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CONTENTS

When Teleology Fails: Aristotle on Bile as a Useless Residue in Parts of Animals

Dmitry Ezrohi

Abstract: Aristotle provides no clear justification for his unique position on the status of bile (χολή). He argues against established tradition and his usual teleological framework that this substance has no function but is a useless residue of the liver. Moreover, the basis for Aristotle's critique of two competing views about bile, that of Plato's Timaeus and the followers of Anaxagoras, has not been fully elucidated. In this paper, I argue that Aristotle's arguments against his predecessors and his non-teleological account of bile are firmly based on anatomical data, specifically from non-human animals. I show that the structure of the exposition of anatomical details and the role comparative anatomy plays in his argument reveal Aristotle's concerns both with the content of his predecessors' physiological explanations and also with their anthropocentric and non-comparative methodology.

Keywords: Aristotle, bile, explanation, teleology, anatomy.

1. Introduction[1]

In chapter 2 of book 4 of *Parts of Animals* (676b16–77b10), Aristotle discusses bile (χόλη),[2] a yellowish bitter substance found throughout the body and concentrated in humans around the liver, in what we today call a gallbladder. Aristotle's main argument in the section is that bile has no physiological function or pathological role but is instead a useless residue, a leftover from processes that occur in the liver. This is an interesting position for two reasons. First, most medical and lay writers of Aristotle's time gave bile

1 An earlier version of the paper was presented at the 'Body and Embodiment in the Ancient World' Graduate Students Conference under the auspices of the annual conference of the Israeli Society for the Promotion of Classical Studies in 2022. I thank Orly Lewis, Naly Thaler, Orna Harari, Marco Vespa, and Ohad Katz for helping me to improve the argument and structure of the paper. I thank two anonymous readers for their valuable comments. Responsibility for any remaining omissions and errors is mine.

2 Galen comments that in earlier Greek, bile (χολή) stands for yellow bile (χολὴ ξανθή) and not for black bile (χολὴ μελαίνη), see *Alim.Fac*. 3.38, 4.742.12–15 K. = 382.3–6 Helmreich; *HNH*. 1.30, 15.77.12–15 K. = 41.15–17 Mewaldt; *Hipp.Epid*.4.4, 17B.129.11–14 K. = 194 Wenkebach. Aristotle comments that bile is yellow and bitter (*de.An.*3.1, 425a31–b2). Louis (1956), 89 is wrong to identify the bile under discussion here with black bile. References to the Hippocratic Corpus follow the abbreviations in Craik (2015), and references to Galen follow Hankinson (2008).

a prominent place in their descriptions of human anatomy, physiology, and pathology.[3] There is evidence for only a small minority that thought otherwise.[4] Second, this is a unique case in which Aristotle rejects two accounts for the role of bile, that of Plato and the followers of Anaxagoras, not to replace it with a teleology of his own but to offer a non-teleological alternative.[5] This might seem like a break in explanatory character.

One would assume that taking the minority position against one's general teleological tendencies would call for an explicit justification. But unfortunately, Aristotle did not leave us one. This silence can be suspicious. It led Vegetti to argue that the explanation for Aristotle's conclusion is to be found in his psychology rather than in the argument itself: Aristotle is supposedly carried away by his polemic zeal against his former teacher, Plato. This makes him transgress his explanatory framework and reject any physiological role for bile.[6] Other commentators, like Lennox, noticed the passage's philosophical import and discussed it, but its structure and argumentation call for further analysis.[7]

In this paper, I account for Aristotle's thesis about bile by drawing the reader's attention to the interrelation between content and structure in Aristotle's gradual exposition of anatomical facts and the physiological conclusion he deduces from them. On the content level, I argue that Aristotle opts for a non-teleological account of bile because he thinks this is the only way to make sense of the anatomical evidence that he gathered about its distribution between different animal kinds and individual specimens of these kinds. Moreover, I show that incongruity with anatomical data, especially from non-human animals, is where Plato's and Anaxagoras' followers' accounts fall short. On the textual level, I show how Aristotle selects and organizes the exposition of anatomical data to suit his argumentative goals. Every anatomical detail he includes in his discussion is weaponized against competing accounts or in the service of substantiating his own goals. So, the relationship between the anatomical data and the physiological theses it supports is complex. On the one hand, the collection of anatomical data determines the result of the inquiry; on the other hand, the segments of anatomical data are selected, and their textual presentation is shaped to enhance the effectiveness of

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3 On bile as a natural and possibly pathological substance in human bodies: *Aff.*1, 6.208.8–17 L. = 6 Potter; *Morb.*1.2, 6.142.13–20 L. = 90–92 Potter; *Morb.*4.5, 7.550 L. = 110 Potter; *Morb.Sacr.*18, 6.388.12–16 L. = 174–176 Jones and others. See also Langholf (1990), 73–93; Soleil (2011). The theory that bile (with phlegm) is a natural bodily substance responsible for critical physiological processes seems to be an early development of the Cnidean Medical school, although the doctrinal historiography is debated; see Fredrich (1899), 36–37; Lonie (1965). For this theory's reflections in literature, see Archil., fr. 96 Diehl; Aesch.*Agam.*, 792; *Choeph.*, 183; Eurip.*Scyr.*, fr. 683 Kannicht.

4 Philolaus of Croton: *Anon.Lond.*18.37–41 Diels = 39 Manetti. Petron of Agina: *Anon.Lond.*20.16–24 Diels = 42–43 Manetti. Gourevitch (1989), 242–46; Manetti (1990), 230–31.

5 By teleological account, I mean an account that assigns a function to a part and explains its salient features in reference to this function.

6 'The observation is methodically exact but at least partly opposes a major premise of the biology of *Parts* [*of Animals*] […]. In this context, it is probably the anti-Platonic polemic that makes Aristotle overstep the limits of his ontology' (1971), 680.

7 Lennox (2002), 288–92.

Aristotle's argument. The text turns out to be more carefully constructed than previously noticed, as Aristotle weaves pieces of anatomical information and physiological argumentation to reach his desired conclusion.

To substantiate my claims, I offer a close reading of Aristotle's argument as it unfolds from the initial presentation of the topic to Aristotle's non-teleological explanation of bile. Then, I corroborate my argument by examining Aristotle's discussion of non-essential attributes in *Generation of Animals*. In the end, I show that his discussion of bile contains explicit and implicit critiques of the methodology by which and the conceptual framework within which both Plato and the medical tradition prior to Aristotle inquired into the body.

2. ARISTOTLE AGAINST PLATO

Aristotle begins his discussion of bile in *Parts of Animals* not with a description or presentation of bile but with an argument that in some animals, it is not located near the liver.

> **T1** 'The majority of the blooded animals also have bile, some near the liver, and others detached near the intestines since its [sc. bile's] nature is no less of the lower cavity. This is clearest in fish, for they all have bile, and the majority have it near the intestines, though some have it hemmed along the whole intestine, such as the bonito. Furthermore, most of the snakes have it in the same manner.'[8]
>
> 'Ἔχει δὲ καὶ χολὴν τὰ πολλὰ τῶν ἐναίμων ζῴων, τὰ μὲν ἐπὶ τῷ ἥπατι, τὰ δ' ἀπηρτημένην ἐπὶ τοῖς ἐντέροις, ὡς οὖσαν οὐχ ἧττον ἐκ τῆς κάτω κοιλίας τὴν φύσιν αὐτῆς. Δῆλον δὲ μάλιστα ἐπὶ τῶν ἰχθύων·χοῦτοι γὰρ ἔχουσί τε πάντες, καὶ οἱ πολλοὶ πρὸς τοῖς ἐντέροις, ἔνιοι δὲ παρ' ὅλον τὸ ἔντερον παρυφασμένην, οἷον ἡ ἀμία· καὶ τῶν ὄφεων οἱ πλεῖστοι τὸν αὐτὸν τρόπον (*Part.An.*4.2, 676b16–22).'

Aristotle's decision to open his discussion of bile with an argument that it can naturally appear near the intestines and not only near the liver justifies addressing bile so late in the treatise. If bile had been exclusively positioned near the liver, it should have been accounted for earlier, when Aristotle described the liver in book 3 (*Part.An.*3.7, 669b1–70b23). Instead, Aristotle positions the section about bile between a discussion of anatomical structures of secondary importance that envelope the digestive system anteriorly and posteriorly: the omentum and the mesentery. Discussing bile here, and omitting it from the account of the liver, must have struck a more anatomically informed reader as odd. By now, he would have become accustomed to Aristotle's order of exposition, going along the longitudinal axis of the human body from head to toe.[9]

Nevertheless, why did Aristotle not simply discuss bile earlier, with the liver, and mention that in some non-human animals, it is located elsewhere? Why break the order of exposition established through *Parts of Animals*? Whenever Aristotle breaks the

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8 Lennox's translation, modified.

9 For Aristotle's justification of his anthropocentric order of exposition, see Lennox (1999). See also Lloyd (1983), 26–43.

anthropocentric order of presentation, he takes himself to have good reasons to do so.[10] Take, for example, his discussion of the bladder before the kidneys: 'But since it is for the sake of the same need that animals turn out to have the kidneys and the bladder, we should now speak about the bladder, departing the serial order of the parts' (*Part.An.*3.7, 670b27–30).[11] Here, Aristotle is justified in describing the more caudal bladder before the more cranial kidneys because they share a function.

Similarly, I take Aristotle to have good reason to dislocate bile from its human position. I think that Aristotle dissociates bile from the liver by arguing that it is not inherently tied to it and by discussing it separately because the assumption that it is placed near the liver in all animals is the focus of his subsequent argument against Plato, which follows immediately upon T1.[12]

> **T2 '**This is why those who say the nature of the bile is for the sake of a certain sort of perception are mistaken. They say the reason it exists is so that when it stings the part of the soul around the liver, that part of the soul congeals, while when it is released, it produces pleasure.'
>
> 'Διόπερ οἱ λέγοντες τὴν φύσιν τῆς χολῆς αἰσθήσεώς τινος εἶναι χάριν, οὐ καλῶς λέγουσι. Φασὶ γὰρ εἶναι διὰ τοῦτο, ὅπως τῆς ψυχῆς τὸ περὶ τὸ ἧπαρ μόριον δάκνουσα μὲν συνιστῇ, λυομένη δ' ἴλεων ποιῇ (*Part.An.*4.2, 676b22–25).'

The conjunction διόπερ clarifies that Aristotle uses the conclusion of T1, that bile is 'no less' from the intestines, to substantiate his rejection of the claim that bile is 'for the sake of a certain sort of sensation', which refers to Plato's account in *Tim.*71a3–e2.[13] In the *Timaeus*, Plato's account takes the position of bile in the human body, near the liver, and incorporates it into a teleological story about its function. Bile is part of a mechanism aimed at ensuring the obedience of the desiderative part of the soul in the liver to the commands of the rational part in the head. It is 'the power carried from the

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10 See van der Eijk (1997); Föllinger (2015); van der Eijk (2017); Leunissen (2017) for Aristotle's order of exposition and its rhetorical and argumentative functions.

11 'Ἐπεὶ δὲ τῆς αὐτῆς ἕνεκα χρείας τούς τε νεφροὺς συμβέβηκεν ἔχειν τὰ ζῷα καὶ τὴν κύστιν, λεκτέον περὶ κύστεως νῦν, ὑπερβάντας τὸν ἐφεξῆς τῶν μορίων ἀριθμόν·'

12 An anonymous reader rightly suggested that another reason for the location of the passage is that Aristotle reserved this section for nonessential parts of the digestive system. This is true as the omentum, mesentery, and bile result from necessary metabolic processes and are not hypothetically necessary for animals that have them. However, bile is the only member of the triad to lack a function altogether. The omentum helps with digestion (*Part.An.*4.3, 677b29–36), and the mesentery houses the vessels through which digested food is transported from the stomach to the vascular system (*Part.An.*4.4, 678b5–20). Be that as it may, it is only reasonable that multiple factors determine the structure of the exposition in *Parts of Animals*. My account emphasizes one such aspect: the argumentative context of the discussion about bile.

13 Aristotle does not name Plato, but commentators are unanimous in suggesting this reference, Mich.Eph. *In.Part.An.*, 68.18 Hayduck; Ogle (1882), 218; Peck and Forster (1937), 305; Louis (1956), 189; Lanza and Vegetti (1971), 680; Jimenez Sanchez-Escariche and Miguel (2000), 181; Lennox (2002), 288; Kullmann (2007), 616. The lexical similarity between the accounts is quite striking.

intellect' ('ἡ ἐκ τοῦ νοῦ φερομένη δύναμις', *Tim.*71b4–5) that causes bile to sting the liver. By 'punishing' it when its desires overstep their due measure, the intellect ensures that the desiderative soul that dwells therein obeys.[14] Given Plato's reliance on human anatomy and its liver-based physiology, he presents bile as part of the liver: '[The god] made the liver something dense, smooth, bright and sweet, though also having a bitterness' (*Tim.*72b1–2).[15] Bile is nothing but a bitterness, or a bitter substance, adjacent to and forming a part of the liver.

Now, it remains to explain why T1 justifies the rejection of Plato's thesis in T2. T1 focuses on the varied natural and regular locations of bile. This variance in location is the key to dismantling Plato's account. Those who say that bile is for the sake of some sensation are wrong because they tie its function to the liver. By showing that bile is not necessarily placed near the liver in T1, Aristotle invalidates the anatomical basis of Plato's physiological account. There are many animals in which bile is detached from the liver and thus unable to sting it. Consequently, just as bile itself is detached from the liver in some animals, Aristotle's discussion of it is likewise detached from the discussion of the liver. The break in Aristotle's characteristic anthropocentric order of exposition occurs because, in this context, excessive reliance on the human anatomical model made Plato reach the wrong conclusion about the physiology of bile.[16]

This is also why Aristotle does not bother to specify which sensation exactly it is the account he attacks has in mind, qualifying it with the indefinite τις (in 'αἰσθήσεώς τινος'). Whatever that may be, it cannot be the function of bile since its instantiation demands, in Plato's account, a stinging of the liver.[17] The problem is not with the function as such but with its explanation, which uncritically extrapolates human anatomical models to the whole group of animals with bile.[18]

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14 For an illuminating account of psychic physiology in the *Timaeus*, as well as other later dialogues, see Lorenz (2006), 106–21; (2012).

15 'πυκνὸν καὶ λεῖον καὶ λαμπρὸν καὶ γλυκὺ καὶ πικρότητα ἔχον μηχανησάμενος'.

16 Ogle (1882), 218 explains the connection between T1 and T2 by the fact that in T1, Aristotle writes that bile appears in the intestines, making it a residue and thus useless. However, there is no reason to assume that appearing near the intestines will make bile a residue. Moreover, as I show below, not all residues are useless.

17 Alternatively, Michael of Ephesus takes αἴσθησις τις to refer to any sensation caused by the desiderative soul, *In.Part.An.,* 68.27–29 Hayduck.

18 Aristotle might seem to build a strawman out of Plato's account. The account of bile in the *Timaeus* to which Aristotle refers is part of a larger attempt to show how the human body facilitates the journey of the rational soul towards virtue and mitigates the necessary but inconvenient results of embodiment. Bile is part of such a mechanism, subordinating the unruly desiderative part of the soul to the rational. Since only humans have a rational soul, criticizing Plato's account by showing it insufficient for non-rational animals might look like a mistake. However, more than a mistake, I consider it to be an indicator of the different teleological schemes within which the two thinkers operate. Due to space constraints, I can only remark that for Aristotle, the function of bile is its definition or essence (*An.Post.*2.2, 90a15–24, 30–34; *Part.An.*1.1, 639b14–16; *Gen.An.*1.1, 715a8–9). However, if subordinating the desiderative soul to the rational is part of the essence of bile, bile cannot appear in non-rational animals. Since it does, subordinating the desiderative soul to the rational is not part of its essence and thus cannot figure in an explanation of bile. On the other hand, Plato operates within a different teleological scheme, in which the contribution

To conclude this section: The main problem Aristotle detects in Plato's account of bile is based on his observations of non-human animals. The comparative anatomical framework within which he locates his discussion of bile makes it clear that its association with the liver, observable in humans and some other animals, cannot form the basis for its function. Whatever function one may attribute to bile should consider and account for its properties in all animals with bile. As he is sometimes characterized in other parts of Aristotle's natural treatises, Plato turns out to be unacquainted, or unbothered, with the complete empirical picture.[19]

3. ARISTOTLE THE FOLLOWERS OF ANAXAGORAS

Next, Aristotle discusses another suggestion about the role of bile in the body, one attributed to Anaxagoras' intellectual *milieu*. As in his argument against Plato, he first introduces an anatomical prelude:

> **T3** '[1] Some animals have no bile at all, such as the horse, mule, ass, deer, and roe. Moreover, the camel does not have it set apart but has small bilious vessels. Furthermore, the seal has no bile, nor does the dolphin among the sea creatures. [2] Also, even within the same kinds, some appear to have bile, while others do not, as in the kind consisting of mice. Humankind is among these kinds; some people appear to have bile near the liver, while others do not […] This sort of thing also happens with sheep and goats.'
>
> '[1] Τὰ μὲν γὰρ ὅλως οὐκ ἔχει χολήν, οἷον ἵππος καὶ ὀρεὺς καὶ ὄνος καὶ ἔλαφος καὶ πρόξ. Οὐκ ἔχει δὲ οὐδὲ ἡ κάμηλος ἀποκεκριμένην, ἀλλὰ φλεβία χολώδη μᾶλλον. Οὐκ ἔχει δ' οὐδ' ἡ φώκη χολήν, οὐδὲ τῶν θαλαττίων δελφίς. [2] Ἐν δὲ τοῖς γένεσι τοῖς αὐτοῖς τὰ μὲν ἔχειν φαίνεται, τὰ δ' οὐκ ἔχειν, οἷον ἐν τῷ τῶν μυῶν. Τούτων δ' ἐστὶ καὶ ὁ ἄνθρωπος· ἔνιοι μὲν γὰρ φαίνονται ἔχοντες χολὴν ἐπὶ τοῦ ἥπατος, ἔνιοι δ' οὐκ ἔχοντες. […] Συμβαίνει δὲ τὸ τοιοῦτον καὶ περὶ τὰ πρόβατα καὶ τὰς αἶγας (*Part.An.*4.2, 676b25–35).'

The theses established in T3 differ from the thesis in T1. In T1, Aristotle focuses on the *location* of bile in different organisms. He does so because this is the premise that he needs in order to critique Plato in T2. In T3, on the other hand, the focus turns to the *existence* of bile, its location notwithstanding, and here Aristotle establishes two claims. In section [1], he argues that not all animals have bile. Already in T1, he qualified that

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of bile to the virtue of souls is enough to explain why the Demiurge and its emissary gods created it. For the close relations, if not identity, between definition, essence, and explanation in Aristotle's logic, see Harari (2004), 116–41; Koslicki (2011); Bronstein (2016), 43–50 and *passim*; Zuppolini (2018). For the explanatory role of definitions as final causes in *Parts of Animals*, see Henry (2021); Lennox (2021), 141–73. For a similar observation, though less sympathetic to Aristotle, see Taylor (1928), 512–13. On Plato's teleological framework, see Lennox (1985); Carone (2005), 29–42; Sedley (2008), 107–13; Johansen (2020). I thank Naly Thaler and Marco Vespa for pushing me on this point.

19 See also, *Gen.Corr*.1.1, 316a5–15, *Part.An.*3.3, 664b3–19, *Resp.*3, 471b24–29. My conclusion is in line with the analysis of Aristotle's discussion of respiration in Lennox (2021), 264–92. In both cases, immanent teleology and careful comparative anatomy prove crucial for eliminating Aristotle's predecessors' views and establishing his own. I thank an anonymous reviewer for the reference.

bile exists only in some blooded animals (a group that roughly corresponds to the modern "vertebrates").[20] Here, however, he lists eight species of blooded animals that do not have bile or, in the case of the camel, do not have it stored in one place in the body. He points out that these species belong to different kinds of blooded animals. The first six (horse, mule, ass, deer, roe, and camel) are viviparous quadrupeds; the dolphin is a sea creature, otherwise called a cetacean, and the seal is a dualizer, an animal in between these two species.[21]

In section [2] of T3, he argues that the existence of bile varies not only at the level of the kind (γένος) or the species (εἶδος) but also on that of the individual. At least in the case of mice, humans, sheep, and goats, some individual ones have bile, and some do not. There is no reason to read this as a closed list. The fact that this is true for these animals also makes it possible for others. So, by the end of T3, Aristotle establishes variance in bile at all taxonomical levels of animal life, from the more general division between blooded and bloodless animals to the individuals of some animal species.

The first anatomical thesis of T3 is immediately recruited to debunk the suggestion attributed to the followers of Anaxagoras.

> **T4 '**The followers of Anaxagoras would seem to have made the incorrect assumption that bile is a cause of acute diseases; for they seem to assume that when bile is excessive, it flows to the lung, vessels, and ribs. However, this is incorrect since practically all those who suffer the affections of these diseases have no bile, which would become apparent in dissections. Furthermore, the amount of bile present during these sicknesses is incommensurate with the amount expelled.'
>
> 'Οὐκ ὀρθῶς δ' ἐοίκασιν οἱ περὶ Ἀναξαγόραν ὑπολαμβάνειν ὡς αἰτίαν οὖσαν τῶν ὀξέων νοσημάτων· ὑπερβάλλουσαν γὰρ ἀπορραίνειν πρός τε τὸν πλεύμονα καὶ τὰς φλέβας καὶ τὰ πλευρά. Σχεδὸν γὰρ οἷς ταῦτα συμβαίνει τὰ πάθη τῶν νόσων, οὐκ ἔχουσι χολήν, ἔν τε ταῖς ἀνατομαῖς ἂν ἐγίνετο τοῦτο φανερόν· ἔτι δὲ τὸ πλῆθος τό τ' ἐν τοῖς ἀρρωστήμασιν ὑπάρχον καὶ τὸ ἀπορραινόμενον ἀσύμβλητον (*Part.An.*4.2, 677a5–11).'

The physiological picture Aristotle attributes to the followers of Anaxagoras is mentioned in passing. Attempts to identify it with a specific medical text are problematic, but the general picture is clear enough.[22] When bile is overabundant in its

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20 On Aristotelian taxonomy and its principles, see Balme (1962); Grene (1974); Lennox (1980); Pellegrin (1982); Henry (2011).

21 On "dualizers", see Witt (2012).

22 Vegetti (1971), 680 identifies the theory attacked in T4 with the one found in the Hippocratic *Places in Man* (*Loc.Hom.*10.2, 6.294 L. = 48 Craik; 14.1–2, 6.302–304 = 56 Craik). It seems, however, that the theory summarized in T4 differs from the one in *Places*. In *Places*, bile is a 'flux to the chest generated by cold' ('ἐς τὸν κίθαρον ῥυῇ ὑπὸ ψύχεος'). These fluxes come to be not due to excess of moisture, as in T4, but by more mechanical reasons: the vessels 'press out the moisture' ('ἐκθλίβουσι τὴν ὑγρότητα') as the flesh 'shivers, contracts and exerts pressure' ('φριξάσης τῆς σαρκὸς καὶ ἐς μικρὸν ἀφικνουμένης καὶ ἐκθλιψάσης'). Also, the theory in *Places* puts bile's origin in the 'flesh in the head' ('ἡ σὰρξ ἡ ἐν τῇ κεφαλῇ') and not the lower abdomen. It seems better to agree with Louis (1956), 108 and Kullmann (2007), 617 that the theory addressed in T4 is a variant of the

proper location, presumably the human liver, it flows to the lungs and causes acute diseases. We have evidence from several Hippocratic texts that bile was identified as responsible for acute lung diseases, such as pneumonia. Since bodily humors were determined by their color, temperature, and consistency, these writers probably identified the yellow-green mucus expectorated during severe lung diseases as bile.[23] The physiological theory discussed in T4 seems to explain the provenance of "bile" in pathological lungs by its origin from some other place to which it belongs in non-pathological cases.

Aristotle uses the first anatomical thesis established in T3, that some animal species do not have bile, to argue against this view. Since most animals that suffer from these diseases do not have bile, bile cannot be the pathological agent in acute diseases. Aristotle explicitly points to evidence from dissections to corroborate his argument.[24] On a deeper level, Aristotle's disagreement with the suggestion in T4 turns out to be similar to his problem with Plato's account: the authors of this theory falsely universalized two observable facts about human anatomy, namely—at least some humans have bile in non-pathological states, and there is "bile" in pathological lungs. An explanation was concocted, which cast bile as a pathological agent, migrating to the lungs and causing the disease. However, as with Plato's account, non-human anatomical research disproves their claims. Animals without bile have acute diseases that, in humans, happen to be accompanied by bile.[25] Limiting one's zetetic horizons to human anatomy misleads the inquirer.

The second objection Aristotle presents in T4 is hard to understand. Ogle (1882, 218–19) and Kullmann (2007, 619) argue that Aristotle refers to cases of jaundice. In these, the amount of bile, i.e., yellow substance, found throughout the body ('τὸ ἀπορραινόμενον') is substantially more significant than the amount of bile found around the liver and in the gallbladder ('τό τ' ἐν τοῖς ἀρρωστήμασιν ὑπάρχον'). However, as Lennox (2002, 289) noted, the text does not discuss jaundice.[26] Given the fact that the followers of Anaxagoras take bile to be the pathological agent of acute lung diseases, it seems better to follow some Byzantine and modern interpretations, which read the

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humoral pathology found in many Hippocratic treatises. On the minor role of bile in *Places,* see Craik (1998), 13–17.

23 Differentiation according to sensory qualities: *Nat.Hom.*5.2, 6.42 L. = 176 Jouanna. Bile and phlegm as causes of pneumonia and pleurisy: *Morb*.1.27–28, 6.194–96 L. = 150–52 Potter. Vomiting bile ('χολὴν ἐμεῖν') is a common symptom in the nosological treatises of the Hippocratic corpus, see *Epid*.2.1.22, 5.220 L. = 14 Jouanna; 79, 5.248 L. = 36 Jouanna; 7.1.2, 5.366 L. = 49 Jouanna; 67, 5.430 L. = 91 Jouanna; *Morb*.2.3, 7.10 L. = 134 Jouanna; 22, 7.36 L. = 156 Jouanna.

24 On systematic dissections in Aristotle, and the debate about whether the term ἀνατομή refers to the practice of dissecting dead and live animals or the graphic representations of animal bodies, see Cosans (1998); Lennox (2018); Bubb (2022), 25–33, 183–93.

25 It is unclear from the text whether Aristotle thinks about animals with bile in healthy states that do not have bile in the lungs when experiencing acute diseases or animals without bile at all that experience acute diseases. Either way, information from non-human animals disproves a universalization of the human condition.

26 But see the connection between bile and jaundice in the Hippocratic Corpus, *inter alia* *Loc.Hom.*16.1, 6.308 L. = 60 Craik.

following:[27] in cases of severe lung diseases, the amount of "bile", that is yellow mucus, present in the lungs and coughed from them is larger than the amount of bile present in and around its natural location near the liver. So, the mucus in the lungs cannot come from the lower abdomen. Therefore, the physiological theory that bile flows from the liver to the lungs is false.

Up to this point, Aristotle employed two out of three anatomical claims about bile to argue against his opponents. First, in T1, he argued for the varied location of bile and used it against Plato in T2. Second, in section [1] of T3, he argued for the varied existence of bile in different animal species and used it against Anaxagoras in T4. Of course, the anatomical theses are insufficient to guarantee the conclusion by themselves, so Aristotle adds additional information as the discussion unfolds. However, they play a necessary and substantial role in the argument for each separate conclusion.

4. ARISTOTLE'S ACCOUNT

After T4, one anatomical claim remains unexploited. In section [2] of T3, Aristotle argues that even within species that sometimes have bile, it is not present in all specimens of the species. I contend that this thesis is the basis of his understanding of bile, which he presents for the first time immediately after debunking the ideas of Anaxagoras' followers.

> **T5 '**Rather, just as bile, when it arises throughout the rest of the body, seems to be some residue or mixture, so also the bile near the liver appears to be a residue and not to be for the sake of something, as does the sediment in the stomach and the intestines as well. Now, sometimes nature even uses residues for some benefit, yet it is not on this account necessary to seek what something is for in every case; on the contrary, when certain things are such as they are, many other such things happen from necessity.'
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> 'Ἀλλ' ἔοικεν ἡ χολή, καθάπερ καὶ ἡ κατὰ τὸ ἄλλο σῶμα γινομένη περίττωμά τι εἶναι ἢ σύντηξις, οὕτω καὶ ἡ ἐπὶ τῷ ἥπατι χολὴ περίττωμα εἶναι καὶ οὐχ ἕνεκά τινος, ὥσπερ καὶ ἡ ἐν τῇ κοιλίᾳ καὶ ἐν τοῖς ἐντέροις ὑπόστασις. Κατάχρηται μὲν οὖν ἐνίοτε ἡ φύσις εἰς τὸ ὠφέλιμον καὶ τοῖς περιττώμασιν, οὐ μὴν διὰ τοῦτο δεῖ ζητεῖν πάντα ἕνεκα τίνος, ἀλλά τινων ὄντων τοιούτων ἕτερα ἐξ ἀνάγκης συμβαίνει διὰ ταῦτα πολλά (*Part.An.*4.2, 677a11–18).'

In T5, Aristotle argues for two independent conclusions: bile is a residue, and bile is a useless residue. Being a residue does not, in and of itself, mean that bile has no function. For, while most residues are not created for the sake of a specific function, they might

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27 Mich.Eph. *In.Part.An*, 69.7–11 Hayduck; Lanza and Vegetti (1971), 680. Michael's explanation seems especially compelling. According to him, the amount of expectorated substance is so large that it is impossible to contain all of it in the relatively small gallbladder. So, Aristotle's argument does not require direct observation of pathological lungs and gallbladders but only an inference from ejected substances and basic volumetric intuitions.

still serve one.[28] In an illuminating passage discussing the stages of embryogenesis in *Generation of Animals* (*Gen.An.*2.6, 744b11–27), Aristotle differentiates between body parts formed from 'concocted, purest and primary nutriment' ('ἐκ τῆς πεπεμμένης καὶ καθαρωτάτης καὶ πρώτης τροφῆς') and others from 'worse [nutriment], remnants and residues' ('ἐκ τῆς χείρονος καὶ τῶν ὑπολειμμάτων καὶ περιττωμάτων'). The residues in question are the leftovers from the formation of the parts made of nutriment. In other words, during the formation of the fetus, some organic material is left unexploited after the initial creation of some essential bodily parts. So, although nature did not plan on creating extra residue, it does not waste available material but forms additional beneficent parts out of leftovers. Among these residue-based parts are the kidneys, the peritoneum, human hair, hooves, and the squid's ink.[29] Similarly, bile might originate from a non-teleological process but later be used for some function.

To clarify that it is not the case with bile, Aristotle likens it to the useless residue *par excellence*: feces. Bile is both a residue and not for the sake of something ('περίττωμα εἶναι καὶ οὐχ ἕνεκά τινος'). Since bile is not for the sake of something, a teleological explanation cannot account for its existence. We must look for efficient and material causes instead. Now, it is left to see how the claim in section [2] of T3 substantiates the conclusion in T5.

The inferential connection between the passages hinges on the regularity of the phenomenon described in T3. Specimens without bile are not rare enough to be dismissed as malformed. Malformations, or 'monstrosities' (τὰ τέρατα), are by definition irregularly occurring phenomena, 'missed shots' ('ἁμαρτήματα'; cf. *Phys.*2.8, 199b2), a rare exception to a general rule. For example, although the spleen is naturally located to the left of the body and the liver to the right, Aristotle acknowledges that some humans are born with the spleen on the right. Since this is indeed the case only in an extreme minority of human beings, Aristotle dismisses it as a malformation, which does not threaten the veracity of the observation that humans, as a rule, have their spleen on the right side (cf. *Hist.An.*1.16, 496b16–20).[30]

In section [2] of T3, however, Aristotle argues that it is natural for some specimens of the same species to have bile and others to lack it. By natural, Aristotle implies regular, 'for it is what happens in every case or for the most part that is in accordance with nature' (*Part.An.*3.2, 663b28–29).[31] This is why the superfluity of bile in some sheep only 'seems to be monstrous' (*Part.An.*4.2, 677a1–2),[32] but it is not. One might think that the copious amount of bile results from some deformity, but the regularity of this situation indicates otherwise. This answers Vegetti's contention that had Aristotle been loyal to his methodology, he would have designated one of the two groups of humans, either those with bile or those without it, as monstrous (1971, 680). If both having and lacking bile are regularly observed phenomena within the same species, both are natural, and no option can be called monstrous.

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28 Semen and menstrual fluids are residues, but their creation is purposeful.

29 Kullmann (1974), 329–38; Leunissen (2010), 76–111; Kerimov (2021).

30 On monstrosities in Aristotle, see Connell (2018).

31 'ἢ γὰρ ἐν τῷ παντὶ ἢ τῷ ὡς ἐπὶ τὸ πολὺ τὸ κατὰ φύσιν ἐστίν'. See Henry 2015.

32 'τὰ μὲν γὰρ πλεῖστα τούτων ἔχει χολήν· ἀλλ' ἐνιαχοῦ μὲν τοσαύτην ὥστε δοκεῖν τέρας εἶναι τὴν ὑπερβολήν'.

Regularly observed inconsistencies between specimens of the same kind are detrimental to any teleological explanation of bile. The *explananda* of Aristotle's teleological explanations are not features of an individual animal as an individual animal but rather the features animals of a particular group share as members of this group. So, for example, the reason a specific fish has fins has to do with it being a member of fish-kind.[33] Fins are necessary for a fish to carry out its proper activities and behaviors as a fish, not as a unique individual fish. Individual differences are incidental and thus teleologically irrelevant. So, since the existence of bile is naturally variegated within individuals in the same species, it cannot be accounted for by reference to its function for that species. Specimens who happen to have bile have it not as members of the species to which they belong but as individuals with their contingent, idiosyncratic characteristics. Since there are no teleological explanations of individual peculiarities but only of features accounted for by the kinds to which animals belong, there is no teleological explanation of bile. That is to say—bile has no function, and naturally, it cannot account for its existence in different animals. The observation in section [2] of T3 anchors the conclusion of T5.

Far from being *ad hoc*, Aristotle's conclusion is based on what he takes to be anatomical data.[34] Of course, no teleological explanation does not equate to having no explanation at all. After dismissing the possibility of a function, one should still look for its other causes. However, these causes will not be essential functions of definite animal kinds. Instead, they will be efficient and material causes.

Aristotle provides such an account (*Part.An.*4.2, 677a18–29). Bile, according to him, is the residue that remains from the formation and maintenance of the liver.[35] In animals whose material constitution is purer, the blood secreted to the liver to form it in the embryonic stage or sustain it in adult animals leaves no impure residues after absorption into the organ. However, in some animals whose material constitution is less pure, not all the blood can be used to form the liver, and a residue remains. This is bile. Aristotle concludes by restating his position: 'It is absurd not to think that, wherever one should see phlegm or sediment of the stomach, it is a residue; likewise, it is clear that bile too is

33 More specifically: it is the fish's unique way of life (βίος) that accounts for its naturally occurring features (*Part.An.*4.13, 695b17–26). Lennox (2010) argues for the explanatory role of βίος in Aristotle's biological works. Humans are similar to other animals, as they share a kind-specific way of life. This observation is crucial for Aristotle's ethics; see Lennox (1999).

34 Aristotle is mistaken about humans. All humans naturally have bile in a gallbladder near the liver. Aristotle's factual mistake might have resulted from an honest attempt to conduct an empirical investigation. His conclusion could be derived from naïve observations of naturally aborted fetuses whose gallbladder did not yet develop. Except for this unfortunate sleight of hand, Aristotle's data is, in most cases, correct. See Ogle (1882), 218–19; Kullmann (2007), 615–18; Zierlein (2013), 508–16. Moreover, and most importantly, Aristotle's argument holds even if all humans have bile. It does not depend at all on human anatomy.

35 Bile is the residue of the liver in a different sense than feces are the residue of the stomach. As Bub (2020) shows, unlike the stomach, Aristotle does not think that the liver digests nutriment. However, just like any other organ, it is formed from blood and sustained by it. So, its residue, bile, is the residue of its constitutive blood.

a residue wherever one sees it and does not differ with its location' (*Part.An.*4.2, 677b8–10).[36]

5. BILE AND POSTNATALLY ACQUIRED AFFECTIONS

My understanding of Aristotle's reasoning regarding the function of bile is corroborated by a passage from the beginning of book 5 of *Generation of Animals*. There, Aristotle discusses postnatally acquired affections of animal parts.[37] These are features of animals that change between specimens of individual species and also alter in the same specimens during their lifetime, for example, hair and eye color and the pitch of voice. These differences are recognized by a unique instantiation pattern, which calls for a non-teleological explanation:

> **T6** 'It happens that some such affections belong to whole kinds, but to some [kinds], they belong randomly, such as occurs especially with humans […] About these [attributes] and all the things of this sort, one should no longer think that there is the same manner of causation [sc. as in teleologically explainable features]. For all those affections which are neither the products of a common nature nor a distinctive feature of each kind—of those sorts of things, none is nor comes to be for the sake of something. […] In some cases, [the attribute] does not reach the definition of the essence [sc. of the kind], but the causes must be referred back to the matter and the source of motion as coming to be from necessity.'[38]
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> 'Τυγχάνει δὲ τῶν τοιούτων ἔνια μὲν ὅλοις ὑπάρχοντα τοῖς γένεσιν, ἐνίοις δ' ὅπως ἔτυχεν, οἷον μάλιστ' ἐπὶ τῶν ἀνθρώπων τοῦτο συμβέβηκεν. […] Περὶ δὲ τούτων καὶ τῶν τοιούτων πάντων οὐκέτι τὸν αὐτὸν τρόπον δεῖ νομίζειν εἶναι τῆς αἰτίας. ὅσα γὰρ μὴ τῆς φύσεως ἔργα κοινῆ μηδ' ἴδια τοῦ γένους ἑκάστου, τούτων οὐθὲν ἕνεκά του τοιοῦτον οὔτ' ἐστιν οὔτε γίγνεται. […] οὔτε δ' ἐπ' ἐνίων πρὸς τὸν λόγον συντείνει τὸν τῆς οὐσίας, ἀλλ' ὡς ἐξ ἀνάγκης γιγνομένων εἰς τὴν ὕλην καὶ τὴν κινήσασαν ἀρχὴν ἀνακτέον τὰς αἰτίας (*Gen.An.*5.1, 778a20–b1).'

In T6, as in T5, Aristotle concludes that certain biological attributes must be explained by material and efficient causes, not by teleological explanations. First, he identifies these features as non-essential due to their random instantiation patterns. The same attribute can behave differently between kinds; in some, it is universally instantiated, while in others, it appears randomly among individuals. For instance, some kinds of animals have uniform eye color, while in others, like humans, it changes between individuals in unpredictable ways. This makes Aristotle conclude that they are 'neither the products of a common nature nor a distinctive feature of each kind' ('μὴ τῆς φύσεως

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36 'Ἄτοπόν τε τὸ μὴ πανταχοῦ νομίζειν, ὅπου ἄν τις ἴδῃ φλέγμα ἢ τὸ ὑπόστημα τῆς κοιλίας, περίττωμα εἶναι, ὁμοίως δὲ δῆλον ὅτι καὶ χολὴν καὶ μὴ διαφέρεσθαι τοῖς τόποις.'

37 The term is taken from Corcilius (2022). For a discussion of this book, see also Leunissen and Gotthelf (2010). The debate about the place of book 5 in the general scheme of *Generation of Animals* is irrelevant to my argument. Following Corcilius (2022), I do not think the parts discussed in T6 have any teleological function. Lennox (2002, 289) already mentioned the text in relation to T1–5.

38 Leunissen and Gotthelf, modified.

ἔργα κοινῇ μηδ' ἴδια τοῦ γένους ἑκάστου'). As shown above, only works of common nature are explainable by teleological explanations. Therefore, he concludes that the affections discussed in T6 should not be accounted for in teleological terms. Animals do not have some specific eye color or voice pitch for the sake of some function.

The situation with bile is similar. Aristotle notes that some kinds, like fish, have it, while others, like humans and sheep, have it randomly. He also notes variations in the formation and location of bile in animals that have it. He concludes that bile has no function. In T6, we get an argumentative link missing in T1–5 since Aristotle explicitly connects the anatomical data to his conclusion and explains why the former substantiates the latter. It seems reasonable to conclude that the same relation holds between the anatomical data and Aristotle's conclusion also in the case of bile. Bile's instantiation pattern makes it clear that it is not for the sake of something. It is true that Aristotle does not mention bile in T6 or later in the book. However, Aristotle clarifies that the affections he discusses are members of a larger group. He writes that we should not look for a teleological explanation 'about these things *and* all such things' ('περὶ δὲ τούτων καὶ τῶν τοιούτων πάντων') since it is irrelevant 'for *all* (ὅσα) those which are neither the products of a common nature nor a distinctive feature of each kind'. [39] The picture that emerged from T1–5 makes it probable that Aristotle considered bile to be a member of this broader group of accidental attributes.[40]

T6 highlights an essential aspect of the argument in T5. By reducing it to a useless residue that should be accounted for by material and not final causes, Aristotle excludes the existence or configuration of bile in the body from being a part of the essence of any animal, even those that regularly have it. In T6, Aristotle opens the possibility that some animals have eye color, and other similar properties, as essential features of their specific kind. However, in general, eye color is not the kind of attribute to feature in the definition of an animal's essence.[41] Neither is bile. We should be reminded of the similarity of bile with feces: the amount of feces an animal has in its body changes over time and depends on local material and efficient causes. It will be misguided to look at an animal's essence to explain the amount of feces it has at each and every moment. Humans have hearts because they are blooded animals but have a certain amount of bile or feces because they overate yesterday.

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39 See Beare (1914) for the semantics of τοιοῦτος in Aristotle, lending support to the idea that there is a wider class of such attributes.

40 In both cases, Aristotle uses the occasion to offer general methodological advice, as if acknowledging the temptation of insisting on final causes. In T5, Aristotle warns that although nature does use even residues for secondary teleological purposes, 'it is not on this account necessary to seek what something is for in every case'. In T6, Aristotle similarly explains that there are some cases in which the attribute 'does not reach the definition of the essence [of the animal], but the causes must be referred back to the matter and the source of motion as coming to be from necessity'.

41 The exception might be, for example, an animal whose range of sight depends upon the eye's specific color.

5. CLOSING REMARKS

Now we can observe the argumentative structure of the passage: In every step of the argument, Aristotle begins by giving a piece of anatomical information that justifies his position; later, he uses that evidence for his argumentative purposes. First, Aristotle focuses on the location of bile to argue against a position that holds it to have a vital physiological role (T1 and T2). Then, he shows that not only its location but also its existence varies between different kinds. He uses it to argue against the position that bile has a pathological role (T3 section [1] and T4). Finally, he shows that the existence of bile varies even within specimens of the same kind. This piece of evidence is used to argue for the final conclusion that bile lacks any role in the body (T3 section [2] and T5; see table 1). If we accept the general analysis of Netz (2001), this passage turns out to have an uncharacteristically deductive structure. According to Netz, Aristotelian paragraphs usually begin with the desired conclusion, which is later justified by a string of independent considerations. In T1–5, however, the anatomical premises come prior to the conclusions they support. Moreover, the conclusions themselves are interrelated, strung into one dialectical move.

ANATOMICAL THESIS	CONCLUSION
Observation 1: Bile is located in different places in different animals and not only by the liver (T1).	Conclusion 1: Plato's account of the physiological role of bile is wrong (T2). *No positive role in the body*.
Observation 2: Some animal species do not have bile. (T3, [1]).	Conclusion 2: Anaxagoras' account is wrong (T4). *No negative role in the body.*
Observation 3: Individual specimens within the same kinds, including humans, regularly have or lack bile (T3, [2]).	Conclusion 3: Bile is a useless residue (T5). *No role whatsoever*.

Table 1: *The anatomical observations and the respective conclusions they support.*

Aristotle carefully stages the location of the discussion about bile as well as the order and content of the anatomical detail to serve his argument. The location of the passage and its anatomical content make the reader distance himself from assumed anthropocentric preconceptions about the location and existence of bile in organisms. Each step of the way, Aristotle "deconstructs", so to speak, something common Greek knowledge about the body took more or less for granted. The final stage comes when the evidence Aristotle gathered from his human and animal fact-collecting process demotes bile from its presumably safe place as a constitutive element of human and animal nature. Aristotle's account of bile is extremely deflationary compared to the Hippocratic accounts of bile as a humor congenital to human nature and Plato's functional explanation in the *Timaeus.*[42] The positions regarding bile are diametrically opposed:

[42] Kullmann (2014), 28 talks about Aristotle's 'demythologizing of bile' in his argument against the account of the *Timaeus*. On bile as congenital to human nature, see *Nat.Hom*.5, 6.42–44 L. = 178.5–9 Jouanna. By referring to a "Hippocratic" account of bile or to

what some of his predecessors took to be an essential agent in bodily processes, Aristotle takes as an inconsequential substance.

An indication of Aristotle's deliberate engagement with previous medical traditions in his discussion of bile can be found in his use of the common medical term for bodily humors, χυμός. In *Parts of Animals*, as in the rest of his corpus, Aristotle's most common uses of the word are in reference to the quality of taste. Once in *Parts of Animals* (*Part.An.*3.15, 661a4), he uses it in another non-technical meaning, referring to fig juice as χυμός. Our section is the only place in *Parts of Animals* in which Aristotle employs the term in its technical, medical meaning as a bodily humor when he refers to bile as a χυμός (*Part.An.*4.2, 677b4).[43] By using the term, Aristotle immerses himself in the medical debates over the natural constituents of the human body and the causes of diseases. His argument denies bile's place in the account of both.[44]

Finally, in light of Aristotle's acquaintance and engagement with the medical writers of his day, it seems reasonable that he is also aware of the unique premises upon which his conclusions are based.[45] His heavy reliance on empirical observations, with a strong emphasis on non-human anatomical research and a mention of dissections, should be read as being, in itself, a critique of previous methods of biological knowledge acquisition. Both Plato and the Greek medical tradition looked to human physiology and anatomy to account for bile. Aristotle, on the other hand, considers the broader zoological anatomical picture. So, over and above the anti-Hippocratic and anti-Platonic content of Aristotle's account, attention to the structure and argumentation of this passage reveals Aristotle's awareness of the sharp methodological differences between him and his predecessors.

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Aristotle as "anti-Hippocratic", I do not imply that all the writers of the Hippocratic corpus subscribe to the same view of bile. Instead, I refer to the fact that the more physiologically oriented treatises in the corpus ascribe to bile a physiological role and usually an important one.

43 Of the three meanings of the term, this is the least common in Aristotle, see Bonitz (1961), s.v. χυμός, 2, 'χυμοὶ τῶν ζῴων'.

44 Here, I follow Langhoff (1990), 72–79 and Lonie (1981), 54–62, who argue that the conceptual framework of humors was developed as an attempt to explicate the etiology of diseases. Later, it was elaborated into more comprehensive humoral physiological theories.

45 On Aristotle and the Hippocratic tradition, see Bartoš (2014; 2021); van der Eijk (2021). Kullmann (2007), 622 writes that in T3 and 5, Aristotle dismisses the theory of the four humors, as presented in the Hippocratic *Diseases 4* and the *Nature of Man*. However, Aristotle does not attack the theory of the four humors but any humoral theory. His arguments apply just as well to binary theories of phlegm and bile as main pathological agents in the body (e.g., *Aff.*1, 7.208 L. = 6 Potter; *Morb.*1.2, 6.142 L. = 90 Potter) or to the multi-humoral theory of *Ancient Medicine* (*VM.*14, 1.600–602 L. = 134–36 Jouanna). Moreover, there is no unified "theory of the four humors" in the Hippocratic corpus. For example, in *Nature of Man*, the four constitutive humors are blood, yellow bile, black bile, and phlegm. In *Diseases 4,* however, the four are bile, phlegm, blood, and water. See Lonie (1981), 54–62; Nutton (2005).

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