possibility that Aristotle may have referred to the medical treatises mentioned above as the principal sources to get information about it. And then, I will turn to Aristotle's hylomorphic theory of the generation of animals to make it clear that the philosopher might have given it as a critical response to the advocates of the Pangenetic theory.

The Scope and Contents of Aristotle's Arguments against the Pangenetic Theory

Aristotle begins his discussion about the essential nature of sperm in the following passage of ch.17 of the treatise *On the Generation of Animals* (*GA*), Book I.

> Δοκεῖ δὲ πάντα γίγνεσθαι ἐκ σπέρματος, τὸ δὲ σπέρμα ἐκ τῶν γεννώντων. διὸ τοῦ αὐτοῦ λόγου ἐστὶ πότερον καὶ τὸ θῆλυ καὶ τὸ ἄρρεν προΐενται ἄμφω ἢ θάτερον μόνον, καὶ πότερον ἀπὸ παντὸς ἀπέρχεται τοῦ σώματος ἢ οὐκ ἀπὸ παντός· εὔλογον γὰρ εἰ μὴ ἀπὸ παντός, μηδ' ἀπ' ἀμφοτέρων τῶν γεννώντων. διόπερ ἐπισκεπτέον, ἐπειδή φασί τινες ἀπὸ παντὸς ἀπιέναι τοῦ σώματος, περὶ τούτου πῶς ἔχει πρῶτον.[13]

In this passage, Aristotle insists that it is part of the same argument (τοῦ αὐτοῦ λόγου) whether both male and female emit sperm or one only, and whether it comes from all the body or not from all, by arguing that it is reasonable (εὔλογον), if the sperm does not come from all the body, that it does not come from both male and female parents (721b10–11). His line of argument here may deserve specific attention, because

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[11] 'Some people' (*GA I*, ch.17, 721b11) and 'the ancients' (*GA I*, ch.18, 725a21). For Anaxagoras, see *e.g. GA I*, ch.18, 723a10, *GA IV*, ch.1, 763b31, etc. For Empedocles, see *GA I*, ch.18, 722b8, *GA IV*, ch.1, 764a2, etc. For Democritus, see *GA II*, ch.4, 740a13, *GA IV*, ch.1, 764a6-7, etc.

[12] The only exceptional case was with a physician Polybus (c.400 BC), who was a son-in-law of Hippocrates (c.460–c.375 BC). In *the History of Animals* (*HA*), Book III, ch.3, 512b12–513a7, Aristotle introduces a description of vascular system in a human body under his name. There is the same description of the vascular system in ch.11 of the Hippocratic treatise *On the Nature of Man* (*Nat.Hom.*). It is probable, then, that the treatise was widely circulated with the authorship of Polybus in the fourth century BC.

[13] *GA I*, ch.17, 721b 6–13. I follow the Greek text of the treatise, edited by Drossart Lulofs, H. J., *Aristotelis De Generatione Animalium*, recognovit brevique adnotatione critica instruxit [Oxford Classical Texts] (Oxford, 1965).

it is logically constructed in the form of a contraposition of the proposition to the effect that, if (p) both male and female parents should emit sperm, (q) it should come from all the body. If (q) should be denied as being contrary to the fact, then it should necessarily follow that (p) is not the case at all [i.e. $(p \supset q) \equiv (\sim q \supset \sim p)$]. Therefore, the philosopher thinks it probable to confirm that sperm is not provided by both of male and female parents but only by one of them, by refuting the Pangenetic theory that it comes from all the body. It should be noted that Aristotle follows the same line of argument at the end of his refutation of the theory, where he is more explicit in saying that female does not emit sperm, but may contribute to the generation in a different way.

> Ἔτι εἰ τὸ θῆλυ μὴ προΐεται σπέρμα τοῦ αὐτοῦ λόγου μηδ' ἀπὸ παντὸς ἀπιέναι. κἂν εἰ μὴ ἀπὸ παντὸς ἀπέρχεται, οὐθὲν ἄλογον τὸ μηδ' ἀπὸ τοῦ θήλεος ἀλλ' ἄλλον τινὰ τρόπον αἴτιον εἶναι τὸ θῆλυ τῆς γενέσεως. περὶ οὗ ἐχόμενόν ἐστιν ἐπισκέψασθαι ἐπειδὴ φανερὸν ὅτι οὐκ ἀπὸ πάντων ἀποκρίνεται τὸ σπέρμα τῶν μορίων.[14]

According to Aristotle, who believes to have been successful in refuting the Pangenetic theory, saying that it is clear that sperm is not secreted from all the parts of the body (724a11–13), it will be confirmed as a logical necessity of his refutation of the theory that female, which does not emit sperm, should be a cause of generation in some other way. He thinks so, by following two arguments (A) that, if the female does not emit sperm, it does not come from all the body, and (B) that, if the sperm does not come from all the body, it would not be unreasonable (οὐθὲν ἄλογον) that it should not come from the female. In these arguments, the proposition (p′) that the female should emit sperm may well be regarded as being equivalent to (p) above, because Aristotle has started his discussion about the essential nature of the sperm from the fact that there are some at least among the animals in which male emits sperm.[15] If (q) should be denied as being contrary to the fact, it should necessarily follow that (p′) is not the case at all, and then it should be concluded that sperm is provided by the male only.

The most crucial question here would be why by denying (q), Aristotle believed to confirm that sperm is provided by the male only. In order to answer this question, it would be necessary for us to discern some of the theoretical implications of the Pangenetic theory. From its theoretical point of view, the Pangenetic theory may have been intended to give an account of physical resemblances between parents and their children in their whole bodies or in particular parts on the basis of the amount of sperm provided by both male and female parents. Take the case of a daughter who resembles her father in some parts of her body, while she

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[14] *GA I*, ch.18, 724a7–13.

[15] *GA I*, ch.17, 721a30–34.

resembles her mother in other parts of her body. It would be because she has got more amount of sperm from her father than her mother, coming from the parts of his body in which she resembles him more than her mother, whereas she has got more amount of sperm from her mother than her father, coming from the parts of her mother's body in which she resembles her mother more than her father. Thus, it would be necessary for the Pangenetic theory to be persuasive enough to give an account of the phenomena, such as the resemblances between the parents and their children, that sperm should be provided by both male and female parents from every part of their whole bodies. It is probable, then, that Aristotle would have had most specific attention to this aspect of the Pangenetic theory, when, by refuting it, he attempts to confirm that sperm is provided by the male only. In fact, he seems to think of this aspect as being the most important of the four pieces of evidence which might be adduced to prove the theory. It is particularly because the philosopher picks it up at the beginning of ch.18 of the treatise *On the Generation of Animals*（*GA*）, Book I, as the first point to disprove the theory, with long and detailed argument against it. [16]

If we turn to the authors of the medical treatises mentioned above, whom I would think of as being the candidates for Aristotle's principal sources for the Pangenetic theory, we can find some interesting passages in which they give theoretical accounts of the phenomena of physical resemblances between parents and their children on the Pangenetic theory, on the basis of which they explain how characteristic features of parents are inherited from them to their children. First of all, I refer to the famous passages from ch.2 of the treatise *On the Sacred Disease*（*Morb. Sacr.*）.

> Ἄρχεται δὲ ὥσπερ καὶ τἆλλα νοσήματα κατὰ γένος. Εἰ γὰρ ἐκ τοῦ φλεγματώδεος φλεγματώδης, καὶ ἐκ χολώδεος χολώδης γίνεται καὶ ἐκ φθινώδεος φθινώδης καὶ ἐκ σπληνώδεος σπληνίης, τί κωλύει, ὅπου πατὴρ ἢ μήτηρ εἴχετο τούτῳ τῷ νοσήματι, τούτῳ καὶ τῶν ἐκγόνων ἔχεσθαί τνα; Ὡς ὁ γόνος ἔρχεται πάντοθεν τοῦ σώματος, ἀπό τε τῶν ὑγιηρῶν ὑγιηρὸς καὶ ἀπὸ τῶν νοσηρῶν νοσηρός.[17]

In this passage, the author of that treatise explains how the disease called 'sacred'（i.e. epilepsy）may be inherited from parents to their children, arguing on the Pangenetic theory that it is because the seed comes from every part of the body, healthy seed coming from its healthy parts and diseased seed from its diseased parts（ὁ γόνος ἔρχεται πάντοθεν τοῦ σώματος, ἀπό τε τῶν ὑγιηρῶν ὑγιηρὸς καὶ ἀπὸ τῶν νοσηρῶν νοσηρός）. That would explain why parents and their children usually share particular physical

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[16] *GA I*, ch.18, 722a3–723b32.

[17] *Morb. Sacr*. ch.2（= ch.5, W. H. S. Jones（ed.）, *Hippocrates II*, Loeb Classical Library（Cambridge, Massachusetts: Harvard UP, 1923））. I follow the Greek text of the treatise, edited by Jacques Jouanna, *Hippocrate, tome II, 3 e Partie, La maladie sacrée*, Collection des Universités de France（Paris: Les Belles Lettres, 2003）.

constitutions, such as bilious and phlegmatic ones, which he thinks have been inherited from them to their children through the seed that may contain some kind of hereditary information of their physical constitutions and may function as a medium for transmitting it from them to their children.

The author of the treatise *On Airs, Waters, Places* (*Aer.*) seems to share the same opinion concerning the function of seed as a medium for transmitting hereditary information of particular physical constitutions from parents to their children.[18] It should be noted, however, that he intends to develop his own arguments to such an extent that he may explain how some characteristic features of parents and their ancestors, including the acquired ones, are inherited from them to their children and their descendants.

> Ὁ γὰρ γόνος πανταχόθεν ἔρχεται τοῦ σώματος, ἀπό τε τῶν ὑγιηρῶν ὑγιηρὸς ἀπό τε τῶν νοσερῶν νοσερός· εἰ οὖν γίνονται ἔκ τε τῶν φαλακρῶν φαλακροὶ καὶ ἐκ τῶν γλαυκῶν γλαυκοὶ καὶ ἐκ διεστραμμένων στρεβλοὶ ὡς ἐπὶ τὸ πλῆθος καὶ περὶ τῆς ἄλλης μορφῆς ὁ αὐτὸς λόγος, τί κωλύει καὶ ἐκ μακροκεφάλου μακροκέφαλον γίνεσθαι;[19]

The author is interested in the question how an unusual form of a long head has been inherited from generation to generation among the people called 'Longheads' (οἱ μακροκέφαλοι). It is clear that he attempts to give his account of the formation of this unusual head, following in the footsteps of the author of the treatise *On the Sacred Disease* (*Morb. Sacr.*), because he refers to the Pangenetic theory at the first sentence of the passage cited above, which exactly corresponds with the last sentence of the passage cited from that treatise, by arguing that the seed comes from every part of the body, healthy seed coming from its healthy parts and diseased seed from its diseased parts (ὁ γόνος πανταχόθεν ἔρχεται τοῦ σώματος, ἀπό τε τῶν ὑγιηρῶν ὑγιηρὸς ἀπό τε τῶν νοσερῶν νοσερός). A crucial difference lies in the arguments by the author of the treatise *On Airs, Waters, Places* (*Aer.*) who, going beyond an account from a pathological point of view of the inheritance of particular physical constitutions, such as bilious and phlegmatic ones, from parents to their children, proceeds to explain the inheritance of characteristic features that have been acquired by the people from generation to generation. This is a most important point, I would insist, because Aristotle himself is referring to the cases of the inheritance of some features acquired by parents from them to their children as what might be adduced as additional evidence for the Pangenetic theory.[20]

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[18] For the authorship of these two treatises, see my article 'Psychological Arguments in the Hippocratic Treatises *On the Sacred Disease and Airs, Waters, Places*', *Japan Studies in Classical Antiquity* [*JASCA*], Volume 2 (2014), pp.47–66.

[19] *Aer*., ch.14. I follow the Greek text of the treatise, edited by Jacques Jouanna, *Hippocrate, tome II, 2 e Partie, Airs, Eaux, Lieux*, Collection des Universités de France (Paris: Les Belles Lettres, 1996).

[20] *GA I*, ch.17, 721b28–36.

It would seem to be conceivable, then, that Aristotle may have had these two treatises in hand as sources for the Pangenetic theory, when he develops his arguments against it. However, I would draw more attention to the author of the set of treatises *On Generation*（*Genit.*）, *On the Nature of Child*（*Nat. Puer.*）and *On Diseases IV*（*Morb. IV*）as a more promising candidate for Aristotle's principal sources for the theory. It is especially because he is much more explicit than the authors of the two treatises mentioned above in explaining the resemblances between parents and their children in their whole bodies or in particular parts of their bodies on the basis of the amount of sperm provided by both of them. To confirm it, I refer to the following passage of ch.8 of that set of treatises.

> Καὶ ὁκόθεν ἂν τοῦ σώματος τοῦ ἀνδρὸς πλέον ἔλθῃ ἐς τὴν γονὴν ἢ τῆς γυναικός, τὸ τέκνον κεῖνο κάλλιον ἔοικε τῷ πατρί· ὁκόθεν δ' ἂν πλέον ἔλθῃ ἀπὸ τῆς γυναικὸς τοῦ σώματος, κεῖνο κάλλιον ἔοικε τῇ μητρί. Ἔστι δὲ οὐκ ἀνυστὸν πάντα τῇ μητρὶ ἐοικέναι, τῷ δὲ πατρὶ μηδέν, οὐδὲ τὸ ἐναντίον τούτου, οὐδὲ μηδετέρῳ ἐοικέναι μηδέν· ἀλλ' ἀμφοτέροισιν ἀνάγκη τίς ἐστιν ἐοικέναι τινί, εἴπερ ἀπ' ἀμφοτέρων τῶν σωμάτων τὸ σπέρμα χωρεῖ ἐς τὸ τέκνον. Ὁκότερος δ' ἂν πλέον συμβάληται ἐς τὸ ἐοικέναι καὶ ἀπὸ πλεόνων χωρίων τοῦ σώματος, κείνῳ τὰ πλείονα ἔοικε· καὶ ἔστιν ὅτε θυγάτηρ γενομένη τὰ πλείονα ἔοικε κάλλιον τῷ πατρὶ ἢ τῇ μητρί, καὶ κοῦρος γενόμενος ἔστιν ὅτε κάλλιον ἔοικε τῇ μητρί ἢ τῷ πατρὶ.[21]

In this passage, the author gives his answer to the question how children resemble their father or their mother in particular parts of their bodies, by arguing that it is because they have got more amount of sperm from their father than their mother, coming from the parts of his body in which they resemble him more than their mother, while they have got more amount of sperm from their mother, coming from the parts of her body in which they resemble her more than their father. It would not be possible for us to imagine, then, that they might resemble their mother than their father in every part of their bodies, and *vice versa*, nor that they might resemble neither of them in every part of their bodies. For the author, who has taken it for granted that sperm is provided by both male and female parents from every part of their bodies, it necessarily follows that children resemble their farther in some parts of their bodies, and their mother in other parts of their bodies, according to the amount of sperm coming from the parts of their bodies in which they resemble their father and their mother respectively.

And then, the author goes further on to refer to（1）the case of a daughter who resembles her father in

[21] *Genit., Nat.Puer., Morb.IV,* ch.8. I follow the Greek text of the set of treatises, edited by Robert Joly, *Hippocrate, tome XI, De la Génération, De la Nature de L'enfant, Des Maladies IV, Du Foetus de Huit Mois,* Société d' Édition（Paris: Les Belles Lettres, 1970）.

more parts of her body than her mother as well as（2）the case of a son who resembles his mother in more parts of his body than his father, by arguing on the basis of the Pangenetic theory that children resemble either one of their parents, who would contribute more to the resemblance by providing more amount of sperm coming from more of the parts of his or her body than the other. This is one of the most crucial points for us to conclude that Aristotle may have had that set of treatises in hand as his principal sources for the Pangenetic theory, when developing his long and detailed arguments against it.[22]

It is most significant to note that Aristotle was particularly interested in the question how there are cases in which children resemble their parent with a different sex more than the one who shares the same sex with his or her children, such as the case of a daughter resembling her farther more than her mother and the case of a son resembling his mother more than his farther. Aristotle attempts to answer this question on the basis of his own hylomorphic theory of the reproduction and generation of a human being, which, I would insist, might have been given by the philosopher as a critical response to the advocates of the Pangenetic theory. In the next section of my discussion, I will turn to the question how Aristotle was historically related to ancient Greek physicians in the development of his theory of the generation of animals, including a human being.

Aristotle's Hylomorphic Theory of the Reproduction and Generation of a Human Being as a Critical Response to the Advocates of the Pangenetic Theory

In ch.3 of the treatise *On the Generation of Animals*（*GA*）, Book IV, Aristotle begins to tackle a series of most complicated issues related to the reproduction and generation of a human being, including, among others, the question how children resemble their parent with a different sex more than the one who shares the same sex with his or her children, i.e. the question how a daughter resembles her father more than her mother, or a son resembles his mother rather than his father. In order to understand how the philosopher answers these questions, we need to turn to his explanation as to the question how male and female sexes will be differentiated from each other, because, he insists, the resemblances between parents and their children and the differentiation between male and female sexes are due to the same causes.[23]

After his long and detailed arguments in the first section of ch.1 of the treatise *On the Generation of Animals*（*GA*）, Book IV, against Presocratic philosophers, such as Anaxagoras, Empedocles and Democritus and others, as concerns their accounts of the differentiation between male and female sexes, Aristotle now gives his own explanation of this issue to the effect that the generation of a male or female may depend on the

[22] For the other point which I think may confirm that Aristotle may have had it in hand in his arguments against the Pangenetic theory, I would draw attention to the intensity of the pleasure in sexual intercourse, to which the philosopher refers in ch.17 of *GA I*, 721b14–17, as the first piece of evidence that might be adduced by the advocates of the theory. We find a discussion to the same effect on the emission of sperm with intense pleasure in *Genit., Nat.Puer., Morb. IV*, ch.1. Aristotle rejects it in ch.18, 723b32–724a3, insisting that it cannot give evidence for the legitimacy of the theory.

[23] *GA IV*, ch.3, 767a36–767b7.

situation whether or not the movement inherent in the sperm provided by the male parent gains the mastery of the material for the body of embryo (i.e. the menstrual fluid), which is derived from the female parent. I refer to the most significant passage that runs as follows.

> Τούτων δ' ὑποκειμένων ἴσως ἂν ἤδη μᾶλλον εἴη φανερὸν δι' ἣν αἰτίαν γίγνεται τὸ μὲν θῆλυ τὸ δ' ἄρρεν. ὅταν γὰρ μὴ κρατῇ ἡ ἀρχὴ μηδὲ δύνηται πέψαι δι' ἔνδειαν θερμότητος μηδ' ἀγάγῃ εἰς τὸ ἴδιον εἶδος τὸ αὑτοῦ ἀλλὰ ταύτῃ ἡττηθῇ, ἀνάγκη εἰς τοὐναντίον μεταβάλλειν. ἐναντίον δὲ τῷ ἄρρενι τὸ θῆλυ καὶ ταύτῃ ᾗ τὸ μὲν ἄρρεν τὸ δὲ θῆλυ.[24]

In this passage, Aristotle, who has defined the female as the opposite (ἐναντίον) of the male, seems to insist that the material should necessarily change into the opposite, when the principle does not gain the mastery nor is able to concoct it due to the deficiency of heat nor leads it into its own proper form, but is defeated in this respect (ὅταν … μὴ κρατῇ ἡ ἀρχὴ μηδὲ δύνηται πέψαι δι' ἔνδειαν θερμότητος μηδ' ἀγάγῃ εἰς τὸ ἴδιον εἶδος τὸ αὑτοῦ ἀλλὰ ταύτῃ ἡττηθῇ). Following A. L. Peck,[25] I would take the term 'the principle' (ἡ ἀρχὴ) in this sentence to be the movement inherent in the sperm provided by the male parent, which will concoct the material (i.e. the menstrual fluid) derived from the female parent by its heat (θερμότης) to fashion it into the body of embryo. If the heat is not sufficient enough to concoct it, the female will be formed out of this material.

Aristotle recapitulates his discussion about the differentiation between male and female sexes in the passage at the end of ch.1 of the treatise *On the Generation of Animals* (*GA*), Book IV. He gives his own explanation of this issue to the effect that the male sperm leads the material into itself when it gains the mastery of it, while it changes into its opposite (i.e. the female), by referring more explicitly to the roles to be played by the sperm provided by the male parent and by the menstrual fluid provided by the female parent as the material for the body of the embryo.

> Ἀναλαβόντες δὲ πάλιν λέγομεν ὅτι τὸ μὲν σπέρμα ὑπόκειται περίττωμα τροφῆς ὂν τὸ ἔσχατον· ἔσχατον δὲ λέγω τὸ πρὸς τὸ ἕκαστον φερόμενον, διὸ καὶ ἔοικε τὸ γεννώμενον τῷ γεννήσαντι· οὐθὲν γὰρ διαφέρει ἀφ' ἑκάστου τῶν μορίων ἢ πρὸς ἕκαστον προσελθεῖν, ὁρθότερον δ' οὕτως. διαφέρει δὲ τὸ τοῦ ἄρρενος σπέρμα ὅτι ἔχει ἀρχὴν ἐν ἑαυτῷ τοιαύτην οἵαν κινεῖν καὶ ἐν τῷ ζῴῳ καὶ διαπέττειν τὴν ἐσχάτην

[24] *GA IV*, ch.1, 766a16–22.

[25] See A. L. Peck, *Aristotle: Generation of Animals*, Loeb Classical Library (Cambridge, Massachusetts, London: Harvard UP, 1942), p.390, who takes it to be the 'movement' derived from the male, the male 'principle',

τροφήν, τὸ δὲ τοῦ θήλεος ὕλην μόνον. κρατῆσαν μὲν οὖν εἰς αὑτὸ ἄγει, κρατηθὲν δ᾽ εἰς τοὐναντίον μεταβάλλει ἢ εἰς φθοράν. ἐναντίον δὲ τῷ ἄρρενι τὸ θῆλυ, θῆλυ δὲ τῇ ἀπεψίᾳ καὶ τῇ ψυχρότητι τῆς αἱματικῆς τροφῆς.[26]

I think that this passage deserves to be noted, especially because Aristotle attempts to answer the question how children resemble their parents, by referring to his own definition of sperm as the residue from the nutriment in its final stage of concoction (περίττωμα τροφῆς ⋯ τὸ ἔσχατον), which he proposed in his long and detailed discussion about the essential nature of the male sperm and the menstrual fluid as its female counterpart in the treatise *On the Generation of Animals* (*GA*), Book I.[27] According to the philosopher, the male sperm and the menstrual fluid provided by the female as the material for the body of the embryo are residues from the blood in its final stage of concoction, before it is distributed to each part of the parents' bodies for the nutriment. It *is* this conception of sperm as the residue from the nutriment in its final stage, before distributed to every part of the body of the parent that Aristotle thinks may explain why children resemble their parents (διὸ καὶ ἔοικε τὸ γεννώμενον τῷ γεννήσαντι). Just as the nutriment at this stage, as Aristotle himself describes it with the phrase 'that which is carried to every part of the body' (τὸ πρὸς τὸ ἕκαστον φερόμενον) in the passage cited above, contains *potentially* the parts that it will nourish, so the male sperm and the menstrual fluid as its female counterpart, too, should contain them *potentially*, given that they are residues from it. It would be conceivable, then, that Aristotle may have ascribed to the male sperm and the menstrual fluid a function for transmitting the so-called hereditary information from parents to their children.

It turns out to be that Aristotle had a conception of sperm, as opposed diametrically to the conception of sperm by the advocates of the Pangenetic theory, who insist that it comes from every part of the male and female bodies, as Aristotle describes it elsewhere as 'that which comes from all the body' (τὸ ἀπὸ παντὸς ἀπιόν).[28] This is a most crucial point for the advocates of the theory, because they believed that it could give a persuasive answer to the question how children resemble their parent with a different sex more than the one who shares the same sex with his or her children, i.e. the question how a daughter resembles her father more than her mother, or a son resembles his mother rather than his father. Their answer was that the children resemble their farther in some parts of their bodies, and their mother in other parts of their bodies, according to the amount of sperm coming from the parts of their bodies in which they resemble their father and their mother respectively.

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[26] *GA IV,* ch.1, 766b7–18.

[27] *GA I,* ch.18-19, 724b21–726a30.

[28] See *GA I,* ch.18, 725a21–27, where Aristotle describes the sperm as 'that which naturally goes to all parts of the body' (τὸ πρὸς ἅπαντ᾽ ἰέναι πεφυκὸς), contrasting it with that of the advocates of the Pangenetic theory.

How is it, then, that Aristotle himself attempts to answer the same question? In order to discuss the matter, I would draw attention to the most intriguing passage below of ch.3 of the treatise *On the Generation of Animals*（*GA*）, Book IV.

> Ἐπεὶ δ᾽ ἐξίσταται πᾶν οὐκ εἰς τὸ τυχὸν ἀλλ᾽ εἰς τὸ ἀντικείμενον, καὶ τὸ ἐν τῇ γενέσει μὴ κρατούμενον ἀναγκαῖον ἐξίστασθαι καὶ γίγνεσθαι τὸ ἀντικείμενον καθ᾽ ἣν δύναμιν οὐκ ἐκράτησε τὸ γεννῶν καὶ κινοῦν. ἐὰν μὲν οὖν ᾖ ἄρρεν θῆλυ γίγνεται, ἐὰν δὲ ᾖ Κορίσκος ἢ Σωκράτης οὐ τῷ πατρὶ ἐοικὸς ἀλλὰ τῇ μητρὶ γίγνεται· ἀντίκειται γὰρ ὥσπερ τῷ ὅλως πατρὶ μήτηρ καὶ τῷ καθ᾽ ἕκαστον γεννῶντι ἡ καθ᾽ ἕκαστον γεννῶσα.[29]

We should be most cautious in taking what it is exactly that Aristotle may intend to say, by explaining how children resemble their parent with a different sex, especially because his discussion of the issue of resemblances between children and their parents and their ancestors in ch.3 of the treatise *On the Generation of Animals*（*GA*）, Book IV has given what might be regarded by some scholars as evidence for individual forms, which has been one of the most crucial matters in modern scholarship on Aristotelian philosophy.[30] I need to admit that it is far beyond the limits of my discussion in this paper, so I focus on the answer which Aristotle may give to the question how children resemble their parent with a different sex.

In the passage cited above, Aristotle explains how a daughter with the same sex as her mother resembles her mother more than her father, *e.g*. Socrates, by arguing with reference to the concept of departure（ἔκστασις）[31] that, when 'what generates and moves' does not gain the mastery, what is not mastered by it will necessarily depart from the standard and become the opposite in respect of the faculty in which it has failed to gain the mastery. In his argument, the phrase 'what generates and moves'（τὸ γεννῶν καὶ κινοῦν）would mean a male parent（i.e. a father）, who plays the role as the moving cause in the generation of a human being, or more exactly, the movement inherent in the sperm provided by the male parent. According to the philosopher, if it gains the mastery over the substance（i.e. the menstrual fluid as a female counterpart to the male sperm）, it will form the substance into its own shape and then generate a male. If it does not gain the mastery, the substance will depart from the standard（i.e. the male）and thus become the opposite（i.e. the

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[29] *GA IV*, ch.3, 768a2–9.

[30] As advocates of the theory of individual forms in Aristotelian philosophy, see David Balme, 'Aristotle's Biology was not Essentialist', *Archiv für Geschichte der Philosophie*, LXII, 1980, SS.1–12, reprinted with appendices in Allan Gotthelf and James Lennox（edd.）, *Philosophical Issues in Aristotle's Biology*（Cambridge UP, 1987）, pp.291–312, and John Cooper, 'Metaphysics in Aristotle's Embryology', in D. Devereux and P. Pellegrin（edd.）, *Biologie, logique et métaphysique chez Aristote*（Paris, 1990）, pp.55–84.

[31] For this concept, see also *GA I*, ch.18, 725a27–28.

female）.[32]

But a male parent（i.e. a father）as the moving cause in the generation of a human being is not only a male parent（i.e. a father）but also a particular male parent（i.e. a particular father, *e.g.* Socrates）with physical and mental features of his own. This is also the case with a female parent（a mother）as the source of the material（i.e. the menstrual fluid）for the body of the embryo, who is also a particular female（i.e. a particular mother）with physical and mental features of her own. This is the most crucial point for Aristotle to explain how children resemble their parent with a different sex. In the passage cited above, the philosopher gives an account of the case of a daughter resembling her mother more than her father, *e.g.* Socrates, arguing that, if 'what generates and moves' does not gain the mastery *qua* being a male, but it does not gain the mastery *qua* being Socrates, there will be a daughter resembling her mother more than Socrates. His arguments would mean that, if it does not gain the mastery *qua* being a male, but it does *qua* being Socrates, there will be a daughter resembling Socrates more than her mother.

Aristotle defines aspects which belong to 'what generates and moves', such as 'being a male' and 'being Socrates', as the faculties（δυνάμεις）, which he thinks are the sources of movements（κινήσεις）inherent in the male sperm as the generative factors for determining physical and mental features characteristic of children, including their sexes. It would be legitimate for us to think that the same kind of movements deriving from the faculties which belongs to the opposite, such as 'being a female' and 'being Xanthippe as Socrates' wife', should be inherent in the menstrual fluid provided by her as its female counterpart. That would explain why, when 'what generates and moves' fails to gain the mastery in the respect of the faculties, such as 'being a male' and 'being Socrates', the substance will necessarily become the opposite and thus a daughter resembling her mother Xanthippe more than her father Socrates will be born.

This is, as a whole, what might be regarded as Aristotle's answer to the question how children resemble their parent with a different sex more than the other who shares the same sex with them. In view of his arguments against the Pangenetic theory and his own discussion of the issues related to the reproduction and generation of a human being, including his answer to the most crucial question, it would be conceivable that Aristotle might have given his hylomorphic theory of the reproduction and generation of a human being as a critical response to the advocates of the Pangenetic theory.

The core of his hylomorphic theory of the reproduction and generation of a human being lies in his conception of the sperm as diametrically opposed to that of the advocates of the Pangenetic theory. Aristotle thought it absolutely necessary to refute the theory, especially because it would be incompatible with his hylomorphism, which *is* the core of his philosophy. By refuting it, he made great efforts to deal with a series of complicated issues related to the reproduction and generation of a human being within a large complexity

[32] Aristotle seems to have thought of a male child（i.e. a son）resembling his male parent（i.e. father）as the standard case of the reproduction and generation of a human being. See *GA IV*, ch.3, 767b5–15.

of the conceptual framework including some unusual concepts, such as the departure, the faculties, and so on. This situation would make us imagine, in turn, that the philosopher might have taken the Pangenetic theory most seriously.

To Conclude: Aristotle and Ancient Greek Physicians in View of the Debate about the Generation of a Human Being

I have discussed the question how Aristotle was historically related to ancient Greek physicians in the development of his theory of the generation of animals, including a human being, focusing on his arguments against the Pangenetic theory to the effect that sperm comes from all the body of both parents.

In the first section of my discussion, I have examined the scope and contents of Aristotle's arguments against the Pangenetic theory with a view to explore the possibility that the philosopher may have referred to the medical writings in the Hippocratic Corpus, such as (a) the treatises *On the Sacred Disease* (*Morb. Sacr.*) and *On Airs, Waters, Places* (*Aer.*), and (b) the set of treatises *On Generation* (*Genit.*), *On the Nature of Child* (*Nat. Puer.*) and *On Diseases IV* (*Morb. IV*), as the principal sources for him to get information about the theory.

First, I have drawn attention to the fact that, in his arguments against the Pangenetic theory in ch.17and 18 of the treatise *On the Generation of Animals* (*GA*), Book I, Aristotle may have thought of the resemblances between parents and their children as being the most important of the four pieces of evidence which might be adduced to prove the theory, by making it clear that the philosopher intended to refute it with a view to confirm his own opinion that sperm is not provided by both male and female, but by the male only. And then, I have turned to the authors of the medical treatises in the Hippocratic Corpus, i.e. (a) the treatises *On the Sacred Disease* (*Morb. Sacr.*) and *On Airs, Waters, Places* (*Aer.*), and (b) the set of treatises *On Generation* (*Genit.*), *On the Nature of Child* (*Nat. Puer.*) and *On Diseases IV* (*Morb. IV*), who attempt to explain on the basis of the Pangenetic theory how children resemble their parents in their physical constitutions as well as in some characteristic features. After I have examined their discussions about the issue in detail, I have drawn a conclusion that Aristotle may have had these treatises in hand as his principal sources for the Pangenetic theory, when he developed his arguments against it.

In the next section of my discussion, I have turned to Aristotle's own hylomorphic theory of the generation of animals, with a focus on his discussion in ch.3 of the treatise *On the Generation of Animals* (*GA*), Book IV, about the complicated issues related to the reproduction and generation of a human being, including the issue of the resemblances between parents and their children. I have made much emphasis on the fact that Aristotle was interested in the question how there are cases in which children resemble their parent with a different sex more than the one who shares the same sex with his or her children, such as the case of a daughter resembling her farther more than her mother and the case of a son resembling his mother

more than his farther, by making it clear that the philosopher may have had to take it over from the advocates of the Pangenetic theory, when he believed to have refuted it completely. Aristotle himself attempted to answer the question on the basis of his hylomorphic theory of the reproduction and generation of a human being, by referring to his own conception of the sperm as the residue from the nutriment in its final stage of concoction, before distributed to every part of the parent body.

I have made it clear that it is diametrically opposed to the conception of the sperm by the advocates of the Pangenetic theory as that which is separated from every part of the parent bodies to transmit the so-called hereditary information of physical and mental features characteristic of the parents to their children. It is without doubt that the core of Aristotle's hylomorphic theory of the reproduction and generation of a human being lies in his conception of sperm, as diametrically opposed to that of the advoocates of the Pangenetic theory. If this is the case, it would be legitimate for us to conclude that Aristotle might have given his hylomorphic theory of the reproduction and generation of a human being as a critical response to them.

These conclusions would help us to shed new light on aspects of the history of the debate about the reproduction and generation of a human being in the field of ancient Greek biology and embryology of the fifth and fourth centuries BC.

Postscript

This article is partly based on the paper which I gave to the session of the 66th Annual Meeting of the History of Science Society of Japan on 25th and 26th May, 2019 at the University of Gifu, Japan, as part of the achievements of my Research Project（Project Title: Philosophical Approach to the View of Humanity in Classical Antiquity with a Focus on the History of Debate on the Generation of Animals）, funded by the Japan Society for the Promotion of Science（JSPS KAKENHI Grant Number:19K00026）. This article also reflects another paper entitled 'Aristotle and Ancient Greek Physicians with a Focus on the Generation of a Human Being', which I had been preparing as part of my achievements of the year 2020 of the same Research Project, funded by the Japan Society for the Promotion of Science, for the 67th Annual Meeting of the History of Science Society of Japan on 30th and 31st May, 2020 at Kokushikan University, Tokyo, Japan, which was suspended unfortunately in the situation caused by the impact of COVID-19.