Why Does Aristotle Think Bees Are Divine? Proportion, Triplicity, and Order in the Natural World

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ABSTRACT

Concluding his discussion of bee reproduction in book 3 of *Generation of Animals*, Aristotle makes a famous methodological pronouncement about the relationship between sense perception and theory in natural history. In the very next sentence, he casually remarks that the unique method of reproduction that he finds in bees should not be surprising, since bees have something “divine” about them. Although the methodological pronouncement gets a fair bit of scholarly attention, and although Aristotle’s theological commitments in cosmology and metaphysics are well known, scholars have almost universally passed over the comment about bees and divinity in silence. This paper aims to show why that comment is no mere throwaway, and offers an exploration and elaboration of the ways in which divinity operates even at fairly mundane levels in his natural philosophy, as an important Aristotelian explanation for order, proportion, and rationality, even in the lowest of animals.

Bees, Aristotle says, are a puzzle.¹ Where other animals have either two sexes or no sexes at all, bees seem to have a threefold division of some kind: kings, workers, and drones.² As he works through the possibilities for how each of these ranks of bees are generated, a few facts weigh on Aristotle’s analysis. For one, bees are a very common insect and one with which humans have had frequent and ongoing interaction. People have long farmed them, manipulated them for economic ends, created and maintained homes for them, moderated conditions in their hives, and generally employed no small expertise in their interactions with these insects. By the time Aristotle comes to give us our earliest extant scientific account of bees, people already know, in short, a fair bit about what it takes to make bees both happy and productive. Not only this, but as an object of description and discussion, bees as a species appear to be second only to humans in the number of pages Aristotle devotes to them in his corpus—he clearly has a fascination.³ And yet, Aristotle tells us, there is a paradox at the heart of all this: we don’t yet really have a handle on how it is that bees reproduce.⁴

There was no shortage of contemporary thinking on the topic, however, and as Aristotle canvasses the available theories one by one, he offers up evidence for why each is insufficient. Eventually he settles on a tentative—and entirely unique—explanation: one that pleases him greatly, as we shall see, but one in which he does not quite have one-hundred-percent confidence, for various reasons. The list of rejected possibilities is, to the modern eye, a strange one, which serves to highlight the great difficulties posed by the apparent facts as Aristotle’s contemporaries knew them.

If we assume that bees reproduce sexually then we need to account for the roles of the three different kinds of bee: are they three different *sexes*, three different *social classes*, three different *species*? Do workers mate with workers to produce workers and drones with drones to produce drones, or is it that workers instead mate with drones to produce all three types? But workers mating with workers or drones with drones makes no sense, says Aristotle, since there is no discernable sex difference from bee to bee, and all mating requires a male and a female, always with observable anatomical differences between. Workers can’t mate with drones because workers don’t seem to be either male or female. They can’t be female since they have stingers, and ‘nature does not give weapons for defense to any females’.⁵ And the workers can’t be male since ‘no males habitually care for their young’, which the workers clearly do. Some people seem instead to think that the various castes of bee are spontaneously generated out in the world somewhere and that the workers then go and fetch these larvae and bring them back to the hive. The problem here, Aristotle points out, is that animals only really take the trouble to care for offspring that appears to be *their own*, ‘*oikeios*’, using what may be a technical term to denote what counts as the legitimate ‘offspring’ of a species in the pseudo-Aristotelian *Problems*.⁶ Another possible alternative method of generation for bees, Aristotle continues, says that perhaps the various castes of bee are in fact the offspring of other insects, left around in flowers for the workers to collect. Aristotle rules this out too, on the same grounds as the previous possibility.

What he settles on, for complex evidential reasons that are beyond the scope of the present paper, is a one-of-a-kind means of species preservation, unique in the animal world, where the drones are produced asexually by the workers, and the workers and kings are both produced asexually by kings. This means that workers and kings must have the generative capacity of both the female and the male, as a combination of some sort within each individual—a system of reproduction unique in Aristotle’s biology. In some respects this lack of distinct sexes parallels a system of reproduction that Aristotle suspects may be at play for two kinds of fish, the *erythrinus* and the *channa*, for whom no males have ever been found. But there are some crucial differences too: for one, *erythrini* are thought to generate only *erythrini* and *channae* to generate *channae*, whereas king bees (usually) and workers (always) generate something different in kind from themselves: kings generating workers, and workers drones. This system, if he is right, is unparalleled elsewhere in Aristotle’s world.⁷

When he is done setting out his ideas on the generation of bees, Aristotle then turns to related animals, wasps and *anthrenae*.⁸ Although they share a genus with bees, wasps and *anthrenae* nevertheless do not have the same remarkable method of reproduction. Instead, these other insects reproduce sexually—a much more pedestrian pattern—and this makes sense, Aristotle tells us, because unlike the genus of bees these animals *don’t have anything divine about them*.

What, I want to ask, could Aristotle possibly mean by associating bees with divinity? Aristotle does not generally appeal to the divine over hastily, and one shouldn’t assume he means it lightly here. Let’s look at his precise wording:

περὶ δὲ τὴν γένεσιν τὴν τῶν συγγενῶν ζώων αὐταῖς, οἷον ἀνθρηνῶν τε καὶ σφηκῶν,
τρόπον τιν’ ἔχει παραπλησίως πᾶσιν, ἀφήρηται δὲ τὸ περιττὸν εὐλόγως· οὐ γὰρ
ἔχουσιν οὐθέν θεῖον ὥσπερ τὸ γένος τὸ τῶν μελιττῶν,⁹

‘concerning the generation of animals in the same family as bees, such as *anthrenae* and wasps, things are in a way similar for all of them, but the unusual aspects are appropriately absent, for they possess nothing divine like the genus of bees does’.

If he means this in more than a hand-waving fashion (and I hope to show that he does), this is a remarkable claim to find about a common species of animal in the context of Aristotelian natural philosophy. Indeed, Aristotle makes a comparable claim to divinity about no other animal except humans anywhere in his corpus. It will be worth it, then, so see if we can determine what he means by saying that bees possess something divine.

What follows is an exploration into a small corner at the intersection of science and theology, at a very early stage of the history of the life sciences. I want to ask: what ways of seeing, what preconceptions, what priorities were at play when Aristotle looked at bees and tried to understand them? Above all, what kinds of *order* did he perceive in those insects in particular and what larger themes about the constitution of nature did that order speak to? Religion and science have seen a good deal of productive scholarship of late, and although most of this literature focuses on later periods than our own, we shall see that many of its central interests find reflection at the heart of Aristotelian ideas about life and reproduction.¹⁰

QUALITIES OF BEES AND OTHER ANIMALS

An easy answer to the question of how bees could be seen as divine might appear to lie in the general high esteem that ancient writers seem to have had for bees, but the vast majority of evidence for this regard is either later—and often much later—than Aristotle, or else is rooted in mythological or cultic references to bees and their imagery.¹¹ Aristotle is not generally one to use folkloric, mythological, or cultic material unreflectively (in fact he is often positively opposed to doing so), and I think it can be shown that something more interesting is afoot in the present case.

In his description of bee generation, Aristotle signals again and again that things are unusual and especially interesting. He repeatedly calls bees and their system of generation ‘unique’, ἴδιος, and ‘extraordinary’, περὶπτός. But neither of these adjectives rises to the level of

divine (to take a contrasting example, at *HA* 536a8-11 we see frogs' tongues singled out as unique, ἴδιος, without any overtones of divinity implied). When it comes to humans, he only twice calls them divine without qualification, the rest of the time giving humans something like divinity by proxy, which is to say, via some divine property or faculty that Aristotle thinks that humans possess.

Depending on how one reads an important passage of *Metaphysics A*, where Aristotle is talking about the ability of thought to contemplate thought itself (something he is working up to as a defining characteristic of god), humans, who clearly are capable of reflexive thinking, may also possess this 'divine' ability.¹² But note that this is a proxy divinity: a person's access to the divine is via the possession of a faculty—reflexive thought—that is itself divine. Aristotle also tells us that a number of other (often closely related) human faculties are divine: the faculty of reason, the possession of intelligence (νοῦς), and the ability to think and reflect. Similarly, Aristotle calls our capacity for moral excellence and happiness divine.¹³ In each of these cases, qualities that humans possess are called divine, but not humans in and of themselves.

There are only two places where Aristotle seems to assign divinity directly to humans, which is to say that he gives humans divinity simply by virtue of their humanity. Both occur in the *Parts of Animals*. In the first of these passages, he says that it is fitting for humans to be the only animal to walk upright, for this is in keeping with our divine essence or substance (οὐσία). He begins the passage by remarking that in the place where other animals have forelegs and paws, humans instead have arms and *what are called hands*.¹⁴ He continues: ὀρθὸν μὲν γὰρ ἐστὶ μόνον τῶν ζώων διὰ τὸ τὴν φύσιν αὐτοῦ καὶ τὴν οὐσίαν εἶναι θεῖαν· ἔργον δὲ τοῦ θειοτάτου τὸ νοεῖν καὶ φρονεῖν,¹⁵ '[humans] are the only animal that is upright, because their nature and their essence are divine, and also because to think and to be intelligent is the task of the divine'. The idea here is that thinking and intelligence would be impossible if the weight of the body were distributed on all fours as it is in other animals, because the bulk of the body would press down on the mind and on the perceptual apparatus. Nature and essence on the one hand, and

thinking and intelligence on the other, are a one-two punch attesting to human divinity. I will deal with each of these distinct parts of the claim in turn.

The initial attribution in this passage (nature and essence) is clearly direct: we have divinity simply because our nature and our *ousia* (our being or essence) are divine. The second attribution (via thinking and intelligence) may at first look like the proxy versions of divinity that we saw a moment ago, where divinity arrives via specific faculties that we possess, but the situation is in fact quite the opposite. Consider the structure of the argument, which is not in the first instance trying to prove that humans are divine (this is simply stated in the previous clause), but rather that the divinity of humans (and only humans) explains why they alone walk upright:

- (a) Thinking and intelligence are the tasks of what is divine.
- (b) Thinking and intelligence are impossible for quadrupeds because of the distribution of body weight,¹⁶ therefore
- (c) Humans, *qua* animals that are divine both in nature and essence, cannot be quadrupedal.

What is being emphasized here is just an add-on to the assertion, already made, that humans are divine. We are divine and therefore intelligent, and therefore must be bipedal because the distribution of weight in quadrupeds prevents the necessary freedoms for the parts associated with intelligence.

This, then, is the first direct attribution of divinity to humans. In the second one, things are a little more nuanced and potentially open-ended. Aristotle puts it this way: ἡ γὰρ μόνον [sc. τὸ τῶν ἀνθρώπων γένος] μετέχει τοῦ θεοῦ τῶν ἡμῖν γνωρίμων ζώων, ἡ μάλιστα πάντων,¹⁷ ‘of all the animals known to us, either the genus of humans alone partakes of the divine, or [it does so] more than all the others’. The qualification ‘more than all the others’ is a concession meant to capture something he discusses in the *Generation of Animals* about the qualities of the souls that all animals (and indeed all living things) possess:

πάσης μὲν οὖν ψυχῆς δύναμις ἑτέρου σώματος ἔοικε κεκοινωνηκέναι καὶ
θειοτέρου τῶν καλουμένων στοιχείων· . . . πάντων μὲν γὰρ ἐν τῷ σπέρματι
ἐνυπάρχει ὅπερ ποιεῖ γόνιμα εἶναι τὰ σπέρματα, τὸ καλούμενον θερμόν. τοῦτο
δ’ οὐ πῦρ οὐδὲ τοιαύτη δύναμις ἐστὶν ἀλλὰ τὸ ἐμπεριλαμβανόμενον ἐν τῷ

σπέρματι καὶ ἐν τῷ ἀφρώδει πνεῦμα καὶ ἡ ἐν τῷ πνεύματι φύσις, ἀνάλογον οὕσα τῷ τῶν ἄστρον στοιχείῳ.¹⁸

The power of every soul seems to have shared in a different and more divine body than the so-called [four] elements . . . For every [animal], what makes the seed generative inheres in the seed and is called its ‘heat’. But this is not fire or some such power, but instead the pneuma that is enclosed in the seed and in foamy matter, and the nature in the pneuma, this being analogous to the element of the stars.

So, the generative power of the seed ‘shares in’ something ‘analogous to’ the aether, the element of the stars (which is frequently characterized as divine by Aristotle). And this is true for all animals.¹⁹ Therefore insofar as (most) animals are generated from seed, they have pneuma, and so they all participate to some extent in the divine. This is no mere throwaway comment.

There is a second aspect, however, in which all species participate in the divine. The process of reproduction is said in the *De anima* to allow each species to continue eternally. Even though this individual snail must perish, the species of snails is a continuity from infinite time past (there was no beginning to the Aristotelian cosmos) and it will continue for infinite time going forward (there is no end). And so, given that it participates in this eternal existence of its own proper species, the individual animal, this individual snail, is participating in the eternal and therefore the divine: φυσικώτατον γὰρ τῶν ἔργων τοῖς ζῶσιν ... τὸ ποιῆσαι ἕτερον οἷον αὐτό, ζῶον μὲν ζῶον, φυτὸν δὲ φυτόν, ἵνα τοῦ ἀεὶ καὶ τοῦ θεοῦ μετέχωσιν ἢ δύνανται,²⁰ ‘the most natural activity for animals is the making of another like itself ... an animal [making] an animal and a plant a plant, in order that they may, to the extent that they are able, participate in the eternal and the divine’.

But people—and bees—are explicitly said to go beyond this basic level. As we have seen, for humans we can parse out from multiple passages what makes them more divine than other animals and the list is not a long one: our possession of reason and *nous* (mind), our ability to think and understand, and our capacities for moral excellence and happiness. But if we then try to parse out the virtues that Aristotle finds in bees, we never see them qualified in quite these human ways, although in a couple of passages Aristotle may come close. In a perplexing section

at the very outset of the *Metaphysics*, Aristotle tells us that bees are ‘prudent’ or ‘wise’ (*phronimos*) but unable to learn or to hear sounds.²¹ *Phronimos* as bees may be, though, we note that Aristotle elsewhere calls the deer, the hare, the weasel, and the crane (to whom we shall return in a moment) as well as ‘some quadrupeds’ *phronimos*, but he never calls any of these other animals divine.²² Similarly, bees, but also ‘all animals like them’, are said to be more *phronimos* in their nature (φρονιμώτερα τὴν φύσιν ἐστίν) than even some blooded animals, but again notice the qualifications: bees *and others*; more than *some* blooded animals.²³ Likewise bees and ants are said to ‘have a *more sagacious* soul’ (συνετωτέραν ἔχει τὴν ψυχὴν) than some blooded animals.²⁴ Again, as with the deer and the hare, the ants and ‘all other animals like bees’ are not called divine. Moreover, when Aristotle tells us at one point that animals other than people οὔτε τέχνη οὔτε ζητήσαντα οὔτε βουλευσάμενα ποιεῖ, ‘do nothing by craft nor do they plan objectives’, he floats two possible outliers to this rule by name, neither of which are bees. He cites instead the spider, the ant, and then adds ‘and animals such as these’, whatever that may mean.²⁵ Finally, he tells us that bees and ants lack *phantasia*, ‘imagination’ or ‘the faculty of representation’, which might be taken to limit, at least somewhat, the extent to which they are *phronimos*.²⁶

Perhaps the most widely discussed of the human-like characteristics that bees are said to possess is their *political* nature:

πολιτικά δ' ἐστὶν ὧν ἔν τι καὶ κοινὸν γίνεται πάντων τὸ ἔργον· ὅπερ οὐ πάντα ποιεῖ τὰ ἀγελαῖα. ἔστι δὲ τοιοῦτον ἄνθρωπος, μέλιττα, σφήξ, μύρμηξ, γέρανος. καὶ τούτων τὰ μὲν ὑφ' ἡγεμόνα ἐστὶ τὰ δ' ἀναρχα, οἷον γέρανος μὲν καὶ τὸ τῶν μελιττῶν γένος ὑφ' ἡγεμόνα, μύρμηκες δὲ καὶ μυρία ἄλλα ἀναρχα.²⁷

Political animals are those for whom work is common and shared among all; not all gregarious creatures act this way. Animals of [the political] sort are the human, the bee, the wasp, the ant, and the crane. Of these some have a leader and some are unruled. Those with a leader are such as the crane and the genus of bees, while ants and many others are unruled.

Once again, however, bees are far from alone. If we cast about to see what other traits bees may share with some of their fellow political animals we find an interesting list. Like cranes, not only do bees have leaders, they also apportion specific jobs to particular individuals, stationing

‘guards’, for example at the openings of their hives.²⁸ Cranes do something similar, stationing them at the outside edges of their flight formations:

φρόνιμα δὲ πολλὰ καὶ περὶ τὰς γεράνους δοκεῖ συμβαίνειν· ἐκτοπίζουσί τε γὰρ μακράν, καὶ εἰς ὕψος πέτονται πρὸς τὸ καθορᾶν τὰ πόρρω, καὶ ἐὰν ἴδωσι νέφη καὶ χειμέρια, καταπτᾶσαι ἡσυχάζουσιν. ἔτι δὲ τὸ ἔχειν ἡγεμόνα τε καὶ τοὺς ἐπισυρίπτοντας ἐν τοῖς ἐσχάτοις, ὥστε κατακούεσθαι τὴν φωνήν. ὅταν δὲ καθίζωνται, αἱ μὲν ἄλλαι ὑπὸ τῇ πτέρυγι τὴν κεφαλὴν ἔχουσαι καθεύδουσιν ἐπὶ ἐνὸς ποδὸς ἐναλλάξ, ὁ δ’ ἡγεμὼν γυμνὴν ἔχων τὴν κεφαλὴν προορᾷ, καὶ ὅταν αἰσθηταί τι, σημαίνει βοῶν.²⁹

A great deal of *phronimos* seems to be a characteristic of cranes. They will travel very far, flying high to see great distances and if they see clouds or stormy weather, they fly down and wait it out. They also have a leader, and heralds on the outsides [of their formations] so that their sound may be heard throughout. When they land, the leader, holding its head up, keeps watch while the others sleep on one foot with their heads under their wings. If the leader sees anything, he makes a sign by calling out.

Like the bees that guard the hives, the cranes here post guards at the edges of their flight formations as well as when they sleep. Notice, too, that the action of the leader for alerting the flock is one of ‘signaling’, albeit wordlessly: σημαίνει βοῶν, “he signals [by] shouting.” Bees do something similar, but rather than alerting the hive to awaken, one of them flies around, buzzing ‘as though to tell’, ὥσπερ σημαίνουσα, the others to go to sleep.³⁰ Again like cranes, bees are also said in this same section to predict the weather: προγινώσκουσι δὲ καὶ χειμῶνα καὶ ὕδωρ οἱ μέλιτται, ‘bees predict both storms and rain’.³¹ Talk of leaders and signaling may play into a larger set of what appear to be military metaphors for the activity of bees in Aristotle: bees are said to be ‘marshalled’ (τεταγμέναι) for different jobs,³² they can suffer ‘splitting of the ranks’ (διασπῶσι),³³ and at one point Aristotle tells us a story about one hive invading the other, with an extended use of military language.³⁴

If we search around for other virtues and vices attributed to bees, we do not see much that seems to be promising with regard to divinity. It is true that bees are said to be especially industrious, ἐργατικώτατον ζώων, but again, Aristotle includes ants in this class, as well as *anthrenae*, wasps, and all such animals.³⁵ Bees are said to be in general ‘thrifty’, and to store food

away for later: φεδόμεναι καὶ ἀποτιθέμεναι τροφῆς χάριν (how this fits with Aristotle's rule that no animals plan for the future, he does not say).³⁶ The last of the positive attributes of bees for Aristotle is their cleanliness. They are said to be 'a most clean' animal (I suspect he does not mean *the* most clean, but Greek can be ambiguous with its superlatives in this way), and he mentions elsewhere that unlike other insects they never settle on rotting flesh.³⁷ More negatively, like other political animals, bees and cranes can be violent to each other,³⁸ and finally, among bees ('like women', as he feels the need to add) the showy and beautiful ones are lazy: αἱ δὲ φαναὶ καὶ λαμπραὶ, ὥσπερ γυναῖκες, ἀργαί [ἐστίν].³⁹

THE DIVINE IN ARISTOTLE

If we can find nothing specific or in combination in the discussion above that can clearly explain what comprises the divinity of bees, we should perhaps grasp the stick from the other end, and have a look at what kinds of things other than bees are said to be divine in Aristotelian natural philosophy.⁴⁰ In addition to bees, we have already seen humans and (some of) their highest virtues, the generative capacity of seed, and the eternality of species each called 'divine'. And on this last count we might note that the eternal, for Aristotle, is often a—if not the—key aspect of divinity. Indeed, for Aristotle it is immortality that in many instances forms the central attribute that defines what (a?) god is: ἑκαστόν ἐστιν, ὃν ἐστὶν ἔργον, ἔνεκα τοῦ ἔργου. θεοῦ δ' ἐνέργεια ἀθανασία· τοῦτο δ' ἐστὶ ζωὴ αἰδίος,⁴¹ 'everything for which there is a function, exists for that function. The activity [actuality] of god is immortality, so the function of god is eternal existence'.

So, too, the fact that the planets move in circles is a key part of what makes the planets and the cosmos as a whole divine in Aristotelian cosmology because circular motion, unlike rectilinear movement, has no beginning and no end.⁴² Anything eternal, whether material or causal, is to that extent divine.⁴³ Eternality, though, is not everything for divinity: primacy also seems to play a role, as we find Aristotle assigning divinity to his prime mover, first cause(s), first

philosophy, and the first or motive principles of physics or philosophy.⁴⁴ None of this, I am afraid, will help us with bees.

Now, we have already seen that bees, like all animals, touch the divine in that they reproduce and maintain the species in eternity. Insofar as they are (non-spontaneously-generated) animals, they must also produce seed to generate young and so they contain pneuma in that seed, which again touches them to the eternal and divine matter of the stars, the aether. But this is true of any animal, and thus far there is nothing in the virtues or character of bees in particular that would seem to make them an especially good link with the kinds of things that Aristotle thinks of as divine, and the problem threatens to be a difficult one. As a solution I want to float the following possibility: perhaps it is just the context in which we found Aristotle attributing divinity to bees that offers the solution. That is to say, there is something specific about their mode of generation that links some aspect of the divine to them.

The worry here is that, if we look back to the assertion about bees and divinity that started us on this question, things may well begin to look a little circular with respect to their divinity. But we could structure it as a syllogism thus:

- (1) Bees have something divine about them because of how they reproduce.
- (2) Wasps do not have anything divine about them as bees do.
- Therefore, (3) wasps do not reproduce as bees do.

That would certainly be the most natural reading of the γάρ in the second clause of ἀφήρηται δὲ τὸ περιττὸν εὐλόγως· οὐ γὰρ ἔχουσιν οὐθέν θεῖον ὥσπερ τὸ γένος τὸ τῶν μελιττῶν,⁴⁵ '[in wasps] the unusual aspects are appropriately absent, *for* they possess nothing divine like the genus of bees does'. This would seem to suggest that the key to bees' divinity may inhere in their three-caste-system for reproduction, one not shared by wasps or other insects. If we look to how Aristotle explains bee reproduction, we find him marveling at two aspects of it in particular: (1) the blending of the sexes in one individual (although he also says that this is at least possibly mirrored by two kinds of fish), and (2) the hierarchy of the castes in their reproductive roles, a feature apparently unique to bees. Let us look at each of these in turn.

After canvassing all the various theories that people have about bee reproduction and dismissing them, the answer that Aristotle settles on as most likely (on his current evidence) puts the power of both genders into each individual worker bee. This strikes Aristotle as interesting:

λείπεται δὴ, καθάπερ φαίνεται συμβαῖνον ἐπὶ τινῶν ἰχθύων, τὰς μελίττας ἄνευ ὀχείας γεννᾶν τοὺς κηφῆνας, τῷ μὲν γεννᾶν οὖσας θηλείας, ἐχούσας δ' ἐν αὐταῖς ὥσπερ τὰ φυτὰ καὶ τὸ θῆλυ καὶ τὸ ἄρρεν.⁴⁶

The remaining [possibility] is that workers generate drones without mating, just as appears to be the case with certain fish. With respect to generating they are female but at the same time having in themselves both the male and the female just as plants do.

He goes on to explain that the same principle applies to the kings, which generate both workers and more kings. The comparison to the fish known as the *erythrinus* and *channa*, though, is imperfect, as we said above, for each of these fish reproduces *themselves* rather than producing something different in kind (and this is assuming that Aristotle is correct in his speculation about how those fish reproduce—even he is often tentative when it comes to the *erythrinus* and *channa*, since he only has a negative observation to go on: that no males have *yet* been found).⁴⁷

TRIPPLICITY AND PROPORTIONALITY

And so this blend of male and female is interesting, and at least *possibly* unique. But what is really unique about bees is their threefold caste system, unseen anywhere else in nature. Not only is it unique in being threefold, but there are also—and this, I think, is the key—several mathematical harmonies in how the reproductive mechanism seems to work across the castes. Notice that the kings produce two kinds of animal: kings and workers, and one class of the animals that they produce, the workers, then goes on to produce *one* other class of animal, the drones, which then goes on to produce nothing at all, giving us a remarkable (and, Aristotle thinks, very beautiful) two-one-zero progression: kings produce two kinds of offspring, workers produce one, drones produce none (see fig. 1).⁴⁸

Moreover, at the two ends of this continuum, we find the kings and drones are each large in size whereas members of the class standing between them (the workers) are small; at the same time, the two generative types (kings and workers) each have stingers while the sterile type (drones) does not (see fig. 2). Aristotle immediately sees a double mathematical beauty to this arrangement, and it is here, I think, that divinity begins to gain a substantial foothold.

διὸ καὶ ἔχει ἀνάλογόν πως ἡ γένεσις αὐτῶν· οἱ μὲν γὰρ ἡγεμόνες μεγέθει μὲν ὅμοιοι εἰσι τοῖς κηφήσι, τῷ δὲ κέντρον ἔχειν ταῖς μελίτταις ... ὥστε συμβαίνει τοὺς μὲν ἡγεμόνας γεννᾶν μὲν καὶ αὐτούς, γεννᾶν δὲ καὶ ἄλλο τι γένος (τοῦτο δ' ἐστὶ τὸ τῶν μελιττῶν), τὰς δὲ μελίττας ἄλλο μὲν τι γεννᾶν, τοὺς κηφήνας, αὐτὰς δὲ μηκέτι γεννᾶν, ἀλλὰ τοῦτ' ἀφηρηθῆσθαι αὐτῶν. ἐπεὶ δ' αἰεὶ τὸ κατὰ φύσιν ἔχει τάξιν, διὰ τοῦτο τῶν κηφήνων ἀναγκαῖον καὶ τὸ ἄλλο τι γένος γεννᾶν ἀφηρηθῆσθαι. ὅπερ καὶ φαίνεται συμβαῖνον· αὐτοὶ μὲν γὰρ γίνονται, ἄλλο δ' οὐθὲν γεννῶσιν ἀλλ' ἐν τῷ τρίτῳ ἀριθμῷ πέρας ἔσχεν ἡ γένεσις. καὶ οὕτω δὴ συνέστηκε τῇ φύσει καλῶς ὥστ' αἰεὶ διαμένειν ὄντα τὰ γένη καὶ μηδὲν ἐλλείπειν, μὴ πάντων γεννώντων.⁴⁹

And so there is a kind of proportion to their generation, for the kings are similar to the drones in magnitude, but similar to workers in having a sting ... And also it happens that the kings generate themselves and also generate another kind (i.e., the workers), while the workers generate another kind (the drones) but do not reproduce themselves, for that has been disallowed to them. And since what is according to nature always has an order, for this reason it is necessary that the drones be disallowed to generate another kind, which appears to be the case: they are generated but do not generate anything. And so the generation [of bees] has its completion in the third member of the series and this has been arranged so beautifully by nature that the [three] kinds always persist and never fall short, in spite of the fact that they don't all generate.

A kind of mathematical proportion (ἀνάλογόν πως),⁵⁰ an orderly arrangement (τάξις), has its completion in the third member of the series (ἐν τῷ τρίτῳ ἀριθμῷ πέρας ἔσχεν)—this is strikingly beautiful (and indeed Aristotle says so explicitly).

Figure 1:

Aristotle's two-one-zero linear series for bee generation. Aristotle sets the hierarchy up in this order (kings, workers, drones) such that the first member of the series generates itself and the next member, the second member generates the third member, and the third generates nothing. The pattern shows itself not just in terms of descending numbers, but in terms of a descending fecundity which maintains the ordering of the castes at both levels of the diagram.

Figure 2:

Parallel proportionalities (size vs. stingers). Note how this centralizes the kings, who have single characteristics in common with each of the other two members of the series, while each of the other two members (workers and drones) are not situated in such a relationship to each other. Rather than reorganizing the earlier hierarchy of kings-workers-drones, we see here a kind of a transcendence of it.

But there is one more factor that I suspect is not trivial. It turns out that Aristotle frequently also finds the number *three* both significant and sublime. For his part, Aristotle is not generally quick to Pythagorize, but we do find him doing so on a few occasions. One such instance occurs at the opening of the *De caelo*, where he is reflecting on the number of geometrical dimensions possible in our universe, and remarks that the fact that there are *three* is no accident. For:

καθάπερ γάρ φασι καὶ οἱ Πυθαγόρειοι, τὸ πᾶν καὶ τὰ πάντα τοῖς τρισὶν ὥρισται· τελευτὴ γὰρ καὶ μέσον καὶ ἀρχὴ τὸν ἀριθμὸν ἔχει τὸν τοῦ παντός, ταῦτα δὲ τὸν τῆς τριάδος. διὸ παρὰ τῆς φύσεως εἰληφότες ὥσπερ νόμους ἐκείνης, καὶ πρὸς τὰς ἀγιστείας χρώμεθα τῶν θεῶν τῷ ἀριθμῷ τούτῳ⁵¹

Just as the Pythagoreans say, the whole and all the things [in it] are bound by three; for a beginning, a middle, and an end comprise the number of the whole, which is to say they comprise the number of the triad. And so, taking this fact from nature as one of nature's laws, we also use this number for the worship of the gods.

Threeness takes us effortlessly for Aristotle from the inherent structure of the cosmos, via a law of nature, to the ritual structure of divine worship. It is worth noting that this may be the only instance in the entire Aristotelian corpus where he mentions the Pythagoreans in more than a passing manner without criticizing or correcting them.⁵²

As his argument develops in book I of the *De caelo*, Aristotle again returns to the number three as significant when he finds that the number of simple motions is also three. One has to be an Aristotelian to really buy into this, but on his analysis, there can only exist (1) straight-line motion, (2) circular motion, or (3) a combination of the two. Moreover we see another threeness in the two 'pure' forms of motion, where straight-line motion is defined as always (1) toward a centre, or (2) away from a centre, and circular motion is (3) around a centre. He seems, in the event, particularly pleased that the number of simple motions should match the number of spatial dimensions: καὶ ἔοικεν ἡκολουθηκέναι κατὰ λόγον τοῦτο τοῖς ἐξ ἀρχῆς· τό τε γὰρ σῶμα ἀπετελέσθη ἐν τρισὶ καὶ ἡ κίνησις αὐτοῦ,⁵³ 'and it is fitting that this follows

proportionally with what we said at the outset: body is completed in a three, and so is its motion’.

To get a sense of the significance of triplicity for Aristotle, I have combed through the entire corpus of his works to isolate the kinds of things he understands in terms of three explicit parameters, and they turn out to be (a) surprisingly ubiquitous and (b) often quite central to his understanding of the world. What follows is, in spite of its length, necessarily non-exhaustive, partly because he doesn’t always flag his triplicities in so many words, and partly because I am bound to have missed a few just by dint of sheer volume. These examples, I should also note, do not count times Aristotle claims that *someone else* thinks that there are three *x*’s, nor the frequent instances where he casually offers up triplicities of adjectives or examples as a simple rhetorical figure. What remains, for all that, is truly impressive.⁵⁴ There are:

appetites, three (will, impulse, desire)
 animal and cosmic parts, three *archai* of (front/back, above/below, right/left)
 animal reproduction, a great number of animals reproduce or come to sexual maturity in intervals of three [months, years], or give birth to three offspring
 animals, three parts of (parts for food intake, excrement, part in between)
 argument, three elements of (speaker, subject, audience)
 attributes, obtain in three ways
 audience, three kinds of (assemblyman, juror, aficionado)
 bodies, three condensed by cold (water, snow, hail)⁵⁵
 coming-to-be, three *archai* of (two contraries plus a subject of whom they are predicated)
 ‘composition’ of animal parts, three kinds of
 causes/*archai*, three (form, privation, matter)
 change, three aspects of (action/passion, combination, contact)
 change, three kinds of
 channels, three from eye to brain
 choice, three objects of (the good, the useful, the pleasant)
 contempt, three kinds of
 commerce. three kinds of (capital, transport, sale)
 constitution, three kinds of
 courts of law, three determinants for (eligibility, mandate, method of appointment)
 craftsman, three grades of⁵⁶
 deception, three causes of
 deduction, three terms in
 demonstration, three divisions of ‘by nature’
 demonstration, three kinds of
 dimensions (spatial), three

dispositions, three kinds of (or three grades of emotion or action: the mean, excess, defect)
 education, three bases for (the mean, the possible, the proper)
 elements (bodily), three (the heavy, the light, the circular) and three elemental 'places'
 emotions, three criteria for understanding
 excellence (in humans), three sources of (nature, habit, reason)⁵⁷
 friendship, three kinds of
 good, three kinds of
 government appointments, three considerations for (who appoints, from whom, how)
 government, three branches of
 government, three forms of
 government, three grounds for equality in
 governments, three conditions for mixed ones
 growth, three properties of⁵⁸
 happiness, three means to (excellence, prudence, pleasure)
 harms in a partnership, three kinds of
 head, three functions for
 heart, three actions of (palpitation, pulsation, respiration)
 heart, three cavities of
 'heaven', three senses of the word
 homonymy, three ambiguities in
 insect bodies, three parts of
 insect development, three stages of
 imitation, three kinds of
 justice, three forms of (based on three forms of government)⁵⁹
 knowing and error, three kinds of
 life, three kinds of (the hedonistic, the political, the theoretical or philosophical)
 love, three causes of
 luck, three determinants of good
 magistrates, three offices for choosing
 moral states, three to be avoided (vice, intemperance, brutality)
 movement, three 'aspects' to (what, where, when), or differently articulated (from what, to what, what), or differently again (mover, moved, instrument of motion), or again (mover, moved, time of motion), or again (beginning, middle, end)
 movement, three kinds of (quality, quantity, place)
 mover, three kinds of
 music etc., three benefits of (education, amusement, contemplation)
 non-being, three forms of
 nutrition, three aspects to⁶⁰
 opposition, three kinds of
 orator, three bases for confidence in (prudence, virtue, goodwill)
 people, three classes of
 perceptibility, three meanings of
 perception, three epistemological grades of
 persuasion, three forms of (speaker's character, listener's disposition, argument)
 physics, three branches of
 poetry, three tools of (rhythm, melody, metre)
 political offices, three qualifications for highest

power relations in a household, three kinds of (master-slave, husband-wife, father-children)
 presentation, three modes of
 problems, three kinds of (ethical, natural, logical)
 ‘productive’ (ποιητικός), three senses of⁶¹
 relaxation, three sources of (sleep, drinking, music)
 rhetoric, three ends of
 rhetoric, three forms of (deliberative, judicial, declamatory)
 rhetoric, three grades of proposition in (proof, likelihood, sign)
 rhetoric, three temporal horizons relevant to (future, past, present)
 sameness, three kinds of
 speech, three sources of vividness (metaphor, antithesis, vigour)
 speeches, three aspects to (ideas, language, arrangement)⁶²
 soul, three characteristics of (movement, sensation, incorporeality)
 soul, three critical faculties of (*phantasia*, sensation, *nous*)
 soul, three functions of
 soul, three parts that control action and truth (perception, mind, appetite)
 soul, three variables in (passions, powers, states)
 stasis and revolution, three causes of
 substance, three kinds of
 ‘substance’, three meanings of (form, matter, combination of the two)
 sutures, three in the skulls of male humans (one in females)⁶³
 theoretical knowledge, three kinds of (mathematics, *physiké*, theology)
 tile, three shapes of to cover a 2-D surface (triangle, square, hexagon)
 toes, three joints in
Topics, three ways it will be useful
 tyrants, three goals of
 voice management, three aspects of (volume, pitch modulation, rhythm)
 ‘voluntary’, three senses of (according to appetite, to choice, to thought)
 wrongdoing, three aspects to a determination of⁶⁴

Trifurcation clearly plays a major role in Aristotle’s conceptual approach to the world. Even if he does not dwell on the significance of triplicity in the instances listed here, at the very least we can see an inherent bias toward—or at any rate a strong fondness for—trifurcation. Much more rarely than these many simple acts of trifurcation, however, Aristotle does also occasionally comment in a little more detail on why triplicity in itself is important to him.

He tells us, for instance, that three is the first number to which the adjective ‘all’ applies (the number two only gives us ‘both’).⁶⁵ This is admittedly not much to go on, but the fact that he feels the need to say it explicitly does indicate something. Going further, however, he also adds in another context that threeness as an organizing principle is simply and inherently ubiquitous in the structure of the world. After pointing out that there are ‘three’ colours in a

rainbow (as he parses them: purplish-red [φοινίκεος], bright green [πράσινος], violet [άλουργόν]),⁶⁶ he adds as a methodological point, ἐπὶ δὲ τὸ πλεῖον οὐκέτι φαίνεται, ἀλλ' ἐν τοῖς τρισίν, ὥσπερ καὶ τῶν ἄλλων τὰ πλεῖστα, '[its colour] does not manifest any further but comes in threes, *as most other things also do*'. Here we see an explicit acknowledgement that there is something special about three for ordering concepts, and that Aristotle recognizes the pattern that we identified above as a characteristic of his own thinking (even if he does not see it, perhaps, as idiosyncratic).

DIVINE ORDER IN NATURE

Three, then, manifests as a significant pattern that emerges from the process of ordering phenomena for Aristotle. And ordering, as it turns out, is a quintessential function of the divine, as he tells us: ὁ τε γὰρ νόμος τάξις τίς ἐστι, καὶ τὴν εὐνομίαν ἀναγκαῖον εὐταξίαν εἶναι, ὁ δὲ λίαν ὑπερβάλλον ἀριθμὸς οὐ δύναται μετέχειν τάξεως· θείας γὰρ δὴ τοῦτο δυνάμεως ἔργον, ἥτις καὶ τόδε συνέχει τὸ πᾶν· ἐπεὶ τό γε καλὸν ἐν πλήθει καὶ μεγέθει εἶωθε γίνεσθαι,⁶⁷ 'law is an ordering, and good law must be good order. But an excessive, jumbled number cannot participate in order, for that is the job of the divine power that contains the whole, since what is beautiful [*kalos*] tends to consist in number and magnitude'. Now, one should be careful not to read too much into the last clause of this claim, the idea that what is beautiful or good consists of number and magnitude, since it is unclear how broadly Aristotle really wants to apply such an argument, but the idea that number and order are themselves attributes and proper actions of divinity seems clear.⁶⁸ Moreover, the passage picks up language Aristotle happened to use in his discussion of size versus fecundity in king bees, where few are produced, but the ones that are, are large. He phrases this in terms of a 'repayment' on the part of nature, where nature takes away from the kings an ability to reproduce many of their kind at once, but repays them with prodigious size. the words he uses for the tradeoff are precisely those he uses to describe beauty

in the politics passage: it is a balance, a symmetry, between number and magnitude: *πλήθος τε καὶ μέγεθος*.⁶⁹

The ethical point in the initial *Politics* passage is that good laws and good societies reflect a good order among citizens, noncitizen residents, and rulers, and Aristotle parses this order in terms of ‘ordered number’ explicitly. This may appear at first to be a point of relatively narrow scope, but the broader comparison it draws has much larger significance: divinity acts to give order to the otherwise non-self-ordering mass of the cosmos. Part and parcel of this active ordering is a beauty-relation of number and magnitude. This matters for two reasons. The first is a potential (but only apparent) conflict involving the idea of the beautiful as number for Aristotle. The specific conflict that is threatened has to do with a Pythagorean-Platonist idea that Aristotle flatly rejects elsewhere (at the end of the *Metaphysics*): the idea that numbers can have causal force. If numbers cannot have causal force for Aristotle, then one might be tempted to argue that one cannot make sense of his statement that the beautiful (a) consists in number, and (b) somehow informs the divinity in ordering the universe. But his argument against the Pythagoreans and Platonists is about how they see particular numbers as final (or even efficient?) causes of unity where Aristotle denies it. Thus, for Aristotle, ‘seven’ may be shared by the number of musical notes and by the number of stars in the Pleiades, but ‘seven’ is not a (Platonic) Form whose essence is being instantiated by things both musical and stellar. This is not to say that it is never significant when particular numbers turn up in different applications, but that in such cases it is not the specific number doing the causal work. The number (in the case of bees, three) may show that two different things share important properties, as we saw with the number of spatial dimensions and the number of simple motions, but the number ‘three’ itself is not *causing* spatial dimensions and simple motions.

The second reason why the divine act of ordering and its relation to beautiful number and magnitude matters in the present context is because of something Aristotle says about

mathematics itself. Mathematics, he says, is beautiful—or more to the point: it exhibits the primary characteristics of beauty, of which, we should not be surprised to learn, there are *three*.

τοῦ δὲ καλοῦ μέγιστα εἶδη τάξις καὶ συμμετρία καὶ τὸ ὁρισμένον, ἃ μάλιστα δεικνύουσιν αἱ μαθηματικαὶ ἐπιστῆμαι. καὶ ἐπεὶ γε πολλῶν αἰτία φαίνεται ταῦτα (λέγω δ' οἷον ἢ τάξις καὶ τὸ ὁρισμένον), δῆλον ὅτι λέγοιεν ἂν καὶ τὴν τοιαύτην αἰτίαν τὴν ὡς τὸ καλὸν αἴτιον τρόπον τινά.⁷⁰

The most important forms of the beautiful are: order, symmetry, and definiteness,⁷¹ which the mathematical sciences show especially. And since these (I mean order and definiteness) seem to be the causes of many things, it is clear that one should speak of this sort of a cause as well: the beautiful as a certain kind of cause.

Order, symmetry, and definiteness are *the* forms of beauty. Here ‘definiteness’, τὸ ὁρισμένον, is a most interesting word choice: this same word—whose root means to limit or to form a boundary—was used by Aristotle in a passage we saw above to say that ‘all things are bound by three’.⁷² And moreover, the language also swings us directly back to Aristotle’s discussion of bees once again. Just as we saw a moment ago with number and magnitude, where these qualities are instantiated in the divine order of the cosmos on the one hand, and simultaneously are reflected in the negotiations of nature between size and fecundity in king bees, so too with order, symmetry, and beauty: these terms and concepts play central roles in Aristotle’s discussion of bees. If we return now to one of the central passages from earlier in the present investigation, we begin to see Aristotle’s description in a much richer light:

διὸ καὶ ἔχει ἀνάλογόν πως ἡ γένεσις αὐτῶν· οἱ μὲν γὰρ ἡγεμόνες μεγέθει μὲν ὅμοιοι εἰσι τοῖς κηφήσι, τῷ δὲ κέντρον ἔχειν ταῖς μελίτταις ... ἐπεὶ δ' αἰεὶ τὸ κατὰ φύσιν ἔχει τάξιν, διὰ τοῦτο ... ἀναγκαῖον ἀλλ' ἐν τῷ τρίτῳ ἀριθμῷ πέρας ἔσχεν ἡ γένεσις. καὶ οὕτω δὴ συνέστηκε τῇ φύσει καλῶς ὥστ' αἰεὶ διαμένειν ὄντα τὰ γένη καὶ μηδὲν ἐλλείπειν, μὴ πάντων γεννώντων.⁷³

And so there is a kind of *proportion* to their generation, for the kings are similar to the drones in *magnitude*, but similar to workers in having a sting ... And since what is according to nature always has an *order*, for this reason it is necessary And so the generation [of bees] *has its completion* in the *third* member of the series and this has been arranged *so beautifully* by nature that the [three] kinds always persist and never fall short, in spite of the fact that they don’t all generate.

It is not just that Aristotle uses general language that could be associated with divinity, but that the passage is rich in very specific references to words and concepts that he elsewhere explicitly

parses as markers of the divine: proportion (symmetry), magnitude, the number three, order, completion (limit, definiteness)—the parallels are really remarkable with the passages on divinity and ordering that we have just seen. And to top it all off? An explicit admission that all of this strikes Aristotle as a very *beautiful* arrangement for nature to have employed with bees—another of his key words for the divine.

Bees, it would seem, are infested with divinity, even when Aristotle is not yet saying it in so many words. Given the recent attention that historians of science have paid to the roles of theology in guiding how naturalists approach the structure of the world, perhaps this should not be surprising. But at the same time, ever since the Middle Ages, discussions of Aristotle's theology have centred almost exclusively on contexts involving his Prime Mover. What bees show is that broad considerations of divinity inform his thinking on considerably more mundane subjects as well.

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¹ He directs the comment specifically at their mode of generation: ἡ δὲ τῶν μελιττῶν γένεσις ἔχει πολλὴν ἀπορίαν, Aristotle, *Generation of Animals* (hereafter *GA*) 759a8. All translations are my own unless otherwise indicated.

² Aristotle calls what we think of as queen bees 'kings.' See, e.g., Rachel D. Carlson, *The Honey Bee and Apian Imagery in Classical Literature*, Diss., University of Washington, 2015; Robert Mayhew, 'King Bees and Mother Wasps: A Note on Ideology and Gender in Aristotle's Entomology', *Phronesis* (1999) 44, pp. 127-34; Malcolm Davies and Jeyaraney Kathirithamby *Greek Insects*, Oxford: Oxford University Press, 1986.

³ I here follow Aristotle in the use of the terms *species* and *genus*, which often differs from modern usage. For Aristotle 'bees' are a *species* relative to some more general category such as 'animal'. The terms genus and species for him capture something closer to the English logical categories 'general' and 'specific' (which are in any case derived from the Latin *genus* and *species*). On volume of Aristotle's references to bees versus humans, see Simon Byl, *Recherches sur les grands traités biologiques d'Aristote*, Brussels: Académie royale de Belgique, 1975, p. 340.

⁴ I add the ‘yet’ because of the optimism Aristotle seems to indicate as he looks forward to future investigations on bees, in a passage that leads up to the famous methodological pronouncement about how theory must accommodate observation in future investigations, not the other way around (*GA* 760b27 f.).

⁵ One assumes (as is indicated by the following clause) that he means ‘without also giving such weapons to the males’, which the drones (the supposed males in this theoretical scenario) lack. The whole passage is at *GA* 759b1 f. On the roles of male vs female in Aristotle, the literature is vast. A good beginning would include Sophia M. Connell, *Aristotle on Female Animals*, Cambridge: Cambridge University Press, 2016; Robert Mayhew, *The Female in Aristotle’s Biology*, Chicago: University of Chicago Press, 2004; Aryeh Kosman, ‘Male and Female in Aristotle’s Biology’, in James G. Lennox and Robert Bolton (eds.), *Being, Nature, and Life in Aristotle*, Cambridge, 2010, pp. 147–67.

⁶ The question in the *Problems* is why something born from seed counts as an animal’s own proper offspring, but something born from the animal’s excrement (a spontaneously generated maggot, for example), does not so count: the one is *oikeios*, and the other not. See Pseudo-Aristotle, *Problems* 878a1. On the *Problems* and the Aristotelian corpus generally, see Robert Mayhew (ed.), *The Aristotelian Problemata physica*, Leiden: Brill, 2015.

⁷ See *GA* 715b16, Aristotle, *History of Animals* (hereafter *HA*) 556b22 f., 539b10. For discussion of spontaneous generation and *genus* see Daryn Lehoux, *Creatures Born of Mud and Slime*, Baltimore: Johns Hopkins University Press, 2017.

⁸ *Anthrenae* is usually translated as ‘hornets’ although it is unclear what the precise distinction between wasps (*sphekes*) and *anthrenae* was seen to be. I speculated in Lehoux, op. cit. (7), p. 49 that *anthrenae* may refer to parasitic wasps rather than stinging wasps. Given the uncertainty, however, I will leave the word untranslated in what follows.

⁹ *GA* 761a2–5.

¹⁰ On religion and science generally, see for example Peter Harrison and Jon H. Roberts (eds.), *Science without God? Rethinking the History of Scientific Naturalism*, Oxford: Oxford University Press, 2019; Peter Harrison, *The Territories of Science and Religion*, Chicago: University of Chicago Press, 2015; Daryn Lehoux, *What Did the Romans Know?* Chicago: University of Chicago Press, 2012; Gary B. Ferngren (ed.), *Science and Religion: A Historical Introduction*, Baltimore: Johns Hopkins University Press, 2002; John Henry, *The Scientific Revolution and the Origins of Modern Science*, London: Macmillan, 1997.

¹¹ On bees in antiquity, see, e.g., Carlson, op. cit. (2); Kenneth F. Kitchell, *Animals in the Ancient World from A to Z*, New York: Routledge, 2014; David Engels and Carla Nicolaye (eds.), *Ille operum custos: Kulturgeschichtliche Beiträge zur antiken Bienensymbolik und ihrer Rezeption*, Hildesheim: Olms, 2008; Davies and Kathirithamby, op. cit. (2); Neville Morley, ‘Civil War and Succession Crisis in Roman Beekeeping’, *Historia* (2007) 56, pp. 462–70; Ian C. Beavis, *Insects and Other Invertebrates in Classical Antiquity*, Exeter: Exeter University Press, 1988; Lilian B. Lawler, ‘Bee Dances and the “Sacred Bees”’, *The Classical Weekly* (1954) 47, pp. 103–6; Arthur Bernard Cook, ‘The Bee in Greek Mythology’, *Journal of Hellenic Studies* (1895) 15, pp. 1–24.

¹² Aristotle, *Metaphysics* (hereafter *Metaph.*) 1072b23

¹³ Reasoning: Aristotle, *Eudemian Ethics* (hereafter *EE*) 1248a25 f. νοῦς: *GA* 737a10, Aristotle, *De anima* (hereafter *De an.*) 408b29, *Metaph.* 1074b16; νοῦς or ‘something else’ either divine or the most divine thing in us: Aristotle, *Nicomachean Ethics* (hereafter *EN*) 1177a16. Other things (planets, stars) ‘more divine’ than man: *EN* 1141b1. People can aspire to the divine: *EN* 1177b28. Moral excellence: *EN* 1145a27. Happiness: *EN* 1099b16–17, 1101b24, 1177a15; *EE* 1215a17, 1217a28.

¹⁴ I’ve long been puzzled by the qualification that humans have τὰς καλουμένας χεῖρας, ‘what are called’, or ‘so-called’, hands. I think there may be something interesting to say here but exploring that question is a task for another paper.

¹⁵ Aristotle, *Parts of Animals* (hereafter *PA*) 686a27–28.

¹⁶ τὸ γὰρ βάρος δυσκίνητον ποιεῖ τὴν διάνοιαν καὶ τὴν κοινὴν αἴσθησιν (*PA* 686a30–31). Note that Aristotle understates a crucial part of the argument: where I have said intelligence is ‘impossible’ for quadrupeds, Aristotle says merely that ‘it is not easy’.

¹⁷ *PA* 656a8. See e.g., G. E. R. Lloyd, *Science, Folklore and Ideology*, Cambridge: Cambridge University Press, 1983, pp. 28–29. Cf. Aristotle, *EN* 1141a33 f.

¹⁸ *GA* 736b29 f., Cf. *GA* 732a3 f.

¹⁹ And indeed, to a limited extent it is true of all things: *EN* 1153b32.

²⁰ *De an.* 415a29 f. On the eternity of biological species for Aristotle, see James G. Lennox, ‘Are Aristotelian Species Eternal?’ in Allan Gotthelf (ed.), *Aristotle on Nature and Living Things*, Pittsburgh: Mathesis Publications, 1985, pp. 67–94.

²¹ *Metaph.* 980b22. On this passage see, e.g., Ömer Orhan Aygün, ‘On Bees and Humans: Phenomenological Explorations of Hearing Sounds, Voices, and Speech in Aristotle’, *Epoché* (2013) 17, pp. 337–50. Contrast *HA* 627a15 where they seem to ‘rejoice’ in hearing certain noises.

²² *HA* 488b15, 611a16, 612a3, 612b1, *GA* 753a12–14. Aristotle also says that blooded animals (so excluding bees) whose blood is thin and cold are more *phronimos* at *PA* 648a8. People, though, are the most *phronimos* of all animals: *GA* 744a30.

²³ *PA* 648a6. They also live longer than some blooded animals: Aristotle, *On Length and Shortness of Life*, 466a4, cf. Aristotle, *On Youth, Old Age, Life and Death, and Respiration* (hereafter *Juv.*) 475a4, *HA* 554b6.

²⁴ *PA* 650b25 f. On the later history of ants as exemplars of moralizing qualities and their place in the hierarchy of intelligence see Charlotte Sleight, *Six Legs Better: A Cultural History of Myrmecology*, Baltimore: Johns Hopkins University Press, 2007.

²⁵ Aristotle, *Physics* (hereafter *Phys.*) 199a23.

²⁶ *De an.* 428a11.

²⁷ *HA* 488a7 f. C.f., *HA* 589a2 and also Aristotle, *Politics* (hereafter *Pol.*) 1253a7 where man is said to be ‘more political’ than bees and other animals. On bees as political animals, see Carla Nicolaye, ‘*Sed inter omnia ea principatus apibus*: Wissen und Metaphorik der Bienenbeschreibungen in den antiken Naturkunden als Grundlage der politischen Metaphor vom Bienenstaat’, in Engels and Nicolaye, op. cit. (11) pp. 114-37; David J. Depew, ‘Humans and Other Political Animals in Aristotle’s ‘History of Animals’, *Phronesis* (1995) 40, pp. 156-81; John M. Cooper, ‘Political Animals and Civic Friendship’, in Günther Patzig (ed.), *Aristoteles ‘Politik’*, Göttingen: Vandenhoeck & Ruprecht, 1990, pp. 221-41; Wolfgang Kullmann, ‘Der Mensch als politisches Lebewesen bei Aristoteles’, *Hermes* (1980) 108, pp. 419-43.

²⁸ *HA* 625b3.

²⁹ *HA* 614b18 f.

³⁰ *HA* 627a27. Some modern commentators have tried to see in this passage an anticipation of von Frisch’s discovery of the bees’ waggle dance but the evidence is weak. On the dance of bees, see Tania Munz, *The Dancing Bees: Karl von Frisch and the Discovery of the Honeybee Language*, Chicago: University of Chicago Press, 2016.

³¹ *HA* 627b10.

³² *HA* 625b18.

³³ *HA* 553b19, 625a16, 629a14 f.

³⁴ *HA* 626b11 f.

³⁵ *HA* 622b20f., cf. *HA* 625b24: συνεχῶς ἐργάζονται.

³⁶ *HA* 623b22.

³⁷ *HA* 626a25, *HA* 596b15.

³⁸ *HA* 554b3, 625a17, 626a14, 626b14, 615b16, etc.

³⁹ *HA* 627a14. C.f. 627a31 f.

⁴⁰ The literature here is vast and much of it centres on the Prime Mover and *Metaphysics* Λ. See e.g., Fabienne Baghdassarian, *La question du divin chez Aristote: Discours sur les dieux et science du principe*, Leuven: Peeters, 2016; Stephen Menn, *The Aim and the Argument of Aristotle’s Metaphysics*, <https://www.philosophie.hu-berlin.de/de/lehrebereiche/antike/mitarbeiter/menn/contents> [accessed 25 February, 2019]; Stephen Menn, ‘Aristotle’s Theology’, in Christopher Shields (ed.), *The Oxford Handbook of Aristotle*, Oxford, Oxford University Press, 2012, pp. 422-64; Jean-Baptiste Gourinat, ‘Le premier moteur selon *Physique*, VIII et *Métaphysique*, Λ: Physique et philosophie première’, in M. Bonelli (ed.), *Physique et métaphysique chez Aristote*, Paris: Vrin, 2012, pp. 175-206; Enrico Berti, ‘Y a-t-il une théologie d’Aristote?’ in Luc Langlois and Yves Charles Zarka, eds., *Les philosophes et la question de Dieu*, Paris: Presses Universitaires de France, 2006, pp. 55-71; Barbara Botter, *Dio e divino in Aristotele*, Sankt Augustin: Academia Verlag, 2005; Michael Frede and David Charles (eds.), *Aristotle’s Metaphysics Lambda*, Oxford: Oxford University Press, 2000. Coming at the question of divinity in Aristotle from very different angles, in some ways perhaps closer to my own approach here, are Matthew D. Walker, *Aristotle on the Uses of Contemplation*, Cambridge: Cambridge University Press, 2018; Richard Bodéüs, *Aristote et la théologie des vivants immortels*, Paris: Belles Lettres, 1992.

⁴¹ Aristotle, *On the Heavens* (hereafter *Cael.*) 286a8-9. C.f. *Cael.* 270b10 and *Cael.* 1.9.

⁴² Planets: e.g., *Cael.* 279b1, 288a4, 292b22, 292b32, *De an.* 405a32, *Metaph.* 1074a30. Cosmos: *Cael.* 279a11, 286a11.

⁴³ *Cael.* 279a31 f., *PA* 644b25, *Metaph.* 1026a20 (on which, see Menn, *Aim and Argument*, op. cit. [40], section I.γ.ι), *Metaph.* 1064a37.

⁴⁴ Prime mover: Aristotle, *Movement of Animals* (hereafter *LA*) 700b34. First cause(s): *Cael.* 279a30, *GA* 732a3 f., *EE* 1248a27. First philosophy: *Metaph.* 1026a18. First principles: *Cael.* 284a4, *GA* 731a24 f., *EN* 1102a4.

⁴⁵ *GA* 761a2-5.

⁴⁶ *GA* 759b27 f.

⁴⁷ Also compare *GA* 741a33-37 where he speculates, again apropos of the *erythrinus*, that it may be possible for an animal that has *only* females (not a combination of the female and the male, as with bees) to reproduce: εἰ δ’ ἔστι τι γένος ὃ θήλυ μὲν ἐστίν, ἄρρεν δὲ μὴ ἔχει κεχωρισμένον, ἐνδέχεται τοῦτο ζῶον ἐξ αὐτοῦ γεννᾶν. ὅπερ ἀξιολύτως μὲν οὐ συνῶπται μέχρι γε τοῦ νῦν, ποιεῖ δὲ διστάζειν ἐν τῷ γένει τῷ τῶν ἰχθύων τῶν γὰρ καλουμένων ἐρυθρίων ἄρρεν μὲν οὐθεὶς ὥπται πω, θήλειαι δὲ καὶ κυημάτων πλήρεις. ‘If there is a species which is [entirely] female and has no [distinct] male, it may be possible for this animal to generate from itself. This has not been reliably observed thus far, at any rate, but there is [an example] among fish that gives us pause, for in the so-called *erythrini*, no male has yet been observed, and the females are full of eggs’.

⁴⁸ Illustrations by Jay Stephens (jaypopgun@yahoo.ca), commissioned by the author.

⁴⁹ *GA* 760a12-14 and a26-b2.

⁵⁰ ἀνάλογος is frequently used for proportionality in Aristotle.

⁵¹ *Cael.* 268a10.

⁵² The minor exceptions are: (1) Aristotle, *Sense and Sensibilia*, 439a31 where he remarks in passing that a Pythagorean term for colour seems to agree with a point he himself makes. (2) Aristotle, *Posterior Analytics* (hereafter *APo.*) 94b33 is noncritical but clearly hypothetical. (3) At *Phys.* 222b18, he cites with approval an otherwise unknown and likely fictitious Pythagorean named ‘Paron’. For what it is worth, Aristotle cites this Paron as saying that ‘time is very stupid’, which is metaphorical at best and inconsequential in any case. (Paron’s name is simply the Greek participle for ‘being present’: see Walter Burkert, *Weisheit und Wissenschaft: Studien zu Pythagoras, Philolaos und Platon*, Nürnberg: Verlag Hans Carl, 1962; ‘Paron’ is entirely omitted from the most recent comprehensive collection of Presocratic material [André Laks and Glenn W. Most (eds.), *Early Greek Philosophy*, 9 vols., Cambridge, MA: Harvard University Press, 2016]). (4) At *Cael.* 284b7, Aristotle more or less agrees with the point the Pythagoreans make, at least in outline, although he thinks his own version is ‘better’ (c.f., 285a10, b25). For similarly qualified support, see Aristotle, *Meteorology* (hereafter *Meteor.*) 986b1 and possibly *EN* 1186b30.

⁵³ *Cael.* 268b24–26.

⁵⁴ Bifurcations, where there are said to be two different aspects to a thing or two different ways of conceiving of an idea are rarer and, in general, individually less central to Aristotle’s philosophy. There are some very important quadripartite divisions, to be sure (elements, qualities, causes), but not nearly as numerous.

⁵⁵ Appetites *LA* 700b22, *EE* 1223a27; animal and cosmic parts *Cael.* 284b20; *LA* 704b20; animal reproduction *passim*, but esp. in *HA*—this schematization is remarkably pervasive; animal parts *Juv.* 468a13; argument *Rh.* 1358a38; attributes *Topics* (hereafter *Top.*) 115a16; audience *Rhetoric* (hereafter *Rh.*) 1358a37; condensed bodies *Meteor.* 347b12.

⁵⁶ Coming-to-be *Phys.* 190b28; composition of animal parts *PA* 646a12; causes *Meteor.* 1069b32; change, aspects, Aristotle, *On Generation and Corruption* (hereafter *GC*) 322b6–328b29; change, kinds *Phys.* 224a19 f., or differently at *Meteor.* 1067b19; channels from eye *HA* 495a13; choice *EN* 1104b30; contempt *Rh.* 1378b13; commerce *Pol.* 1258b22; constitution *EN* 1160a31; courts of law *Pol.* 1300b15; craftsman *Pol.* 1282a3.

⁵⁷ Deception *Rh.* 1378a9; deduction *Prior Analytics* (hereafter *APr.*) 25b27, 41b36 f. *et pass.*; demonstration, kinds *APo.* 75a39; dimensions *passim*; dispositions *EN* 2.6–8; education *Pol.* 1342b34; elements *Cael.* 277b13; emotions *Rh.* 1378a24; excellence *Pol.* 1332a40.

⁵⁸ Friendship *EN* 1156a7, 1162a34, etc.; good *EN* 1098b13, *Pol.* 1323a25; government appointments *Pol.* 1300a10; government branches *Pol.* 1297b41; government forms *Pol.* 1288a32; government equality *Pol.* 1294a19; mixed government *Pol.* 1294a35; growth *GC* 321a18.

⁵⁹ Happiness *EE* 1214a31; harms *EN* 1135b11; head *PA* 686a19; heart actions *Juv.* 479b17; heart cavities *HA* 496a4 *et pass.*; heaven *Cael.* 278b10; homonymy *Sophistical Refutations* 166a17; insect bodies *HA* 531b25; insect development *GA* 759a2; imitation *Poetics* (hereafter *Po.*) 1447a16; justice *EE* 1241b33.

⁶⁰ knowing *APr.* 67b4; life *EN* 1095b17, *EE* 1215a35; love *EN* 1155b27; luck *Rh.* 1361b39; magistrates *Pol.* 1323a6; moral states *EN* 1145a16; movement aspects *Phys.* 227b24, *De an.* 433b12, *Phys.* 236b2, *Phys.* 266a13, *Phys.* 256b14, *Phys.* 262a19; movement kinds *Phys.* 225b7 f., *Cael.* 268b26, *Cael.* 310a23, *Meteor.* 1068a9, *et pass.*; mover *Phys.* 243a8; music *Pol.* 1339b14; non-being *Meteor.* 1069b27; nutrition *De an.* 416b20.

⁶¹ Opposition *APr.* 63b25; orator *Rh.* 1378a8; people *Pol.* 1295b2; perceptibility *De an.* 418a8; perception *De an.* 428b25; persuasion *Rh.* 1356a2; physics *Phys.* 198a29; poetry *Po.* 1447b25; offices *Pol.* 1309a33; power *Pol.* 1.3; presentation *Po.* 1460b9; problems *Top.* 105b19; ‘productive’ *Rh.* 1362a31.

⁶² Relaxation *Pol.* 1339a20; rhetoric ends *Rh.* 1358b20; rhetoric forms *Rh.* 1.3; rhetoric grades *Rh.* 1359a7; rhetoric temporal horizons *Rh.* 1358b13; sameness *Top.* 103a7; vividness *Rh.* 1410b35; speeches *Rh.* 1403a34.

⁶³ Soul characteristics *De an.* 405b10; soul critical faculties *LA* 700b19; soul functions *GA* 2.3; soul parts *EN* 1139a17; soul variables *EN* 1105b19; stasis *Pol.* 1302a19; substance kinds *Meteor.* 1069a30, 1070a9; substance meaning *De an.* 414a14; sutures *HA* 516a18.

⁶⁴ Theoretical knowledge *Meteor.* 1064b1; tile *Cael.* 306b5; toes *HA* 498b1; *Topics Top.* 101a25; tyrants *Pol.* 1314a15; voice *Rh.* 1403b30; ‘voluntary’ *EE* 1224a4; wrongdoing *Rh.* 1368b3.

⁶⁵ *Cael.* 268a19.

⁶⁶ *Meteor.* 374b30 f. One may want to cavil about the specific division here, but cross-cultural, cross-linguistic, and cross-temporal colour categories are notoriously foreign looking. For present purposes let us simply grant him the categories as given.

⁶⁷ *Pol.* 1326a32

⁶⁸ Aristotle’s point is aimed in the first instance at the qualities of the good state, as the context makes clear.

⁶⁹ *GA* 760b28.

⁷⁰ *Metaph.* 1078a36–b5. I warmly thank Giora Hon for bringing my attention to the importance of this passage in the context of the present argument.

⁷¹ This last word might be translated as ‘specificity’ or even ‘limit’. For the meaning of *symmetry*, in this context, see Giora Hon and Bernard R. Goldstein, *From Summetria to Symmetry: The Making of a Revolutionary Scientific Concept*, New York: Springer Verlag, 2008.

⁷² *Cael.* 268a10.

⁷³ *GA* 760a12–14 and a26–b2.