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Anaximander's Zoogony

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Abstract

Aetius v, 19, 4 gives the following account of Anaximander's zoogony:

Ἄναξιμανδρος ἐν ὑγρῷ γεννησθῆναι τὰ πρῶτα ζῶα φλοιοῖς περιεχόμενα ἀκανθώδεσι, προβαινούσης δὲ τῆς ἡλικίας ἀποβαίνειν ἐπὶ τὸ ζηρότερον καὶ περιρρηγνυμένου τοῦ φλοιοῦ ἐπ' ὀλίγον χρόνον μεταβιῶναι.

I argue that we should translate this as:

“Anaximander said that the first animals were generated in moisture and enclosing themselves in spine like barks, as they advanced in age they moved onto the drier and shedding their bark for a short time they survived in a different form.”

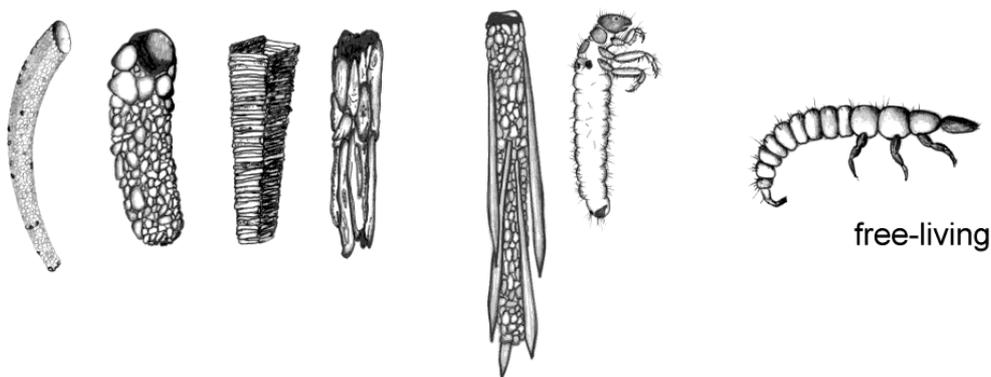
I argue that Anaximander's hypothesis on the origins of life is based on the life cycle of the Caddis fly. If so, his account of zoogony is neither myth nor outright speculation, but is based on observational knowledge. This has significant implications for the nature of Anaximander's zoogony and its relation to his cosmogony and cosmology.

Anaximander's Zoogony

It is generally recognised that Anaximander of Miletus (610-547 BCE) made the first attempt at a natural explanation of the origins of life. This is important as a part of a shift from mythological and theogonical explanations for the origins of life and the cosmos initiated by the Milesian philosophers. In this paper I argue that Anaximander's hypothesis is based on the life cycle of an existing type of insect, the Caddis fly of the order Trichoptera. If so, his account of zoogony is not outright speculation, nor is it a piece of arbitrary philosophising, but it is based, however loosely, on observational knowledge. We may then need to re-assess the nature of Anaximander's zoogony and its relation to his cosmogony and cosmology.

I

There would have been many species of Caddis Fly living in Greece in Anaximander's time and they are widespread throughout Europe today with around 220 species in mainland Greece. These flies begin their life as eggs in freshwater, before becoming larvae. The larvae then construct a case for themselves out of small twigs, bark, vegetation, mollusc shell, gravel or sand, depending on species and environment. These cases are typically 25mm long and 5mm in diameter, and are cemented together with a secretion from the larvae. Again depending on species and environment these cases can be fairly smooth or quite rough in texture. They can be tubular, spiral or square and they can be straight or curved along their length. They are usually but not always closed at one end and they serve as both camouflage and physical protection. The larvae next pupate, usually attaching the case to the underside of a stone, and sealing up both ends. The pupae then break out of the cases, swim to the surface, shed their skin and fly off. They live for several months in the water, and while there is some variation, they live on average for between one and two weeks as flies. Caddis fly cases can look like this: ¹



II

Aetius v, 19, 4 gives the following account of Anaximander's zoogony:

Ἄναξιμανδρος ἐν ὑγρῷ γεννησθῆναι τὰ πρῶτα ζῶα φλοιοῖς περιεχόμενα ἀκανθώδεσι, προβαιούσης δὲ τῆς ἡλικίας ἀποβαίνειν ἐπὶ τὸ ζηρότερον καὶ περιρρηγνυμένου τοῦ φλοιοῦ ἐπ' ὀλίγον χρόνον μεταβιῶναι.

Kirk, Raven and Schofield (KRS) translate this:

"Anaximander said that the first living creatures were born in moisture enclosed in thorny bark; and that as their age increased they came forth on to the drier part and, when the bark had broken off, they lived a different kind of life for a short time." (1983: 141)

However, it is possible to translate this passage in other ways and I would translate:

"Anaximander said that the first animals were generated in moisture and enclosing themselves in spine like barks, as they advanced in age they moved onto the drier and shedding their bark for a short time they survived in a different form."

As a considerable amount turns on the translation here let us look at this in more detail.

1) Most translators have the first animals generated in moisture enclosed in bark. Here I separate the generation and the enclosure, taking περιεχόμενα as having a middle sense, so enclosing (or perhaps defending or protecting) themselves in the bark after being generated.

2) Most translators render φλοιοῖς... ἀκανθώδεσι as 'thorny' or 'prickly' bark'.

i) LSJ give 'A. bark of trees, esp. smooth bark (such as one can cut one's name on)' for φλοιοῖς. When Aristotle speaks of the young of snakes, he says that, they have 'no shell like φλοιοῖς surrounding', which again would suggest something smooth (Historia Animalium: 558a28). Anaximander may simply mean 'bark' as in a tree though, which would allow for some roughness.

ii) Primarily ἀκανθώδης means thorny or prickly. LSJ give ‘any thorny or prickly plant’ as the primary meaning of ἄκανθα, but it can also mean the backbone of animals or men (Herodotus 4.72.5, Euripides *Electra* 492) or the spines of a hedgehog. I translate ‘spine like’ so as to leave the options open here.

Cornford (1952: 171) translates φλοιοῖς... ἀκανθώδεσι as ‘prickly bark’ and suggests the first animals were ‘like sea-urchins’, but this is rather a dead end as sea-urchins do not move onto the drier or undergo any interesting transformations. Clearly a critical question is how appropriate ἀκανθώδης is as a description of the Caddis fly case. I suggest four possibilities here:

a) We can give ἀκανθώδης the usual sense of prickly or thorny, but understand this as rough or uneven. The cases of some types of Caddis fly are quite rough and uneven, but not prickly.

b) We can translate ἀκανθώδης as ‘backbone like’, as the cases are long, hollow and slightly curved. However, there would then be the question of the relation of ribs to the spine.

c) We can translate ἀκανθώδης as ‘spine shaped’ with the spines of a hedgehog in mind, with the sense that the case is long, thin, hollow, slightly curved and closed at one end.

d) We can translate ἀκανθώδης as ‘thorny’, but with the sense that the cases are constructed from long thin shards of bark, which is correct for some Caddis flies, and take it that this says nothing about the overall shape of the cases.

All of these possibilities fit well with φλοιοῖς taken to mean a degree of roughness similar to tree bark.

3) I preserve the comparative ζηρότερον (some translations use dry rather than drier) as there is a difference between moving onto the (absolutely) dry and moving onto something drier which may still be significantly moist.

4) I take περιρρηγνυμένου as having a middle sense, so taking the connotations of shedding a

covering for oneself rather than having it broken. LSJ give *'break off all round: freq. of clothes, rend and tear off'* and under middle usages *'tore off her own garments'*.

Aristotle uses περιρρήγνυμι at *Historia Animalium* 551a23 for a butterfly breaking out of a of chrysalis, at 552a9 for gnats breaking out of their sheaths, at 552a9 for all animals which break out of larvae, and at 554a30 for bee larvae breaking out of their membranes.

5) This is the only occurrence we are aware of for μεταβιῶναι, so LSJ are understandably brief in giving only 'live after, survive'. However, Kahn discusses the word and says that:

“A verbal compound in meta- normally indicates a change from one condition to another, and μεταβιῶναι should mean “to live a different life” or “to survive in a different form.” Either sense is applicable to Anaximander’s view.” (1960: 69)

While I agree with Kahn’s philology, the senses he gives can be interpreted in radically different ways:

a) If our creature emerges from its bark “to live a different life”, this might be essentially the same form of the creature now living on the land rather than in the water, or simply living an adult life rather than being a juvenile in its bark. Diels gives 'mutare vitam'. LSJ give *'change one's way of life'* for μεταδιδιτάω.

b) If our creature emerges "to survive in a different form" this may be a creature which has undergone metamorphosis and now has a very different form to when it was in its bark.

An important part of my proposal is that these creatures undergo metamorphosis, and so survive in a different form rather than live a different life.

II

The life cycle of the Caddis fly is not identical to that described by Anaximander, but is reasonably close given what was likely to have been known at the time. Caddis flies are not of course generated spontaneously from moisture, though it is quite possible Anaximander

believed that. Certainly Aristotle believed that the larvae of many flying insects were produced spontaneously (*Historia Animalium*: 551b27-552b25, 569b). Possibilities for observing supposed spontaneous generation were widespread in the ancient world, the instance most usually cited being the proliferation of flies arising from the drying mud of the Nile after flooding. The young larvae do enclose themselves in cases, and in fact may do this several times, shedding their cases as they grow too large for it and constructing a new ones. On the question of what ἀκανθώδης describes, I am inclined to think it either refers to the overall shape of the case (long, circular, slightly curved, hollow, closed at one end like a hedgehog spine) or that it refers to the shape of the pieces of bark the case is constructed from.

Caddis flies do not ‘move onto the drier’ in the sense of moving onto dry land, but as they are often found underneath stones that may be sufficient for them to be described as moving to the drier. They do break out of the case for themselves. KRS have the case being broken by heating:

“Moreover the general principles of the development of birth are similar: moisture is contained in a bark-like covering, and heat somehow causes an expansion or explosion of the husk and the release of the completed form within.” (1983: 142)

I don’t see the grounds for this supposition about the cases other than a comparison with Anaximander’s cosmogony, and as I argue below, KRS overplay the similarities between Anaximander’s cosmogony and his zoogony.

Caddis larvae do undergo metamorphosis and so survive in a different form. Their life as adults is significantly shorter than their life pre- metamorphosis, so they do survive in a different form for a short time. Anaximander probably only knew that they survived as adults for a relatively short time. There are many other species of fly living in and around rivers which have a very short life as adults, sometimes as short as one day.

It is at least a reasonable hypothesis then that Anaximander had the Caddis fly in mind in this passage. The Caddis fly would have been widespread and numerous in ancient Greece, and the cases they create are fairly obvious to anyone who turns over a few stones in a stream at the right time of year, and so their existence and behaviour may well have been common folk knowledge.

III

There are some very positive things we can say about Anaximander's zoogony. Against a background of myth and theogony, he is the first person we are aware of who sees the origins of animals as an entirely natural event. What is more, his theory appears to have some basis in observation. In other testimonia, Anaximander also definitely locates human beings as part of the natural order. There is also some notion of change from the first life forms to the life forms we see today. The relevant passages are:

Hippolytus, *Refutation of all Heresies*, 1, 6, 6:

“Life forms are generated from moisture by evaporation from the sun. In the beginning, man was similar to another life form, namely fish.”

Pseudo-Plutarch, *Stromateis* 2:

“In the beginning, he says, man was generated from other life forms. Others are swiftly able to sustain themselves, man alone being in need of nursing for a long time. Because of this, he would not have long survived if this had been the original form.”

How this change is supposed to work is another matter. Does Anaximander suppose that the flies are capable of mating with one another and producing offspring? Does this happen alongside what appears to be a repeated original generation of flies? Is the early life of the flies offspring similar or quite different from those generated from moisture in spine like barks? If there was a significant disparity between the number of cases found and the number of flies observed, as would be very likely, a reasonable conclusion would be that while some flies are generated *ab initio* each year, the adult flies have another method of reproduction. One important aspect of Milesian cosmogony was that the underlying processes which generate the cosmos are ongoing, unlike mythical or theogonical accounts. The separating out and interchange of elements does not cease once the cosmos has been formed in Anaximander, nor does the condensation and rarefaction of elements in Anaximenes. There is of course progress in that the cosmos has been formed, but the basic processes remain in action. So I would disagree with Barnes (1979: 22) who says that:

"There is no suggestion that this mode of reproduction occurred more than once."

We might wonder why Anaximander chooses the Caddis fly. He obtains several important components for a theory of the natural origin of animals, and could claim to have a clear example of these components. He gets the initial (and ongoing) generation of living things from moisture. He gets the transfer of an aquatic life form to something which lives on the earth and in the air, establishing a pathway for evolution. With this metamorphosis he gets an example of an apparently simple life form (the Caddis grub) transforming into an apparently much more complex life form (the Caddis fly), and doing so relatively swiftly. He might have chosen other flies but here is something indigenous to ancient Greece which comes from streams rather than any human generated water source.

Anaximander has man as a descendent of fish, so one might wonder how Caddis flies produce fish and ultimately man. That Caddis flies are the first animals does not preclude fish being generated independently from moisture as well, especially if the generation of animals from moisture is a relatively common and ongoing process.

IV

We must differentiate Anaximander from modern theories of evolution. There is nothing in Anaximander to suggest survival of the fittest or adaptation to the environment. One interesting aspect of Anaximander's theory is that it does not seem to rely on chance in any way, or at least we have no evidence that he invoked chance either in his cosmogony or his zoogony. This places him in very sharp contrast with Empedocles. There is no sense in what little we have of Anaximander that this might happen differently in different places as in the early atomists. This also differentiates Anaximander very sharply from modern notions of chance adaptations.

One question we might then raise is how it is that life begins in moisture and how metamorphosis takes place. If Anaximander does not allow a large number of chance occurrences out of which come adaptations, does he rely on the intervention of a God? I would agree with Cornford (1952: 170) that there is no place for a creator in Anaximander or indeed any of the Milesians. However, there is another possibility which is that there is some organising principle associated with the *apeiron* which guides the formation of the cosmos and of animals. The key passage here is Aristotle, *Physics* G4, 203b7ff:

“The infinite has no *arche*... However, this seems to be the *arche* of all other things, and it surrounds and steers (κυβερνᾶν) all, as all those who do not suppose other explanations, such as mind or love, beyond the infinite. This is divine, for it is immortal and indestructible, as Anaximander and most of the physiologi say.”

Anaximander would not be alone among the presocratics having some form of steering principle. These can arguably be found in Thales, Anaximenes, Heraclitus, Parmenides, the Hippocratic corpus and Diogenes of Apollonia.² Diogenes is particularly interesting, in that Fr. 5 reads:

"That which has intelligence is called air by men, and all men are steered by this and it has a power over all things (καὶ ὑπὸ τούτου πάντα καὶ κυβερνᾶσθαι καὶ πάντων κρατεῖν) This seems to be a God to me and to have permeated everywhere, to arrange (διατιθέναι) all things and to be in all things."

So that which steers has the power to arrange all things, and so might be thought to be instrumental in cosmogony and zoogony. Admittedly, for Diogenes the key substance is air, but there is no reason why the unlimited could not perform this function. In the absence of other forms of explanation, this would explain why the cosmos and animals come to be in Anaximander.

V

It is common for commentators to draw tight parallels between Anaximander's cosmogony and his zoogony.³ The important cosmogonical passage here is Pseudo-Plutarch *Stromateis* 2:

“He (Anaximander) says that which is productive out of the eternal hot and cold was separated at the genesis of this cosmos, and that a sphere of flame was formed around the air around the earth like the bark around a tree. When this was broken off and enclosed in certain circles, the sun, moon and stars were formed.”

I do not wish to deny that early cosmogonies were often modelled on biological processes. It is a perennial problem in cosmogony to be able to say what cosmogony was *like*. With

limited options available, it was perfectly reasonable for early thinkers to think of the origins of a complex, self-sustaining, self-moving cosmos in biological terms. Nor do I wish to deny that Anaximander was influenced by biological processes in his cosmogony. What I would question though is the extent to which he envisaged the processes of zoogony and cosmogony as being identical. In relation to the Aetius passage, KRS (1983: 142) say that:

"The use of φλοιοῖς here reminds one of the bark-simile in the cosmogonical account; both ball of flame and prickly shell broke away from round the core (here περι- not ἀπορρήγνυσθαι)."

This is why KRS have the barks being expanded and then split by heating. As the texts stand, we do have different verbs for what happens to the cosmos and to the first animals. There is of course a question with both these testimonia of how far they reproduce Anaximander's own words, even in they represent his thought reasonably well. Dealing with what we have though, we have ἀπορραγείσης, meaning 'to be broken off or severed from' and περιρρηγνυμένου, which I have taken to mean 'shedding for themselves'. We might also compare περιεχόμενα, which I have taken to mean 'enclosing themselves' with περιφυῆναι, 'to have formed around'. While the first living creatures create their own cases, the earth has its sphere of flame formed for it. Perhaps we should give Anaximander some greater credit here in differentiating between what passively happens to the cosmos and what living things are capable of doing for themselves.

There is also no need to attempt to tie Anaximander's zoogony with his theory that the earth is becoming drier.⁴ The first life forms in their cases are not forced to migrate onto the drier by changing climatic conditions, but do so naturally as part of their life cycle. Moving to dry land is not then an adaptation to a changing environment as Burnet (1920: 71) and Kahn (1960: 113) have suggested. Nor need we take it with Barnes (1979: 22) that the first life forms were amphibians. A further consideration here is that it is the sea that is said to be currently drying up, and not the freshwater sources relevant to Caddis flies. I also take the view that the drying up is not a terminal affliction of the earth, though neither is it simply part of a cycle. It is quite possible that the earth at an early stage is more moist than it is now, but when a sufficient amount has been evaporated off, a stable weather cycle of evaporation/rainfall is established.

VI

If the Caddis fly hypothesis is correct, then Anaximander's zoogony is rather more than the 'genial fantasy' Barnes (1979: 23) describes it as. It is a serious attempt to explain the origins of life by natural means, in a non-arbitrary manner, with observational support. As with Anaximander's cosmogony, his zoogony eschews ad hoc explanations in favour of law like ongoing processes. We have virtually nothing on how Anaximander believed that life developed beyond the Caddis fly, except that metamorphosis may play a significant part in demonstrating that more complex life forms may develop from less complex life forms. The Caddis fly example also shows that aquatic life forms may develop into land or air based creatures.

Anaximander was very far from any modern theory of evolution. He had no concept of the roles of chance mutation, adaptation or survival of the fittest. If my suggestion is right though, he believed that the *apeiron* in some way steered the formation of the cosmos and of living things. None of this should detract from Anaximander's achievement of being the first to suggest natural origins for animals and mankind, and the first to try to give that some form of empirical foundation.⁵

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¹ www.seanet.com/~leska/Online/Guide.html

² Thales: Cicero *On the Nature of the Gods* 1, 10, 25, cf. Aristotle *De Anima* 405a19, 411a7, Diogenes Laertius I, 24, Aetius 1, 7, 11, Stobaeus 1, 1, 11, Anaximenes: Aetius I, 3, 4, Heraclitus: Fr. 41 and 64, Parmenides: Fr. 12, 'Hippocrates' *On Regimen* I/10.

³ E.g. Kahn (1960: 109), Guthrie (1965: 90-91), KRS (1983: 141-142), Freudenthal (1986: 216-217).

⁴ See Aristotle (*Meteorologica*: 353b6), Alexander (*Meteorologica*: 67, 11).

⁵ My thanks to Dr. Dirk Couprie and an anonymous referee for their comments.