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III

KATERINA IERODIAKONOU

THEOPHRASTUS ON NON-HUMAN ANIMALS THAT CHANGE COLOUR[1]

ABSTRACT

In the fragments of his lost treatise *On Creatures that Change Colour*, Theophrastus claims that the octopus and the chameleon change the colour of their skin in order to match their background and protect themselves from danger or facilitate the capture of their prey. Theophrastus explains this remarkable phenomenon on the basis of a change in the animals' physical constitution, but what is particularly intriguing is the difference he draws between the automatic reaction of the chameleon and the goal-directed behaviour of the octopus. He claims that the chameleon changes its colour from fear and to no purpose, whereas the octopus acts with foresight and has a certain aim. It seems, therefore, that, according to Theophrastus, non-human animals cannot make judgements, but some of them are endowed with cognitive capacities that allow them to plan their actions in such a way that they have a better chance in achieving their goals.

[1] This article would not have been written without the abundant help from Bob Sharples' meticulous and infatigable scholarship. I would like to dedicate it to his memory. Also, I would like to thank Andreas Ott, who first brought to my attention Theophrastus' generous stance towards the cognitive capacities of non-human animals. Finally, thanks are due to all the participants of the *Entretiens* at the Fondation Hardt as well as to Sophia Connell, Domicele Jonauskaite, and Christoph Riedweg for their helpful suggestions on an earlier version of this article.

1. Introduction

Emotional responses to colours and the various ways they affect human behaviour represent a familiar aspect of today's psychological research.[2] Psychologists have investigated, for instance, whether the colour red truly enhances sexual attractiveness,[3] or whether there is good evidence to suggest that blue lighting reduces depression.[4] There is also, however, another aspect of colour psychology, which examines not how colours influence human emotions and actions but the reverse relation, namely how emotions affect our appearance, with particular attention paid to the colour of our skin. Standard paradigmatic cases are those of shy or embarrassed people who blush, of angry or excited people who turn red, and of sad or frightened people who become pale. Interestingly enough, such phenomena are not only observed in human beings; contemporary naturalists and bioscientists systematically look into instances of non-human animals that change their colour under certain conditions.

The cases of the chameleon and the octopus are particularly striking, since they have often been observed changing the colour of their skin in order to match their close surroundings, in an attempt to threaten aggressors, or after mating. In fact, sometimes these changes are substantial and camouflaged chameleons or octopuses can hardly be visible from just a few feet away. Recently, a handful of books about the octopus' emotional reactions and cognitive capacities have enjoyed great publicity, presenting and discussing in detail the latest findings and explanations of the octopus' chromatic displays, which "can include elaborate patterns of stripes and spots, flashing rings and waves of rippling colour".[5] Less known, but also part of the present cutting-edge biological research, is the case of the guppy, among the most popular aquarium fish, whose iris turns instantly from

[2] E.g. Elliot / Fairchild / Franklin (2015).
[3] E.g. Lehmann / Elliot / Calin-Jageman (2018).
[4] E.g. Terman / Terman (2005).
[5] Srinivasan (2017); see Montgomery (2016) and Godfrey-Smith (2017).

a silvery colour to jet black when defending or pursuing its food. Blackening the iris enlarges the perceived size of the guppy's pupil, and, presumably, this is meant to send "signals of dominance and aggression, like a gorilla beating its chest or a dog baring its teeth".[6]

Though not extensively studied, the phenomena of colour changing in non-human animals were not unknown in Antiquity. They are occasionally mentioned in different genres of ancient Greek texts and used as examples for different purposes. For instance, the changing colours of the chameleon and the octopus are found in texts ranging from the time of the archaic poetry of Pindar and Theognis to the Christian writings of the fourth century theologian Gregory of Nazianzos and the twelfth century Byzantine historian Nicetas Choniates.[7] They were mainly used, for the most part with negative connotations, as metaphors for people who have a tendency to adjust their views and behaviour to ephemeral circumstances.[8] Nevertheless, such texts do not give us much information about how the Greeks and the Romans experienced and, most importantly, how they explained the ways non-human animals change their colour as a reaction to external or internal factors.[9]

[6] YONG (2018); see HEATHCOTE *et al.* (2018).

[7] E.g., PLUT. *De amic. mult.* 96f; *De soll. an.* 978e; *Aet. phys.* 916b13-c4; GREG. NAZ. *Contra Iulianum* 35, 585, 3; *De seipso* 36, 277, 1; NIC. CHON. *Historia*, Reign Man. 1, pt. 4, 136, 17.

[8] On the octopus in particular, and how its colour variations are depicted and used metaphorically in ancient Greek literature, see DETIENNE / VERNANT (1991) 27-54.

[9] Two other examples of changing colour in non-human animals, namely the shimmering colours of the dove's neck and of the peacock's tail, were studied more thoroughly by the philosophers of the Hellenistic period and Late Antiquity. They were probably introduced by the ancient sceptics with the intention to question, against the Epicureans and the Stoics, the reliability of sense perceptions, since the dove's neck and the peacock's tail appear at one time to have one particular colour and a moment later a quite different one. The sceptics claimed that we are not actually able to judge which sense perception, if any, is veridical. But, in contrast to the examples of the chameleon and the octopus, neither the sceptics nor their dogmatic opponents ever implied that the changes of the dove's or the peacock's colour are due to internal factors; rather, they are said to depend

To get a better grasp on how ancient authors explained these exceptional phenomena, we must look carefully into the biological treatises of the Aristotelian tradition. More specifically, information on this topic is found in the works of Theophrastus, who was Aristotle's close associate in his project of systematic inquiry into various manifestations of nature. Theophrastus is reported to have written a small treatise with the title *On Creatures that Change Colour* (*Περὶ τῶν μεταβαλλόντων τὰς χρόας*), in which he endeavoured to closely analyse the phenomenon of changing colour in non-human animals. It is his account of such cases that constitutes the topic of my study (Fig. 3.1).

2. Aristotle's sketchy account

Before engaging with Theophrastus, we must first examine what Aristotle has to say about the changing colour of the chameleon and the octopus. In the second book of his *History of Animals*, Aristotle devotes some paragraphs to the chameleon, in which he also describes its colour changes:

> "The change in its colour takes place when it is inflated with air; it is then black, not unlike the crocodile, or yellow like the lizard but black-spotted like the leopard. This change of colour takes place over the whole body, for the eyes and tail come alike under its influence." (Arist., *Hist. an.* 503b2-8, trans. J. Barnes slightly modified)[10]

Also, in the fourth book of his treatise *On the Parts of Animals*, Aristotle mentions the chameleon's changes of colour, but this

on the external conditions under which they are perceived, in particular, on the light and its angle of incidence (IERODIAKONOU [2015]). Our ancient sources, however, sometimes group all these cases together and present them as demonstrations of how fallible sense perception is (e.g. PHIL. *Ebr.* 42, 172-174).

[10] Τῆς δὲ χροιᾶς ἡ μεταβολὴ ἐμφυσωμένῳ αὐτῷ γίνεται· ἔχει δὲ καὶ μέλαιναν ταύτην, οὐ πόρρω τῆς τῶν κροκοδείλων, καὶ ὠχρὰν καθάπερ οἱ σαῦροι, μέλανι ὥσπερ τὰ παρδάλια διαπεποικιλμένην. Γίνεται δὲ καθ' ἅπαν τὸ σῶμα αὐτοῦ ἡ τοιαύτη μεταβολή· καὶ γὰρ οἱ ὀφθαλμοὶ συμμεταβάλλουσιν ὁμοίως τῷ λοιπῷ σώματι καὶ ἡ κέρκος.

time he explains them on the basis of its character, namely on the fact that it is a cowardly animal. It is also worth noting that in this text Aristotle also provides a physiological explanation of the chameleon's fear, which is, in his view, the result of scantiness of blood and lack of natural heat:

> "Of all oviparous animals that live on land there is none so lean as the chameleon. For there is none that has so little blood. The explanation of this is to be found in the psychical temperament of the creature. For it is of a timid nature — hence its many changes of appearance. But fear is a refrigeration, and results from deficiency of natural heat and scantiness of blood." (Arist., *Part. an.* 692a21-25; trans. J. Barnes)[11]

Concerning the octopus, Aristotle in his *History of Animals* groups it with the cuttlefish and the angel-fish as creatures with the capacity to adjust their colour to that of the nearby environment, allowing them to hide both from predators and prey. However, no other explanation is given for this phenomenon apart from the octopus' cowardice, which is repeated in the treatise *On the Parts of Animals* (679a13-14), and its interest in catching its prey:

> "The octopus is a stupid creature, for it will approach a man's hand if it be lowered in the water; but it is thrifty in its habits: that is, it lays up stores in its nest, and, after eating up all that is eatable, it ejects the shells and sheaths of crabs and shell-fish, and the skeletons of little fishes. It seeks its prey by so changing its colour as to render it like the colour of the stones adjacent to it; it does so also when alarmed. By some the cuttlefish is said to perform the same trick; that is, they say it can change its colour so as to make it resemble the colour of its habitat. The only fish that can do this is the angel-fish, that is, it can change its colour like the octopus." (Arist., *Hist. an.* 622a3-14, trans. J. Barnes)[12]

[11] Ἰσχνότατος δ' ὁ χαμαιλέων τῶν ᾠοτόκων καὶ πεζῶν ἐστι πάντων· ὀλιγαιμότατος γάρ ἐστιν. Αἴτιον δὲ τὸ τῆς ψυχῆς ἦθός ἐστιν αὐτοῦ· διὰ γὰρ τὸν φόβον γίνεται πολύμορφος. Κατάψυξις γὰρ ὁ φόβος δι' ὀλιγαιμίαν καὶ δι' ἔνδειάν ἐστι θερμότητος.

[12] Ὁ δὲ πολύπους ἀνόητον μέν ἐστι (καὶ γὰρ πρὸς τὴν χεῖρα βαδίζει τοῦ ἀνθρώπου καθιεμένην), οἰκονομικὸς δ' ἐστίν· πάντα γὰρ συλλέγει μὲν εἰς τὴν θαλάμην, οὗ τυγχάνει κατοικῶν, ὅταν δὲ καταναλώσῃ τὰ χρησιμώτατα, ἐκβάλλει τὰ ὄστρακα καὶ

These are the only relevant texts among Aristotle's extant treatises. We are left, therefore, with many unsettled issues: What does it mean for the chameleon and the octopus to have a cowardly character and experience fear? Is the change of their colour an automatic reaction or does it involve some forethought? Which is exactly the physical mechanism that results in the changing of their colour? To answer these questions, we turn to Theophrastus for help, who took up Aristotle's interests in the animal kingdom and seems to have studied it rather systematically.

3. Theophrastus' fragments

Unfortunately, Theophrastus' small treatise *On Creatures that Change Colour* has not survived.[13] There are only four works by much later authors that give some rudimentary information of its content. Two of these texts are found in Plutarch's *Moral Essays*, one in Athenaeus of Naucratis' *Deipnosophistae* from the early third century, and one in Patriarch Photius' *Biblioteca* from the ninth century. In what follows, I briefly present and analyse these texts in reverse chronological order, starting with Photius' *Biblioteca* that provides us with a selective but reliable summary of Theophrastus' treatise:[14]

> "Read from the (writings) of Theophrastus *On (Creatures) that Change Colour*.
> (I read) that the creatures that change their colour and take on the colours of the adjacent plants and localities and stones are

τὰ κελύφια τῶν καρκίνων καὶ κογχυλίων καὶ τὰς ἀκάνθας τῶν ἰχθυδίων· καὶ θηρεύει τοὺς ἰχθῦς τὸ χρῶμα μεταβάλλων καὶ ποιῶν ὅμοιον οἷς ἂν πλησιάζῃ λίθοις. Τὸ δ' αὐτὸ ποιεῖ καὶ φοβηθείς. Λέγεται δ' ὑπό τινων ὡς καὶ ἡ σηπία τοῦτο ποιεῖ· παρόμοιον γάρ φασι τὸ χρῶμα ποιεῖν τὸ αὑτῆς τῷ τόπῳ περὶ ὃν διατρίβει. Τῶν δ' ἰχθύων τοῦτο ποιεῖ μόνον ἡ ῥίνη· μεταβάλλει γὰρ τὴν χρόαν ὥσπερ ὁ πολύπους.

[13] On the title, chronology, and content of Theophrastus' treatise as well as on our surviving sources, see HUBY (1985) 319; SHARPLES (1995) 90-91; WHITE (2002) 23-24.

[14] On Photius as a source of Theophrastus' treatise, see SHARPLES (1995) 25-26; WHITE (2002) 4; ZUCKER (2008) 331.

the octopus and the chameleon and the wild animal called the *tarandos* which they say occurs among the Scythians or the Sarmatians.

The chameleon changes to all colours, except that it does not admit of change to white or red. And it does not only change to match the colours of its surroundings, but also changes its colour of its own accord if one as much as touches it.

The *tarandos* is about the size of an ox, but its face is like that of a stag, except that it is broader, as if it were made from the faces of two stags joined together. It has cloven hoofs, and horns; its horns are branching, like that of the stag, and are covered with hair all over, for around the bone there is stretched a covering of hide, from which the outgrowth (of hair) takes place. Its hide is as thick as a finger and very strong; and for this reason they even make breastplates by drying it out. The creature is rare and infrequently seen. Its changing (of colour) is remarkable and almost incredible. For with the other creatures the change takes place in the skin, through an alternation of the moisture within, whether it is of the nature of blood or something else of a similar sort, so that the correspondence (of the external colour to the changes in the fluid within) is clear; but that hairs should change colour, being dry and separate, and altogether not of such a nature as to change, is truly contrary to expectation and incredible, especially as they take on diverse (colours) to match many (different surroundings).

The chameleon seems to effect its changes in colour by means of its breath; for it is full of breath by nature. A sign of this is the size of its lungs; for they extend through almost its entire body. And it is clear that it puffs itself up when it is agitated." (Phot. *Bibl.* 278, 525a30b21 = 365A FHSG, trans. FHSG)[15]

[15] ἀνεγνώσθη ἐκ τῶν Θεοφράστου Περὶ τῶν μεταβαλλόντων τὰς χρόας.

ὅτι τὰς χρόας μεταβαλλόμενοι καὶ ἐξομοιούμενοι φυτοῖς καὶ τόποις καὶ λίθοις, οἷς ἂν πλησιάσωσι, πολύπους ἐστὶ καὶ χαμαιλέων καὶ τὸ θηρίον ὁ τάρανδος ὃ ἐν Σκύθαις φασὶν ἢ Σαρμάταις γίνεσθαι.

Μεταβάλλει δ' ὁ χαμαιλέων εἰς πάντα τὰ χρώματα, πλὴν τὴν εἰς τὸ λευκὸν καὶ τὸ ἐρυθρὸν οὐ δέχεται μεταβολήν· καὶ οὐ πρὸς τὰ παρακείμενα μόνον χρώματα μεταβάλλει, ἀλλὰ καὶ αὐτὸς καθ' ἑαυτὸν, ἐάν τις μόνον ἅψηται αὐτοῦ τὸ χρῶμα μεταβάλλει.

ὁ δὲ τάρανδος τὸ μὲν μέγεθός ἐστι κατὰ βοῦν, τὸ πρόσωπον δὲ ὅμοιος ἐλάφῳ, πλὴν πλατύτερος, ὡσανεὶ ἐκ δύο συγκείμενος ἐλαφείων προσώπων. δίχηλον δέ ἐστι καὶ κερασφόρον. ἔχει δὲ τὸ κέρας ἀποφυάδας ὥσπερ τὸ ἐλάφου, καὶ τριχωτόν ἐστι δι' ὅλου· περὶ γὰρ τὸ ὀστοῦν δέρματός ἐστιν ἐπίτασις, ὅθεν ἡ ἔκφυσις. τὸ δὲ δέρμα τῷ πάχει δακτυλιαῖόν ἐστιν, ἰσχυρὸν δὲ σφόδρα· διὸ καὶ τοὺς θώρακας ἐξαυάζοντες αὐτὸ ποιοῦνται. σπάνιον δὲ τὸ ζῷον καὶ ὀλιγάκις

According to Photius' testimony, Theophrastus in his treatise offers three paradigmatic cases of non-human animals changing colour. These include the familiar cases of the chameleon and the octopus, but also the exotic case of the *tarandos*, an animal that has been identified, on the basis of its descriptions in our ancient sources, with the reindeer and the elk (or the American moose).[16] Photius' summary does not discuss further the case of the octopus, but has interesting details concerning the changes in colour of the other two cases.

The chameleon's skin is able to display all colours apart from white and red,[17] and Theophrastus suggests two different explanations to account for this phenomenon. The chameleon sometimes changes colour because it simply adjusts to the external surroundings, yet sometimes it changes colour "of its own accord" (αὐτὸς καθ' ἑαυτὸν) because it is touched. There is no explicit mention in this passage of the chameleon being frightened and acting cowardly, but the latter explanation points towards an internal factor that could be understood in this way. To account for this, Theophrastus includes two physiological explanations. The chameleon changes colour because of an alternation in its moisture — that is, because of an alternation

φαινόμενον. θαυμαστὴ δ' ἡ μεταβολὴ καὶ ἐγγὺς ἀπιστίας. τοῖς μὲν γὰρ ἄλλοις ἐν τῷ δέρματι γίνεται ἡ μεταβολή, ἀλλοιουμένης τῆς ἐντὸς ὑγρότητος, εἴτε αἱματώδους ἢ καί τινος ἄλλης τοιαύτης οὔσης, ὥστε φανερὰν εἶναι τὴν συμπάθειαν· ἡ δὲ τῶν τριχῶν μεταβολή, ξηρῶν τε οὐσῶν καὶ ἀπηρτημένων καὶ ἀθρόον οὐ πεφυκυιῶν ἀλλοιοῦσθαι, παράδοξος ἀληθῶς καὶ ἀπίθανος, μάλιστα πρὸς πολλὰ ποικιλλομένη.

ὁ δὲ χαμαιλέων δοκεῖ τῷ πνεύματι ποιεῖν τὰς μεταβολάς· πνευματικὸν γὰρ φύσει. σημεῖον δὲ τὸ τοῦ πνεύμονος μέγεθος· σχεδὸν γὰρ δι' ὅλου τοῦ σώματος τέταται· ἅμα δὲ καὶ ἐξαιρόμενος αὐτὸς καὶ φυσώμενος δῆλός ἐστιν.

[16] In the spurious Aristotelian treatise *Mirabilia* (832b7-16), in ANTIG. CAR. *Historiae mirabiles* (25b1-c4), and in AEL. *NA* (2, 16), *tarandos* is given a similar description to that in Photius' *Biblioteca*; these texts also present as remarkable the fact that the colour of *tarandos*' hairs changes. For similar descriptions of the wild animal *tarandos*, see PHIL. *Ebr.* 174; IO. DAM. *Sacra parallela* (*PG* 95, 1584B).

[17] In PLIN. *NH* 8, 122, too, the chameleon is said to take all other colours except of white and red, but in PLUT. *Natural Explanations* (916f1-5) and in IO. DAM. *Sacra parallela* (*PG* 95, 1851B) it is only into white that the chameleon's colour does not change.

in its blood —, but also as a result of the change in the breath or *pneuma* (πνεῦμα) that constitutes it. However, what does it mean that the colour changes of the chameleon come from the animal itself, "of its own accord", and not from an external source? Also, in what way do the changes in the chameleon's moisture or *pneuma* affect its colour? Finally, why is it that these physical mechanisms do not produce the colours white and red on the chameleon's skin?

In contrast to the chameleon, Theophrastus' *tarandos* changes the colour of its hairs, rather than its skin.[18] No explanation is given for this phenomenon, which is described as remarkable and almost incredible (θαυμαστή, ἐγγὺς ἀπιστίας, παράδοξος ἀληθῶς, ἀπίθανος). Yet, what makes this particular case extraordinary offers further clues about the important factors in colour changing. For it seems that Theophrastus finds it difficult to explain the change of colour in this case, because the *tarandos'* hairs are dry and unrelated to its inner moisture. Thus, it is again confirmed in this passage that the colour changes generally depend on the amount of inner moisture an animal has.[19] But why are the colour changes of the *tarandos*' hairs considered remarkable, when they correspond to our common experience of humans whose hair colour changes due either to age or to the seasons?[20]

[18] In Photius' passage it is implied that the *tarandos* changes the colour of its hairs in order to match different surroundings. It seems plausible, though, that the seasonal colour changes of the *tarandos*' hairs have been confused with the colour changes of the chameleon, the confusion perhaps resulting from the fact that this animal was not often seen (SHARPLES [1995] 96; [2008] 70).

[19] It is intriguing that the correspondence lacking between the *tarandos*' hair colour and the animal's inner moisture is called συμπάθεια. This term, which no doubt belongs to Theophrastus' vocabulary, signifies the close affinity between different parts of the body or different parts of the world, and explains the fact that changes in one part may result in changes in any other part; see e.g. THEOPHR. *C.P.* 1, 7, 4; 4, 6, 2; *Lass.* 10, 75 Sollenberger; *Od.* 63, 2 Wimmer. The Theophrastean notion of συμπάθεια is the precursor of the more sophisticated Stoic notion of the same name, which thereafter had a long and interesting history (IERODIAKONOU [2006]).

[20] On Aristotle's account of this phenomenon, see ARIST. *Gen. an.* 786a8-12; 29-34.

Compared to Photius' summary, Athenaeus' report of Theophrastus' treatise is more concise and less informative:

> "Theophrastus, in *On (Creatures) that Change Colour*, says that the octopus takes on the colour chiefly, or only, of stony places, doing this through fear and for the sake of self-protection." (Ath. *Deipnosophistae* 104, 317F = 365B FHSG, trans. FHSG)[21]

The only case discussed is that of the octopus and the explanation of its colour changing is not particularly elaborate. However, we find in this explanation an explicit reference to the emotion of fear (φόβῳ) as well as to the motivation behind the octopus' change of colour, namely its self-protection (φυλακῆς χάριν). While there are no physiological explanations offered in this text, the emotion-driven behaviour of the octopus is clearly explained on the basis of its ultimate goal.

The same explicit reference to fear is to be found in Plutarch's *Natural Explanations*, where we find a brief discussion of Theophrastus' account of the colour changing octopus:

> "Why does the octopus change its colour? Is it, as Theophrastus thought, by nature a cowardly creature? So when it is alarmed, there is a change in the air (*pneuma*) in it, and its colour changes along with this — as with a man; for which reason it is said: 'For the coward's colour changes'." (Plut. *Aetia physica* 916b6-10 = 365c FHSG, trans. FHSG)[22]

Plutarch's text reveals that Theophrastus' physiological explanation is also based on the *pneuma* that constitutes the octopus, since changes in the *pneuma*, when the octopus is frightened, are said to result to colour changes in the octopus' skin. Furthermore, Plutarch compares the emotional response of the octopus with that of human beings, who are also said to change

[21] Θεόφραστος δ' ἐν τῷ Περὶ τῶν μεταβαλλόντων τὰς χρόας τὸν πολύποδά φησι τοῖς πετρώδεσι μάλιστα <ἢ> μόνοις συνεξομοιοῦσθαι, τοῦτο ποιοῦντα φόβῳ καὶ φυλακῆς χάριν.

[22] διὰ τί τὴν χρόαν ὁ πολύπους ἐξαλλάττει; πότερον, ὡς Θεόφραστος ᾤετο, δειλόν ἐστι φύσει ζῷον· ὅταν οὖν ταραχθῇ, τρεπόμενον τῷ πνεύματι συμμεταβάλλει τὸ χρῶμα καθάπερ ἄνθρωπος· διὸ καὶ λέλεκται "τοῦ μὲν γάρ τε κακοῦ τρέπεται χρώς".

colour and become pale when in fear, going so far as to cite a Homeric verse to support this claim (*Iliad* 13, 279). But the comparison between the changing colour of humans and that of non-human animals needs not be part of Theophrastus' reasoning, considering that it is Plutarch himself who, immediately after the presentation of Theophrastus' view, chooses to cite Pindar and Theognis, thus demonstrating his eagerness to invoke the literary authorities of the past in order to strengthen his argument (Plut. *Aet. phys.* 916b13-c4).

A most illuminating point is found in the following passage, where Plutarch presents his own explanation for the change of colour in an octopus, proposing an alternative to the account that he attributes to Theophrastus. Plutarch claims that, even if Theophrastus' account of the phenomenon may be plausible, it does not adequately explain the perfect assimilation of the octopus' colour to that of its close environment:

> "Or do they imagine that it treats its colour like a garment, just easily making a change of clothes as it wishes? Is the truth this, that although the creature itself initiates the effect by feeling fright, the determining factor in the causation lies elsewhere? Just apply to the consideration of the problem the recognition that there are, as Empedocles wrote, 'emanations from all things that ever were.' Many streams of particles continuously leave not only animals and plants, earth and sea, but also stones and bronze and iron. Indeed everything that decays or gives off a smell does so because something is always streaming away and leaving it… Now it is particularly likely that many minute particles are continually detached from rocks by the sea-shore as they are sprayed and fretted by the sea; these fragments do not adhere to the bodies of any animal but the octopus: they either slip off the surface of those that have narrower pores or pass quickly through those that have more open ones, and in neither case can they be seen. The octopus, however, has a flesh which is obviously honeycombed in appearance and full of pores and so receptive of emanations; when it is frightened, it undergoes a change in its *pneuma* and effects one by it, tightening, so to speak, and contracting its body, so as to harbour on its surface the emanations from near-by objects without allowing them to penetrate it. And indeed its combination of roughness with softness, by offering places of lodgement to the particles that settle

> on it, which do not disperse but collect and remain in position, causes its surface to be coloured so as to resemble the rocks. A strong piece of evidence in favour of this explanation is that this creature does not take on a likeness to all neighbouring objects any more than the chameleon does to pale colours: both take a likeness to those things only with whose emanations their pores are commensurate." (Plut. *Aet. phys.* 916c8-f5, trans. F.H. Sandbach)[23]

The details of Plutarch's alternative explanation will be discussed later. For the time being, let me focus on the first lines of this text and point out that Plutarch, here, seems to group Theophrastus together with those who attribute to the octopus, just like in the case of humans, the capacity to change the colour of its skin at will (ᾗ βούλεται).

A similar case is found in his essay *On the Intelligence of Animals*, where Plutarch claims that, according to Theophrastus, the octopus differs from the chameleon in that it may change its colour at will, while the chameleon merely does so from fear and to no purpose:

> "For the chameleon changes (colour) not by any design, nor concealing itself, but does so from fear and to no purpose, being naturally frightened by noise and cowardly. And in accordance

[23] ἢ καθάπερ ἐσθῆτι τῇ χρόᾳ νομίζουσι χρῆσθαι, ῥᾳδίως οὕτως ᾗ βούλεται μετενδυόμενον. ἆρ' οὖν τὴν μὲν ἀρχὴν αὐτὸς ἐνδίδωσι τοῦ πάθους δείσας, τὰ δὲ κύρια τῆς αἰτίας ἐν ἄλλοις ἐστί; σκόπει δή, κατ' Ἐμπεδοκλέα 'γνοὺς ὅτι πάντων εἰσὶν ἀπορροαὶ ὅσσ' ἐγένοντο·' οὐ γὰρ ζῴων μόνον οὐδὲ φυτῶν οὐδὲ γῆς καὶ θαλάττης, ἀλλὰ καὶ λίθων ἄπεισιν ἐνδελεχῶς πολλὰ ῥεύματα καὶ χαλκοῦ καὶ σιδήρου· καὶ γὰρ φθέγγεται πάντα καὶ ὄδωδε τῷ ῥεῖν ἀεί τι καὶ φθείρεσθαι συνεχῶς... μάλιστα δὲ τῶν παράλων πετρῶν ἐπιρραινομένων καὶ ψηχομένων ὑπὸ τῆς θαλάττης ἀπιέναι μέρη καὶ θραύσματα πολλὰ καὶ λεπτὰ <εἰκὸς> συνεχῶς, ἃ τ<οῖς χρώμασιν ἀλλήλων διαφέροντα τοῖς μὲν ἄλ>λοις οὐ προσί<σχεται> σώμα<σιν> ἀλλὰ λανθάνει περιολισθάνοντα τῶν πυκνοτέρους ἐχόντων πόρους ἢ διεκθέοντα τῶν μανοτέρους. ὁ δὲ πολύπους τήν τε σάρκα προσιδεῖν αὐτόθεν ἀνθρηνιώδης καὶ πολύπορος καὶ δεκτικὸς ἀπορροιῶν ἐστιν, ὅταν τε δείσῃ, τῷ πνεύματι τρεπόμενος καὶ τρέπων οἷον ἔσφιγξε τὸ σῶμα καὶ συνήγαγεν, ὥστε προσδέχεσθαι καὶ στέγειν ἐπιπολῆς τὰς τῶν ἐγγὺς ἀπορροίας. καὶ γὰρ ἡ τραχύτης μετὰ τῆς μαλακότητος ἕλικας παέχουσα τοῖς ἐπιφερομένοις μέρεσι, μὴ σκεδαννυμένοις ἀλλ' ἀθροιζομένοις καὶ προσμένουσι, σύγχρου<ν ἀπεργάζεται> τὴν ἐπιφάνειαν <τοῖς ἐγγύ>τατα. τεκμήριον δὲ τῆς αἰτίας μέγα τὸ μήτε τοῦτον πᾶσιν ἐξομοιοῦσθαι τοῖς πλησίον μήτε τὸν χαμαιλέοντα τοῖς λευκοῖς χρώμασιν, ἀλλὰ μόνοις ἑκάτερον, ὧν ταῖς ἀπορροίαις πόρους συμμέτρους ἔχουσιν.

> with this, too, is the great amount of breath (in it), as Theophrastus says; for almost the entire body of the creature is filled by its lungs, and from this he infers that it is full of breath and for this reason able to change (colour). But the change (of colour) of the octopus is something that it does, rather than something that happens to it; for it changes (colour) deliberately, using this as a device both to hide from (the creatures) it fears and to capture (those) on which it feeds. For by (this) deceit it captures the latter as they do not try to escape, and escapes the former, as they pass it by." (Plut. *De soll. an.* 978e8-f6 = 365d FHSG, trans. FHSG)[24]

To summarise briefly the different explanations suggested of the chameleon's and the octopus' colour changing: The chameleon is said to change from fear (δέους), to no purpose (ἄλλως), with no plan (οὐδέν τι μηχανώμενος) or aim to hide itself (οὐδὲ κατακρύπτων ἑαυτὸν). The change of its colour is due to its cowardly natural disposition and the alterations of the *pneuma* that fills its lungs, which in this case comprise most of its body. In the case of the octopus, changes of colour are not due to a simple affection (οὐ πάθος) that happens to it. Rather, the octopus acts with forethought (ἐκ προνοίας) and by design (μηχανῇ χρώμενος), both in order to avoid its enemies and in order to catch its prey. But can a non-rational animal, like the octopus, act with forethought? What does it mean to say, in this case, that it acts in such a way so as to achieve its goal?

It is not clear, however, where exactly in this text the attribution to Theophrastus ends. Could it be that Plutarch presents Theophrastus' view concerning the chameleon's change of colour and adds, immediately after, his own interpretation of the octopus' response? Indeed, it has been claimed that Plutarch

[24] μεταβάλλει γὰρ ὁ μὲν χαμαιλέων οὐδέν τι μηχανώμενος οὐδὲ κατακρύπτων ἑαυτὸν ἀλλ' ὑπὸ δέους ἄλλως τρέπεται, φύσει ψοφοδεὴς ὢν καὶ δειλός· συνέπεται δὲ καὶ πνεύματος πλῆθος, ὡς Θεόφραστος· ὀλίγον γὰρ ἀποδεῖ πᾶν τὸ σῶμα τοῦ ζῴου πλῆρες εἶναι πνεύμονος, ᾧ τεκμαίρεται τὸ πνευματικὸν αὐτοῦ καὶ διὰ τοῦτο πρὸς τὰς μεταβολὰς εὔτρεπτον. τοῦ δὲ πολύποδος ἔργον ἐστὶν οὐ πάθος ἡ μεταβολή· μεταβάλλει γὰρ ἐκ προνοίας, μηχανῇ χρώμενος τοῦ λανθάνειν ἃ δέδιε καὶ λαμβάνειν οἷς τρέφεται· παρακρουόμενος γὰρ <τὰ μὲν> αἱρεῖ μὴ φεύγοντα τὰ δ' ἐκφεύγει παρερχόμενα.

makes a distinction between the chameleon's and the octopus' reaction that Theophrastus would not recognise.[25] However, Plutarch does not give any indication that the distinction is his own, although he makes sure to distance himself from Theophrastus when, in the previously quoted passage from his *Natural Explanations*, he introduces his alternative physiological explanation of the colour change of the octopus. Besides, the motivation of the octopus' reaction, in this passage, does not differ from the one that Plutarch attributes to Theophrastus in his *Natural Explanations*, where the octopus is said to change colour at will for the sake of its self-protection, while here it is said to change colour in order to escape its predators and to catch its prey.

Having presented the evidence for Theophrastus' account of the phenomenon of colour changing in non-human animals, I move to discuss the different explanations attributed to his view. These can be distinguished into two categories, psychological or formal explanations and physiological or material explanations. It is important to note, that these particular explanations only concern colour changes that involve internal factors, such as an animal's reaction to external stimuli, and do not concern those colour changes that come about merely as the result of external conditions. In other words, these explanations concern neither the case described by Photius, in which the colour of the chameleon simply adjusts to that of the animal's surroundings, nor the likely case of the octopus that changes its colour while peacefully moving from one part of the sea bottom to the other.

4. Psychological or formal explanations

The psychological explanations attributed to Theophrastus concern those cases in which the soul of the chameleon and the

[25] Sharples (1995) 95; (2006) 169; Rheins (2015) 393, n. 47.

octopus is affected in such a way that the colour of their skin changes. More specifically, we may distinguish between two types of psychological explanations offered by Theophrastus:

First, the colour changes of the chameleon's skin are understood as automatic emotion-driven responses to some external disturbance, because the colour of the chameleon changes when the animal is in fear and it has no control over this change. This is how Photius and Plutarch read Theophrastus' account, namely that the chameleon changes colour from fear, and in this sense of its own accord, but with no design or forethought.

Second, the colour changes of the octopus' skin are understood as emotion-driven responses involving some kind of forethought and being goal-directed, since the colour of the octopus changes both when the animal tries to avoid its predators and, crucially, when it plans to catch its prey. This is what Athenaeus implies when he mentions that the octopus changes its colour for self-protection. In addition, this is what Plutarch suggests when he points out that the octopus' colour changes do not simply happen, but it is the octopus itself who initiates these changes.

To grasp the difference between these two types of psychological explanations, it is perhaps helpful to explore the same phenomenon in the case of human beings. The colour changes of one's complexion, when blushing or turning pale, is explained as an automatic emotion-driven response involving no design. Human beings have no capacity to change their colour at will, although they are rational and able to act with forethought. It becomes clear, therefore, that the two types of psychological explanations are offered by Theophrastus in order to differentiate the behaviour of two species of non-human animals, the chameleon and the octopus, and not in order to draw the line between rational human beings and non-rational animals.

But is it possible to characterise the octopus' colour changing — or, for that matter, the behaviour of any non-human animal — as an emotion-driven response involving forethought and having a certain aim? For such a claim is based on two

highly disputed assumptions: The first is that non-human animals have emotions, which motivate and guide their actions, while the second is that they also have cognitive capacities, allowing them to plan their actions in order to achieve their goals. However, can we attribute emotions and, in particular, fear to non-human animals? Some contemporary philosophers have suggested that emotions always imply beliefs, and hence beliefs should be regarded as necessary and sufficient conditions of emotions. This is the reason why some among them have claimed that emotions are uniquely human, even if certain species of non-human animals can be said to feel fear, pain, and pleasure. Others, though, especially those who are interested in animal rights, defend the view that the differences between human and non-human animals should more properly be considered ones of degree, since their cognitive capacities stand in a relationship that can justly be called an evolutionary continuum, including the emotions as well. Finally, there are also contemporary philosophers who have altogether denied that emotions are necessarily judgements, arguing instead that emotions are evaluative reactions shared by human and non-human animals alike.[26]

Focusing on the Aristotelian tradition, and beginning with Aristotle himself, it is important to underline that Aristotle uses the term πάθη, i.e. passions or affections, to include all kinds of bodily drives and sensations, as well as what we nowadays consider as emotions. For instance, both the painful sensation of being burnt and the emotion of envy are called πάθη, with no distinction made between them. The question becomes, therefore, whether or not Aristotle actually ascribes those passions that are associated with emotions, in particular fear, to non-human animals. This issue has been debated extensively among scholars who have rightly detected a tension among

[26] On contemporary philosophical theories concerning the emotions of non-human animals, see e.g., NUSSBAUM (2001); KNUUTTILA (2004); NEWMYER (2016).

Aristotle's treatises, and their suggestions to resolve it have been diverse. The main point of disagreement lies, again, on whether or not Aristotle thinks that at least some of the passions associated with emotions should be understood as involving beliefs and, if they do involve beliefs, it is equally questionable whether or not non-human animals can be said to possess them.

There are many passages in the Aristotelian corpus, in which non-human animals are said both to cause fright to others and to be themselves frightened. More specifically, in the eighth and ninth book of his *History of Animals*, Aristotle clearly seems committed to the humanisation of non-human animals when it comes to their emotional responses and characters.[27] In this context, human beings and non-human animals differ only quantitatively both in regard to emotions, like fear and confidence, as well as in their capacity for natural virtues, like courage and cowardice.[28] According to these books, emotions are associated with the faculty of sensation, and they can thus be attributed to humans and to non-human animals in varying degrees without any apparent difference in kind. But is fear, in Aristotle's view, simply a sensation or does it involve the belief that something is terrible? The definition of fear in Aristotle's *Rhetoric* (1382a21-22) suggests that the mere imagination (φαντασία) of something terrible may arouse a genuine fear, even in the absence of any beliefs about its objects. On the other hand, later in the *Rhetoric* (1382b29-32), as well as in both the *De anima* (427b21-22) and the *Nicomachean Ethics* (1115a9; 1117a20-21), Aristotle seems to imply that fear does involve some belief (δόξα) and expectation (προσδοκία), but also that there are certain beliefs that seem to be able to prevent fear.

Some scholars have argued that Aristotle does not really ascribe emotions to non-human animals, in our sense of the

[27] E.g., ARIST. *Hist. an.* 588a22; 608b31; 609a34; 609b17; 622b14; 627a18-19; 629b21; 630b12. It should be noted, though, that it is still controversial whether the eighth and ninth book of the *History of Animals* were actually written by Aristotle himself; see e.g. LLOYD (1983) 21; HUBY (1985).

[28] On natural virtues, see e.g. WHITE (1992).

term, but only bodily drives and pleasant or painful sensations. The fact that he applies emotional terms to animal responses is understood as the result of merely drawing an analogy to human experience, or simply recognising no need to avoid the metaphors of everyday language. Besides, the ancients were also guilty of anthropomorphism, and Aristotle was no exception.[29] On the other hand, there are scholars who have defended the thesis that Aristotle does ascribe emotions to non-human animals, but there is disagreement among them in how Aristotelian emotions should be conceived. Some have claimed that Aristotle does not regard beliefs as necessary for emotions, while others have insisted that he thinks of them as judgements about emotionally relevant matters.[30] But if Aristotelian passions associated with emotions imply beliefs, does this mean that the cognitive capacities of non-human animals are no different from those of human beings, who are presented as unique in making judgements upon which they act, and are thus the only rational animals?

According to Aristotle, the soul of a plant is only characterised by nutritive capacity, non-human animals have, in addition to this, appetitive and perceptive capacities, while human beings alone possess the intellectual capacity to form concepts and organise knowledge into systematic bodies.[31] Indeed, Aristotle is occasionally cited as someone who strictly distinguishes human from non-human animals in terms of their cognitive capacities. These include, in particular, the capacity to reason (λόγος) and calculate (λογισμός), as well as the capacity for technical skill (τέχνη), knowledge (ἐπιστήμη), thought (διάνοια), and theoretical understanding or intellect (νοῦς).[32] Hence, in Aristotle's view, non-human animals possess imagination (φαντασία), but none

[29] FORTENBAUGH (1971); LLOYD (1983); KONSTAN (2006) xii and 21.
[30] NUSSBAUM (1978) essays 4 and 5; SORABJI (1993) 56-57.
[31] E.g., ARIST. *De an.* 414a29-b3; 414b16-19.
[32] E.g., ARIST. *De an.* 404b4-6; 427b7-15; 428a20-25; 429a6-8; 433a11-12; 434a10-12; *Mem.* 450a15-17; *Eth. Nic.* 1098a3-4; *Eth. Eud.* 1224a27; *Pol.* 1332b5.

have belief (δόξα) or conviction (πίστις);[33] relying on imagination, they act voluntarily and are able to find subgoals that fit to their ultimate aim.[34] Nevertheless, there are texts in which Aristotle blurs this clearly drawn distinction, by attributing to non-human animals some kind of practical sense (σύνεσις) or intelligence (φρόνησις), and considering them able enough to think about their future and to possess a power of forethought (δύναμις προνοητική: *Nicomachean Ethics* 1141a22-28). For Aristotle recognises that at least some non-human animals have memories, some can learn and teach, and a few even achieve a small degree of experience (ἐμπειρία).[35] Indeed, in his *History of Animals* (588a23-31), Aristotle draws similarities between human and non-human animals not only in regard to emotional complexities, but also as concerns their intelligent understanding. For instance, deer, hares, cuckoos, cranes, swallows, and elephants are all said to have some kind of practical intelligence, and wild birds are said to build their nests for the safety of their offspring.[36] Also, in the *De anima* (427b7-11), he explicitly attributes to some animals practical sense or intelligence, and makes clear that this is different from theoretical understanding.

So, there is another tension in Aristotelian psychology, this time concerning non-human animal intelligence, and scholars have dealt with it in different ways. Some have suggested that Aristotle's claims about the similarities between human and non-human animals are simply analogous; just as technical skill, practical intelligence, and wisdom are found in humans, so too in certain animals some other such natural capacity is found. In other words, when it comes to non-human animals, Aristotle's references to practical intelligence should not be understood in a

[33] E.g., ARIST. *De an.* 428a18-b9; 433a10-13; 433b27-30; *De motu an.* 701a34-36; 701b18-19.

[34] E.g., ARIST. *Eth. Nic.* 1111a25-26; 1111b7-9.

[35] E.g., ARIST. *De an.* 428a8-11; 24-25; *Mem.* 449b28-30; *Metaph.* 980a27-b28.

[36] E.g., ARIST. *Hist. an.* 488b15; 608b2; 612b18-32; 614b31-32; 618a25; 618b18; 630b21.

technical way, but rather in a loose colloquial manner. The thought, then, is that Aristotle projects human concepts onto other animals as is done in folklore and fable; animals are motivated by appetite and desire, but not reason. However, in the absence of reason, Aristotelianism preserves resources for many cognitive capacities in non-human animals, since they clearly possess, imagination, memory, and various types of sense perception.[37] On the other hand, many scholars have defended the view that practical intelligence exists in all human and non-human animals, proclaiming a universal concept of intelligence that is found in different species on a spectrum that requires each case to be treated individually. In this view, the practical intelligence that non-human animals develop is rather limited, since the experience they develop by retaining through memory what they have perceived is rather limited. In fact, Aristotle claims that, in contrast to human beings, the sort of memory and experience non-human animals develop does not give them the ability to think. Animals cognitively respond in complex ways to their surroundings, but they do not have the ability to grasp universals, and thus to formulate thoughts. Other scholars, however, have been more generous towards the cognitive capacities of non-human animals, and have been even willing to attribute to them concepts and the exercise of practical syllogism.[38]

These are some of the intricacies that have already been detected in Aristotle's project of animal psychology, which concern, in particular, the similarities and differences between human and non-human animal cognition. His immediate collaborators, especially Eudemus, Theophrastus, and Strato, participated in this project and extended it. To focus on Theophrastus' contribution, he is reported to have written a treatise with the title *On the Intelligence and Habits of Living Creatures* (*Περὶ ζῴων φρονήσεως καὶ ἤθους*), but unfortunately, we have no surviving fragments that we can

[37] FORTENBAUGH (1971); LLOYD (1983) 18-43; SORABJI (1993) 12.

[38] LABARRIERE (1984); (1990); LENNOX (1999) 21-22; OSBORNE (2007) 79-94; FREDE (2008); LEFÈBVRE (2008); CONNELL (forthcoming).

definitively tie to it (Diog. Laert. 4, 49). We have, though, fragments from his treatise *On Creatures that Retreat into Holes* (*Περὶ τῶν φωλευόντων* 366-370 FHSG), in which he regards hibernation and aestivation as measures taken by some non-human animals to avoid the cold in the winter or the heat in the summer. Moreover, the fact that, in his small treatise *On Creatures Said to be Grudging* (*Περὶ τῶν λεγομένων ζῴων φθονεῖν* 362A FHSG), Theophrastus denies that non-human animals are motivated by envy, grudgingness, and hostility towards human beings does not mean that they lack all sorts of emotions; what they lack are only those emotions that imply knowledge of human technology and medicine.[39] Interestingly enough, in the same treatise, he even accuses humans of applying their own suppositions (ὑπολήψεις) when they impose grudgingness upon non-rational animals (ἄλογοι) as a motive for their actions. Therefore, it seems that Theophrastus, here, points to a clear difference between non-rational animals and rational human beings. But what kind of difference does he have in mind? Is there a gap between human and non-human animals, or a cognitive continuum of different degrees?

Among Theophrastus' fragments, we find passages in which he follows Aristotle in suggesting that the acquisition of beliefs is a later development with which only humans are endowed:

> "And just as the growth of the branches of knowledge and of skills is a later development, so also is what is called opinion. For when the soul yields to the phantasia being produced in it from the sensation, and inclines and assents to the object that has appeared, it is said to be opinion." (Sext. Emp. *Math.* 7, 225-226 = 301A FHSG, trans. FHSG)[40]

On the other hand, Theophrastus often emphasises the links rather than the distinctions between humans and other animals, suggesting that, in his view, animals have broader cognitive

[39] FORTENBAUGH (1971); COLE (1992); ZUCKER (2017).

[40] ὥσπερ δὲ ἡ τῶν ἐπιστημῶν καὶ τεχνῶν φύσις ἐστὶν ὑστερογενής, οὕτω καὶ ἡ καλουμένη δόξα· ὅταν γὰρ εἴξῃ ἡ ψυχὴ τῇ ἀπὸ τῆς αἰσθήσεως ἐγγενομένῃ φαντασίᾳ καὶ τῷ φανέντι πρόσθηται καὶ συγκατάθηται, λέγεται δόξα.

capacities than are seen in the work of Aristotle. For instance, in the opening lines of the first book of his *History of Plants*, where some general remarks about plants are made, animals are said to carry out actions (πράξεις) in contrast to plants. This statement is particularly striking, given that Aristotle (*Eth. Nic.* 1139a19-20; 1139a30-35) denies actions to animals, since actions presuppose a decision based on the exercise of reason. Thus, the ascription of actions to non-human animals by Theophrastus implies that, according to him, they have at least some degree of reason.

Most importantly, we have statements of Theophrastus quoted in Porphyry's *On abstinence* that stress the commonality or kinship (οἰκεῖος, συγγενής) that humans have with non-human animals. These statements, which mostly or entirely come from Theophrastus' treatise *On Piety*, belong to a series of arguments against animal sacrifice. Theophrastus states that the souls of human and non-human animals do not differ in their natures, which is to say that they do not differ in their desires (ἐπιθυμίαι) and impulses (ὀργαί), nor even in their calculations (λόγοι) and sense perceptions (αἰσθήσεις):

> "Thus also we posit that all men are kin to each other and indeed also to all the animals; for the principles of their bodies are naturally the same. I say (this) not with reference to the primal elements, for they are the source also of plants. Rather (I mean), e.g., skin, flesh and the kind of fluids naturally present in animals. And much more (are men and animals related) because the souls they have are not naturally different. I mean, of course, (not different) in their desires and angry impulses, and further in their calculations and above all in their sensations. But just as with bodies so with souls, some animals have them in a highly finished condition, others less so, yet for all of them the principles are naturally the same. The relationship of emotions makes this clear." (Porph. *Abst.* 3, 25, 16-29 = 531 FHSG trans. FHGS)[41]

[41] οὕτω δὲ καὶ τοὺς πάντας ἀνθρώπους ἀλλήλοις τίθεμεν [καὶ] συγγενεῖς, καὶ μὴν <καὶ> πᾶσι τοῖς ζῴοις· αἱ γὰρ τῶν σωμάτων ἀρχαὶ πεφύκασιν αἱ αὐταί· λέγω δὲ οὐκ ἐπὶ τὰ στοιχεῖα ἀναφέρων τὰ πρῶτα· ἐκ τούτων μὲν γὰρ καὶ τὰ φυτά· ἀλλ' οἷον δέρμα, σάρκας καὶ τὸ τῶν ὑγρῶν τοῖς ζῴοις σύμφυτον γένος· πολὺ δὲ μᾶλλον τῷ τὰς ἐν αὐτοῖς ψυχὰς ἀδιαφόρους πεφυκέναι, λέγω δὴ ταῖς ἐπιθυμίαις καὶ ταῖς ὀργαῖς, ἔτι δὲ τοῖς λογισμοῖς, καὶ μάλιστα πάντων ταῖς

Theophrastus' claim, here, is quite intriguing. But is he going so far as to say that animal souls are the same as human souls, or that they are the same in kind but still different in degree? It has been argued that these texts signal an important change from Aristotle's doctrine, but there is no reason to regard Theophrastus' stance as critical or polemical towards Aristotle. The difference between their approaches has reasonably been interpreted as one of emphasis: Aristotle marks the discontinuities and dissimilarities between human and non-human animals, whereas Theophrastus stresses their deep underlying similarities. Indeed, Theophrastus' views on non-human animals can be seen as an elaboration of Aristotle's doctrines rather than a divergence from them. He, too, acknowledges that animals have cognitive capacities of at least some degree, but chooses to underline the gap between animals and plants and not, as Aristotle does, between human and non-human animals.[42]

Thus, when Plutarch reports Theophrastus' distinction between the automatic response of the chameleon and the octopus' exercise of forethought in changing the colour of its skin, it should not surprise us that a non-human animal possesses practical intelligence. For it seems that, according to Theophrastus, just as for Aristotle, non-human animals have no beliefs yet may still be endowed with cognitive capacities that allow them to plan their actions in such a way so as to have a better chance in achieving their goals. However, Theophrastus seems to take a more respectful and generous stance than Aristotle towards non-human animals, recognising degrees in their cognitive capacities and enlarging the list of animals who have the ability of forethought. As we have seen, Aristotle (*Part. an.* 679a13) does not consider the octopus as particularly intelligent, whereas Theophrastus grants it the capacity to change its colour with the aim of avoiding its enemies

αἰσθήσεσιν. ἀλλ' ὥσπερ τὰ σώματα, οὕτω καὶ τὰς ψυχὰς τὰ μὲν ἀπηκριβωμένας ἔχει τῶν ζῴων, τὰ δὲ ἧττον τοιαύτας, πᾶσί γε μὴν αὐτοῖς αἱ αὐταὶ πεφύκασιν ἀρχαί. δηλοῖ δὲ ἡ τῶν παθῶν οἰκειότης.

[42] FORTENBAUGH (1971) 151-157; (1974) 63-70; (2011) 402-403; COLE (1992); SORABJI (1993); SHARPLES (1995) 32-37; RHEINS (2015) 390-396.

and, even more strikingly, at catching its prey. Hence, it may be true that Plutarch is one of only a few extant ancient authors who devotes entire treatises to issues relating to animals,[43] but the difference in motivation he reports between the chameleon's and the octopus' colour changing should be considered as part of Theophrastus' own account of animal intelligence.

5. Physiological or material explanations

There seems to be complete agreement between the psychological explanations put forth by — that is, the physical mechanisms invoked to explain the colour changing phenomena — where these authors differ significantly.

Let us take Aristotle's account, again, as our point of departure for understanding the physical mechanisms behind the colour changes of the chameleon and the octopus. As we have seen above, in his *History of Animals* (503b2-8), Aristotle claims that the chameleon turns black when it is "inflated with air". It has been suggested that this passage reads like a detailed report of a dissection,[44] but we may also assume that the chameleon inflates itself by breathing air. After all, the ancients mistakenly thought that the chameleon is the only animal that does not live on food or drink, but derives its total nutrition solely from the air.[45] On the other hand, the octopus' change of colour is described in Aristotle's *Parts of Animals* (692a21-25) as due

[43] Plutarch's moral essay *On the Intelligence of Animals* offers an extensive defense against the Stoics, taking the position that all animals have a share of reason, although Plutarch himself acknowledges that non-human animals are incapable of attaining to the fullness of reason to which education and practice can lead humans. On Plutarch's account of animal intelligence, see NEWMEYER (2006) 10-47 and (2014).

[44] Later in the same chapter it is mentioned that the chameleon continues to function with its breath or *pneuma* even after being cut open, but there is no explicit link there between the amount of breath and the change of colour (SHARPLES (1995) 92; (2006) 169 n. 13).

[45] PLIN. *NH* 8, 122.

solely to fear. Cephalopods are said to have a cold constitution due to being bloodless,[46] and this disposes them to easily become frightened and emit ink or change their colour, at least in the case of the octopus (*Part. an.* 679a12-14).

In addition, there are other Aristotelian passages that stress the importance of blood for colour changes. For instance, again in the *Parts of Animals* (651a12-17), the nature of blood is said to affect both the natural disposition and the sensory faculties of animals in many ways. This is what we might reasonably expect, since blood is the material and nutrient from which the whole body is constituted. It thus makes a considerable difference whether blood — or the fluid that is analogous to blood in bloodless animals — is hot or cold, thin or thick:

> "Some at any rate of the animals with watery blood have a keener intellect. This is due not to the coldness of their blood, but rather to its thinness and purity; neither of which qualities belongs to the earthy matter. For the thinner and purer its fluid is, the more easily affected is an animal's sensibility. Thus it is that some bloodless animals are more intelligent than some among the sanguineous kinds. Such for instance, as already said, is the case with the bee and the tribe of ants, and whatever other animals there may be of a like nature. At the same time too great an excess of water makes animals timorous. For fear chills the body; so that in animals whose heart contains so watery a mixture the way is prepared for the operation of this emotion. For water is congealed by cold. This also explains why bloodless animals are, as a general rule, more timorous than such as have blood, so that they remain motionless, when frightened, and discharge their excretions, and in some instances change colour." (Arist. *Part. an.* 650b18-33)[47]

[46] Cephalopods are bloodless but have a fluid that is the counterpart of the blood and an organ that is the counterpart of the heart (ARIST. *Part. an.* 647a30-31; 648a1-20; 678b1-4).

[47] Συμβαίνει δ' ἔνιά γε καὶ γλαφυρωτέραν ἔχειν τὴν διάνοιαν τῶν τοιούτων, οὐ διὰ τὴν ψυχρότητα τοῦ αἵματος, ἀλλὰ διὰ τὴν λεπτότητα μᾶλλον καὶ διὰ τὸ καθαρὸν εἶναι· τὸ γὰρ γεῶδες οὐδέτερον ἔχει τούτων. Εὐκινητοτέραν γὰρ ἔχουσι τὴν αἴσθησιν τὰ λεπτοτέραν ἔχοντα τὴν ὑγρότητα καὶ καθαρωτέραν. Διὰ γὰρ τοῦτο καὶ τῶν ἀναίμων ἔνια συνετωτέραν ἔχει τὴν ψυχὴν ἐνίων ἐναίμων, καθάπερ εἴρηται πρότερον, οἷον ἡ μέλιττα καὶ τὸ γένος τὸ τῶν μυρμήκων κἂν εἴ τι ἕτερον

The octopus, therefore, changes colour as a result of being frightened and its particularly cowardly disposition is explained by reference to the watery fluid that constitutes it. But it is worth noting that, although the thinness of this fluid could be said to make the octopus more intelligent than some sanguineous animals, Aristotle does not use the octopus here as a paradigmatic case in this regard.

In general, emotions in human and non-human animals are associated with the heating or chilling of blood, which causes respectively small expansions and contractions of the heart. However, such cardiac movements are also associated in Aristotle with the expansion or contraction of what he calls the "connate *pneuma*" (σύμφυτον πνεῦμα), a warm air form substance that is generated together with each individual animal and kept inside it, primarily in the heart. Aristotle's notion of the *pneuma* was influenced by, if not borrowed from, the medical theories of his time, but it is uncertain whether or not he himself had a systematic theory on the topic, since his relevant surviving remarks are not always consistent with one another nor with other Aristotelian doctrines.[48] Although Aristotle's account of the *pneuma* has received recent careful study, it is admittedly very difficult to reconstruct a coherent narrative, given the scattered nature of the evidence. It seems plausible, though, that the role of the *pneuma* is to convert qualitative change into quantitative change, such as thermic alterations of the heart into expansion and contraction. This is to say, if the perception of an object is pleasant or painful, the perceptual alteration in the heart is accompanied by a respective heating or chilling response that results in the expansion or contraction of the *pneuma*. This creates a mechanical impulse that brings about the motion of the limbs. But apart from its

τοιοῦτόν ἐστιν. Δειλότερα δὲ τὰ λίαν ὑδατώδη. Ὁ γὰρ φόβος καταψύχει· προωδοποίηται οὖν τῷ πάθει τὰ τοιαύτην ἔχοντα τὴν ἐν τῇ καρδίᾳ κρᾶσιν· τὸ γὰρ ὕδωρ τῷ ψυχρῷ πηκτόν ἐστιν. Διὸ καὶ τἆλλα τὰ ἄναιμα δειλότερα τῶν ἐναίμων ἐστὶν ὡς ἁπλῶς εἰπεῖν, καὶ ἀκινητίζει τε φοβούμενα καὶ προΐεται περιττώματα καὶ μεταβάλλει ἔνια τὰς χρόας αὐτῶν.

[48] Not even the spurious treatise *Περὶ πνεύματος* (*De spiritu*), transmitted with the *Corpus Aristotelicum*, offers a unified account of the connate *pneuma*. For the authenticity issue of the *De spiritu*, see GREGORIC / LEWIS (2015) 159-160.

principal role in animal motion, the *pneuma* also has an important role in the reproduction of animals as well as in their capacity for sense perception, notably in connecting the heart with the peripheral sense organs.[49]

It seems, though, that the *pneuma* is given a more extended role by Theophrastus than it is by Aristotle, so much so that it has been suggested that, in Theophrastus, we find a unified *pneuma* theory. In this view, the function of the *pneuma* is to keep the body and the soul of human and non-human animals together, linking psychic functions with physical motions.[50] It is precisely this *pneuma* to which Theophrastus refers in his attempt to explain the colour changes of the chameleon and the octopus. As we have seen in Photius' text, Theophrastus gives two physiological explanations of the chameleon's and the octopus' colour changing: He claims, at first, that these changes in colour are due to an alteration of the moisture within these animals; for the chameleon, this is an alteration of the blood, while in the case of the octopus, this refers to some other fluid of a similar sort. Immediately after this, though, Theophrastus explicitly states that the chameleon changes colour by means of its *pneuma*. Moreover, it is, again, due to their *pneuma* that both the chameleon and the octopus change their colour in both passages from Plutarch's essays: as soon as these animals get frightened, Theophrastus is reported to have claimed that their *pneuma* changes, and this consequently affects the colour of their skin. But are these two different physical mechanisms consistent? Theophrastus does not seem to have found anything problematic in presenting the moisture and the *pneuma* as alternative explanations, a pattern that he also presents in the case of perspiration at the beginning of his small treatise *On Sweat* (*Περὶ ἱδρώτων* 1, 2-6 Fortenbaugh). Perhaps he thought

[49] The remarks in this paragraph on Aristotle's account of the *pneuma* are based on FREUDENTHAL (1995) 106-148; BERRYMAN (2002); CORCILIUS (2008) 332-343; BUDDENSIEK (2009); CORCILIUS / GREGORIC (2013); GREGORIC / KUHAR (2013); CONNELL (2016) 215-220; GREGORIC (forthcoming).

[50] SHARPLES (1995) 28-29; 93.

that the *pneuma* functions as a means of altering the blood of an animal, or some other similar fluid, thus affecting its moisture and leading to a change in its colour. However, no ancient source gives us any additional information on this point.

Furthermore, there is no inconsistency between these physiological or material explanations and the psychological or formal ones; they should rather be seen as two complimentary ways of looking at the same phenomenon.[51] For, according to Theophrastus, physical mechanisms and emotion-driven behaviour are just two descriptions of the same phenomenon in the case both of human beings and of non-human animals. This is certainly an Aristotelian position, which is made clear when we take into account the definition of anger in the *De anima* (403a29-b7) both as the boiling of blood around the heart as well as the desire to hurt someone in return.

6. Colour theories

But how does Theophrastus explain the specific colours produced on the skin of the chameleon and the octopus? Unfortunately, there is no evidence to help us answer this question. It is interesting, though, that there is no mention in Theophrastus' fragments of the transparent (διαφανές), which is, in Aristotle's view, what makes things coloured. Indeed, colour is characterised by Aristotle (*De sensu* 439b11-12) as the limit of the transparent in a determinately bounded body. But there are also passages in the Aristotelian corpus suggesting that heat and air make bodies white, while water and earthy matter make bodies black.[52] I have elsewhere claimed that, according to Aristotle, the presence of each of the four basic elements — fire, air, water, and earth — influences the degree to which a body is transparent, and thus

[51] SHARPLES (2006) 169.

[52] E.g., ARIST. *Mete.* 374a7-8; 18-19; 377b22-23; *Gen. an.* 735b33-37; 784b13-15; 786a12-21.

the colour of a body seems to depend on the proportion of the different elements which constitute it.[53]

However, some Peripatetics after Aristotle abandoned the notion of the transparent altogether, and decided to attribute colour directly to the four elements themselves.[54] Perhaps it is not surprising, then, that Theophrastus does not refer to the transparent. He may have thought that an animal's colour depends on the proportion of its constitutive elements and, when this proportion changes — for instance, because of changes in the animal's moisture, due to the expansion or contraction of its *pneuma* — the colour of its skin also changes. To again adopt the cases of the chameleon and the octopus, when they are in fear their blood chills, their *pneuma* contracts, and their colour gets darker, since heat and air are said to make the colour of bodies white. Needless to say, this is a highly speculative reconstruction of Theophrastus' colour theory.

On the other hand, we know more about Plutarch's alternative theory. For, as we have seen above, Plutarch (*Aet. phys.* 916c8-f5) refers to Empedocles and claims that, when frightened, the octopus undergoes a change in its *pneuma* that causes its body to contract. It thus retains the emanations from nearby objects on its surface, which is full of pores, without allowing them to penetrate it. In fact, the same colour theory is also found in Plutarch's essay *On Having Many Friends*, in which he contrasts the superficial changes of the octopus' colour to the long-lasting changes that are due to real friendships:

> "However, the changes in the octopus have no depth, but are wholly on the surface, which, owing to its closeness or looseness of texture, takes up the emanations from objects which come near to it; whereas friendships seek to effect a thorough-going likeness in characters, feelings, language, pursuits, and dispositions." (Plut. *De amic. mult.* 96f-97a, trans. F. Cole Babbit slightly modified)[55]

[53] On Aristotle's theory of colour, see IERODIAKONOU (2018).

[54] GANSON (2004).

[55] καίτοι τοῦ πολύποδος αἱ μεταβολαὶ βάθος οὐκ ἔχουσιν, ἀλλὰ περὶ αὐτὴν γίγνονται τὴν ἐπιφάνειαν, στυφότητι καὶ μανότητι τὰς ἀπορροίας τῶν

According to Empedocles' theory of colours, things are coloured because of the proportion of the elements of fire and water that constitute them. Moreover, we perceive colours because particles of fire and water, which are emitted from all things, enter the commensurate pores of our eyes.[56] Plutarch invokes Empedocles' theory, but his description of it does not exactly correspond to what we know from other sources. Although Plutarch also talks of emanations, these are not particles of fire and water but rather of stone, bronze, and iron.

Does Plutarch apply Empedocles' theory to the chameleon's and the octopus' colour changing phenomenon in a clumsy way, or is it that the emanation theory of colour has undergone certain developments by Plutarch's time? I am afraid I cannot resolve, this issue here, but it is clear that Plutarch disagrees with Theophrastus' theory of colour changing and bases his own on two strong arguments: First, his emanation theory is supposed to explain the perfect assimilation of the colour of the chameleon and the octopus to their surroundings, since what they retain in their skin are particles from their surroundings. Second, his emanation theory is supposed to explain the fact that the chameleon and the octopus do not take all colours, but only the colours of those things with whose emanations their pores are commensurate.[57]

7. Conclusion

Is Plutarch's account of the colour changing phenomena in non-human animals an improvement over the one suggested by Theophrastus? Given that the textual material available to us is so

πλησιαζόντων ἀναλαμβάνουσαν· αἱ δὲ φιλίαι τὰ ἤθη ζητοῦσι συνεξομοιοῦν καὶ τὰ πάθη καὶ τοὺς λόγους καὶ τὰ ἐπιτηδεύματα καὶ τὰς διαθέσεις.

[56] On Empedocles' theory of colour, see IERODIAKONOU (2005).

[57] Since Plutarch's suggestion is that the chameleon and the octopus retain the emanations from their surroundings on their skin, it makes no sense to claim that their colour depends on whether or not their pores are commensurate with these emanations.

scarce, it is extremely difficult to take sides in this debate. But we do know something about its later history. In a small essay with the title *Why does the Octopus Change its Colour to Assimilate to the Stones?* (Διατὶ τὴν χροιὰν ὁ πολύπους ἐξαλλάτει αἷς ἂν πέτραις προσομιλήσῃ), the eleventh century Byzantine scholar Michael Psellos (*De omnifaria doctrina* 181) is clearly influenced by Plutarch. He explains the colour changes of the octopus by reference to the particles of stones, bronze, and iron that are emitted by near-by things and are commensurate with the pores of the octopus' body. So, whether it was Theophrastus or Plutarch among the ancients who offered the best explanation of such phenomena, it seems that Plutarch's explanation was better received by later readers.

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DISCUSSION

D. Reitzenstein: In Theophrastus' fragment from Photius' *Biblioteca* we read that the chameleon does not change its colour to white or red. I wonder if this was meant to be the maximum differentiation one could make to contrast the chameleon from the human beings' capacity of blushing and blanching. Also, the similarities of this fragment to Pliny's *Natural History* 8, 122 are striking. According to Pliny's *Natural History* 1, 8, Theophrastus was among the authorities Pliny studied for this book but there must have been other sources, too, as he records in addition to Theophrastus that the colour of the dead chameleon is pale (*pallor*). Is the reference to the pale colour of a dead chameleon part of an on-going discussion about the true colour of the chameleon?

K. Ierodiakonou: Unfortunately, there are no other sources that could help me reply to your questions. Yes, it is true that humans blush and become pale, but there is no text, as far as I know, that contrasts this phenomenon to that of the chameleon not turning white or red. Also, there are no texts, as far as I know, discussing the 'true' colour of the chameleon. It is interesting, though, to note that the chameleon becomes pale when it dies, that is, when its *pneuma* leaves its body; for one would expect the *pneuma*, and not its lack, to turn something white.

E. Cagnoli Fiecconi: What does αὐτὸς καθ' ἑαυτὸν mean in the Photius' passage where we learn about the colour change of the chameleon? Does it indicate that the chameleon changes colour because of an internal stimulus or does it simply mean that the colour it takes on is not the one of the surrounding environment? If the latter, the point might just be to prove that the chameleon does not intentionally imitate its surroundings.

K. Ierodiakonou: To understand the phrase αὐτὸς καθ' ἑαυτὸν, translated as "of its own accord", I read closely the contrast between the two cases of colour changing of the chameleon's skin that Photius describes: in the first case the colour of the chameleon changes simply because it adjusts to that of its close surroundings, without the chameleon causing this reaction; in the second case, the chameleon is in fear, so the change of its colour results from its emotional response to an external stimulus, even though there is no forethought on its part.

A. Rouveret: À propos du poulpe, à la fois peureux et prédateur, il me semble qu'on pourrait expliquer cette apparente contradiction, en suivant les analyses de M. Detienne et de J.-P. Vernant sur les "ruses de l'intelligence", qui font du poulpe un des animaux par excellence de la *mètis*. Par analogie avec les différentes manières de chasser des humains, le poulpe, habile à se dissimuler, y compris par la métamorphose, a recours à la ruse pour mieux capturer sa proie.

Quant à l'interrogation sur l'existence ou non chez le poulpe de la faculté de prévoir pourrait-elle être déjà présente dans le caractère *oikonomikos* du poulpe chez Aristote ? En tout cas, un élément de réponse positif au regard du jugement de Théophraste pourrait être apporté par la représentation du combat entre le poulpe et la langouste, très populaire jusqu'à l'époque impériale dans le décor public et surtout domestique (mosaïques et peintures murales). Cette image illustre l'hostilité entre ces deux animaux (auxquels il faut ajouter la murène), évoquée par Aristote, à plusieurs reprises, dans l'*Histoire des animaux*. Certains des plus beaux exemples, peut-être inspirés de modèles alexandrins, ont été mis au jour dans la mosaïque de l'"Antre des Sorts" à Préneste (le poulpe et la murène), ainsi que dans la Maison du Faune à Pompéi (le poulpe, la langouste et, à proximité, la murène), des œuvres datées l'une et l'autre à la fin du IIe siècle av. J.-C.

K. Ierodiakonou: I agree that the case of the octopus is particularly interesting especially when we take into consideration

the octopus' ability to use forethought in order to catch its prey; for it is not that the octopus changes colour only because it reacts in fear, but also because it plans how to attack its prey in order to achieve its aim.

A. Grand-Clément: J'ai également en tête un autre cas de changement de couleur chez les animaux, mais il ne s'agit apparemment pas d'émotion : c'est lié à l'alternance des saisons. Aristote (*Histoire des animaux* 633a) signale les variétés d'oiseaux qui changent à la fois de voix et de couleur au cours de l'année. L'association entre aspect coloré et aspect sonore est d'ailleurs très intéressante (la *poikilia* des oiseaux est tant visuelle — celle du plumage — que musicale — du ramage). J'ignore en revanche si Aristote explique dans son œuvre les mécanismes physiologiques qui conduisent à ces transformations colorées. S'agirait-il d'une adaptation aux conditions climatiques ?

K. Ierodiakonou: As I have said, in his treatise *On the Generation of Animals*, Aristotle mentions the change of the hair colour of human and non-human animals depending on the different seasons. Here is the relevant text:

Aristotle, *Gen. an.* 786a29-34, trans. J. Barnes:

> Μεταβάλλουσι δὲ τὰ χρώματα καὶ τῶν ὀρνίθων τινὲς καὶ τῶν τετραπόδων τῶν ἀγρίων ἔνια κατὰ τὰς ὥρας. αἴτιον δ' ὅτι ὥσπερ οἱ ἄνθρωποι κατὰ τὴν ἡλικίαν μεταβάλλουσι, τοῦτ' ἐκείνοις συμβαίνει κατὰ τὰς ὥρας· μείζων γὰρ διαφορὰ αὕτη τῆς κατὰ τὴν ἡλικίαν τροπῆς.
>
> "Some birds and some wild quadrupeds change their colour according to the seasons of the year. The reason is that, as men change according to their age, so the same thing happens to them according to the season; for this makes a greater difference to them than the change of age."

I think we have no more information on this subject. But there is another passage earlier in the same treatise (*Gen. an.* 786a2-7), in which Aristotle explains that animals which drink hot waters are white, whereas those which drink cold waters are

black. And there are more passages which indicate that, according to Aristotle, heat and air make bodies white, whereas water and earthy matter make bodies black (references in note 52).

M.M. Sassi: In asking my question on the emotions of non-human animals, I would like to say in advance that I agree with those scholars who find in Aristotle a notion of cognitive continuity between human and non-human animals. So, I would like to focus on the passage from *Part. an.* 650b18-33 where, *inter alia*, Aristotle clearly assigns *dianoia* to non-human animals. However, what I would like to emphasise concerns rather Aristotle's concept of the non-human animal's character. Aristotle says here that animals with more watery mixture (note that *krasis* is a medical notion) in the heart are constitutionally 'predisposed' to fear, since water is the element most exposed to be refrigerated by fear. Would you agree about the fact that fear does not change the 'character' of the animal's blood, but it changes it momentarily with respect to a stable emotional disposition which is analogous to human *hexis*?

K. Ierodiakonou: Yes, it seems that Aristotle and Theophrastus attribute to animals a certain character, based on their physical constitution, which makes them predisposed to act in certain ways depending on the circumstances. Thus, the chameleon and the octopus are both considered as cowardly animals, because their blood, or a similar sort of fluid, is such that it chills immediately when confronted to frightening sense perceptions.

D.B. Wharton: Could the 'emanations' that Plutarch describes that are lodged in the octopus' pores to allow it to change colour be very small chunks of earth, bronze, stone, etc. whose emanations give it different colour appearances, rather than being the more basic fire/water elements that compose colour?

K. Ierodiakonou: Not according to Empedocles, at least. The particles that contribute to the nature and perception of colour

are only particles of fire and particles of water. But it may be the case that Plutarch is not interested in the details of the Empedoclean doctrine, but simply wants to use the basic of the theory of emanations in explaining the colour changing phenomena. However, as I have pointed out, his claim that this theory is better than Theophrastus' because it can explain the fact that the chameleon and the octopus do not take all colours, but only the colours of those things with whose emanations their pores are commensurate, proves that Plutarch is rather confused. For if the chameleon and the octopus retain on their skin the emanations from their surroundings, it makes no sense to refer to the pores that are commensurate with these emanations.