

THERE IS NO PARADOX OF EVOLUTION: A REPLY TO FESER

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Abstract

Edward Feser, in his recent paper 'Life, Reproduction, and the Paradox of Evolution', argues that reproduction cannot be explained by natural selection, and as a result is irreducibly teleological. And further, since definitions of life depend on the concept of reproduction, the definition of life is irreducibly teleological as well. It will be argued here that Feser does not make his case. At issue is the absence of an appropriate distinction between "replicability" and "reproduction". Natural selection can, then, explain reproduction, as reproduction is just selected-for replicability.

Keywords

Feser • Evolution • Reproduction • Replication • Natural Selection

Edward Feser, in his recent paper 'Life, Reproduction, and the Paradox of Evolution',¹ argues that reproduction cannot be explained by natural selection, and as a result is irreducibly teleological. And further, since definitions of life depend on the concept of reproduction, the definition of life is irreducibly teleological as well. It will be argued here that Feser does not make his case.

To press his point, Feser adapts arguments he attributes to Peter Geach, John Haldane, and Stephen Rothman. But before we examine these, some terminological work needs doing. Somewhat surprisingly, Feser does not characterize 'teleological' at any point in the paper. This is surprising, because Feser has a paper² that carefully lays out more than 10 distinctions between various conceptions of teleology. While he describes himself (in that paper) as having sympathies with an Aristotelian-Thomistic view, he doesn't commit to that in the paper at issue here. For our purposes, I will take 'being teleological', loosely and uncontroversially, as being inherently directed towards some end. But, what does this mean? One way of thinking about teleology is, as Aristotle suggests, as being a certain kind of answer to the question, 'Why is this thing (or feature) here?' 'X is here because it does Y', or 'to do Y', are teleological answers. Such answers may

then prompt one to evaluate whatever X as being good or bad, successful or failed, at either being an X, or at doing Y.

This leaves open the role of a designer in such directedness, including that of a divine designer. I don't think this is at odds with an Aristotelian approach, and thus hopefully agrees, at least generally, with Feser's sympathies. There are some other concepts that need further clarification: natural selection, reproduction, and replication. But we will turn to these in due course.

Feser's arguments

While there are many things that may be teleological in nature, biological structures seem like especially good candidates. The heart appears to have a purpose, to pump blood. And this purpose seems to further the end of the survival of the organism and indirectly, the survival of the species. This is in fact what allows us to speak of 'bad' hearts – they do a poor job of fulfilling that function. And so on, for the snout of the anteater, an eagle's feathers, etc. Many theists take the intuitive plausibility of biological teleology (and its associated complexity) as evidence of a divine creator. This seems to be at the heart of Paley-style design arguments, for instance.

It is no surprise, then, that evolutionary biology presents a challenge to such theists – since it seems to make unnecessary the referencing of a designer for the explanation

1 Feser E. *Life, reproduction, and the paradox of evolution*, Vol. 5. BioCosmos; 2025.

2 Feser E. *Teleology: A shopper's guide*, Vol. 12. Number 1. Philosophia Christi; 2010.

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of hearts, or any other biological traits. This is supposedly so either because evolutionary explanations can fully explain such natural directedness by using non-teleological language, or that it eliminates the need for teleological talk altogether. So, speaking of the 'function' of the heart would be only speaking *as if* the heart has a function.

Feser, however, contends that this 'naturalistic reduction' can't be done for the explanation of life itself. This is so because explaining life requires explaining reproduction, and evolution's key tool in attempting to explain the teleology present in biological traits is natural selection. But natural selection *presupposes* reproduction. So, explaining life by means of natural selection requires using reproduction to explain reproduction – which would be no explanation at all.

Let me try to reconstruct Feser's argument more carefully (I hope, charitably so):

- (1) Conceptually, reproduction is essential to the very nature of what life is.
- (2) Life can be non-teleological only if reproduction is non-teleological.
- (3) Reproduction is a biological trait.
- (4) The only extant non-teleological explanation of biological traits is natural selection.
- (5) Natural selection presupposes the existence of reproduction.
- (6) A process that presupposes a trait cannot explain that trait.
- (7) Natural selection can, therefore, not explain the presence of reproduction.
- (8) There is, therefore, no extant non-teleological explanation of reproduction.
- (9) There is, therefore, no extant non-teleological account of the nature of life.

Though recognizing that this does not mean that a non-teleological account of life is impossible, Feser believes that it does mean that biologists that want to adopt such an approach to explaining life have their work cut out. As an Aristotelian and Catholic philosopher, Feser's sympathies lie with a teleological account.

It is unclear from Feser's article whether he believes natural selection's inability to explain teleology is a failing unique when applied to reproduction, or if natural selection fails generally – and so does not succeed in explaining even hearts being directed at pumping blood, etc. There might be a unique problem in applying natural selection to reproduction (the self-reference in 6, above) in addition to other problems it has for other traits. However, that would make his argument

much less interesting – beating a dead horse, so to speak. I will assume that Feser recognizes that natural selection does present a real challenge to the idea that biological traits have an inherent directedness, but that this challenge fails because it cannot explain *all* it needs to explain – that there is at least one trait that cannot be so explained – reproduction.

Unfortunately, this argument is unsuccessful. Feser plausibly argues for (1), though there are worries about whether connection is truly conceptual (as will be raised later). But he is in good company there, and thus with (2). The chief difficulties arise with (3), (4), (5), and/or (7). Though facially plausible, at least one of these is false. At issue is the absence of an appropriate distinction between reproduction and "replicability".

His argument, following Geach,³ is roughly that explanations of biological traits are thought to be purely mechanistic, and so not teleological, because they can be explained, fully, by the causal mechanism of natural selection. However reproduction, or perhaps the trait of 'reproducibility', cannot be explained by natural selection, since natural selection presupposes reproduction. He says:

....explaining a trait's existence within a population by appeal to natural selection involves proposing a scenario in which certain ancestors of that population survived and reproduced in greater numbers. Hence such explanations presuppose that reproduction already exists. In that case, they can hardly explain how reproduction came to exist. To appeal to natural selection in order to explain reproduction is like trying to get the cart to pull the horse⁴

Haldane, in his back-and-forth with J.J.C. Smart, argues similarly. There is, to be sure, a reading of 'how reproduction came to exist' where the quoted passage comes out as obviously true – and, a reading where it comes out false. This will depend, again, on hashing out the differences, between reproduction and replication.

'Replication' enters the picture via Haldane. As can be seen from the following passage, he treats replication and reproduction as the same thing.

Notice, however, that cumulative selection presupposes some form of replication possessed by the original and intervening living entities. They need to have some mechanism of reproduction.⁵

3 Geach P. *Providence and evil*. Cambridge: Cambridge University Press; 1977. p.77.

4 Feser., p. 8.

5 Smart JJC, Haldane J. *Atheism and theism*. Oxford; 1996. p.92.

Feser uses these interchangeably as well. As both Haldane and Feser recognize, the crucial question then becomes, 'Can the initial instance of replication be explained non-teleologically – that is, without reference to a function?' It is plausible to worry if natural selection can do that job. But, it should be clear that what is needed is not an explanation of the *biological trait* of replicability. The replicability in question will be pre-biological.

To try to be a bit more careful here, let's attempt something akin to some working definitions of 'biological', 'reproduction', and 'replication':

Something is *biological*, if it is about or relates to living things. *Reproduction* is the biological process by which organisms produce other organisms with similar structures and abilities. *Replication* is the process by which a (relevantly similar) copy of a thing is made. *Replicability* is the disposition for replication to occur under particular conditions. By these readings, it should be clear that much, and perhaps all, reproduction is a subcategory of replication – reproduction applying specifically to living things. However, it will also be clear that not all replication is reproduction – as with a document going through a photocopier. To be sure, there are colloquial uses of 'reproduction' that are synonymous with replication, like, 'This isn't an original Picasso. It's a reproduction.' My point here is not to police the use of words, but to use them to make plausible distinctions.

Returning to the above possibility of non-evolutionary causal explanations, Haldane anticipates this possibility that:

natural selection might generate reproducing organisms out of organisms that lack reproduction, by way of an intermediate stage of 'proto-replication'⁶

One does wonder why the non-reproducing entities in question would count as an 'organism' in the first place, as opposed to simply bits of organic matter. One also wonders what work the 'proto' does here. Why not just, 'replication' (and then, as above, treating replication as conceptually distinct from reproduction)? The envisioned situation is one where there are chains of (let's suppose) amino acids that don't replicate, and then there are.

In any event, Feser goes on to explain Haldane's critique of 'proto-replication' as follows:

Whatever 'proto-replication' amounts to, though, it will have to involve the transmission from an earlier generation to a later one of features that are the same as or similar to those of the earlier

generation. We can distinguish the 'channels' through which this transmission is made and the 'communication' through these channels of the information by which the later generation comes to have the features in question. The problem is that the existence of these 'channels' themselves is among the things the 'communication' process presumably brings about, but no communication can occur unless the channels are already in place. Hence, the appeal to proto-replication doesn't solve the original problem at all, but merely kicks it back a stage.⁷

Haldane himself says:

One way of regarding this process [the inheritance of traits] is in terms of the transmission of organizational information through enduring and reliable channels to which the various parties have access.⁸

This, it must be said, is perplexing. Smart politely notes that biologists don't typically avail themselves of communication-theoretic principles. But in any event, a literal application of these seem to be a significant misapplication of Claude Shannon's work.⁹ Getting into the full details of his approach would risk turning this into another paper. But since both Feser and Haldane rely on communication theory something must be said.

Following Lombardi,¹⁰ Holik, and Vanni, Shannon's goal was to move closer to error-free communication. That is, Shannon was concerned with communication as an artifice – not 'natural' information or communication. The parts of his systems, which he mathematized, were

- (1) The source of the message
- (2) A transmitter to send the message
- (3) A channel over which the message is sent
- (4) A receiver of the message
- (5) The destination of the message

Application of this to natural systems has been attempted. Some of these have failed miserably, as with Fred Dretske's *Knowledge and the Flow of Information*.¹¹ Indeed, I have strong doubts as to whether the idea of natural information is even sensible.

⁷ Ibid.

⁸ Smart and Haldane, p.92.

⁹ Shannon, C, Weaver W. *The mathematical theory of communication*. Urbana, IL: The University of Illinois Press; 1949.

¹⁰ Lombardi O, Holik FH, Vanni L. What is Shannon information? *Synthese*. 2016;193: 1983–2012.

¹¹ Dretske F. *Knowledge and the flow of information*. MIT Press; 1983. It is striking to see Dretske transition from "natural information" as a central idea there, to its non-existence (bar a single footnote) in *Naturalizing the Mind*.

⁶ Feser, p.8.

But more importantly, if Feser (or Haldane, or whomever) believes that these communication-theoretic tools are to be of use here, it is incumbent on them to say how so. How is this to be applied in the case of the replication of amino acid chains? Feser speaks above of the transmission of 'features', Haldane of 'organizational information'. But these just raise more questions. What kinds of things are features? Whatever they are, how are they to be transmitted over a channel? What are the mechanics of the channels involved? Are messages being sent between amino acid chains? What is the nature of the message? From where did the message originate? Are they 'being told how to organize themselves'? How could an amino acid change receive this information before it was even constituted? No answers are provided. It's not even clear what such answers would look like. And most importantly, what does any of this have to do with teleology?

But even so, there is no need for these communication-theoretic principles. What is simply needed is a story about how a state of affairs could arise wherein copies are subsequently made.

Feser flatly rejects this, claiming that:

Replication involves more than just one thing bringing about another. Again, it involves the cause's transmitting to the effect features that are the same as or similar to those that the cause itself has. And that requires something like the 'channels' Haldane speaks of, whether or not researchers realize this or use that particular term.¹²

But again, the *why* is missing from the claim was to the requirement for 'something like 'channels''. It does not help that even Feser himself here felt it appropriate to use scare quotes. Perhaps Feser and Haldane appeal to these, because things like communication channels or information connote purposiveness – and thus involve teleology. But, why think the appeal to communication is anything more than metaphor?

To be sure, there is a colloquial use of the term 'information' that fits here. Don't we often speak as though our DNA 'carries the information' about how organisms 'are to develop'? And 'information' does carry with it concepts of representational content, an intention to communicate, and other teleological ideas. But, this is just colloquial. It would be like saying that dark storm clouds carry information about their water content, or that it's about to rain. But, not really. We can infer things from dark storm clouds, given what we already know about clouds and rain, and we can reason inductively about what then to expect. But, there is no communication here. No channels.

¹² Feser, p.8.

No signal loss to worry about. The clouds aren't telling us anything. Not really. Again, perhaps there is more than mere analogy at work in applying communication theory to amino acid replication, and perhaps part of that involves teleology. But, we are owed a story about how this is supposed to go.

At this point, the need to separate 'replication' and 'reproduction' becomes clear. Both Feser and Feser's Haldane view replication as the 'transmitting' of traits. But that seems more fitting of the reproduction associated with living things – as when parents 'transmit' eye color to their children. The kind of 'copying' associates with the replication at issue here, though, needn't be of the biological sort, or even of the biochemical sort. Rather, it is just organic chemistry.

Replication from non-replication

Let's pause for a simple thought experiment. Clearly, there are amino acid chains that replicate, our DNA chains being one. Take the simplest of these, and remove individual amino acids (or, change the folding pattern, etc.), and see if replication can still occur. Eventually, we will go from replicating to non-replicating. Now, imagine this in reverse, and you have replication from non-replication. Whether a particular chain of amino acids, folded in a particular way, will or won't replicate, in a particular environment, is simply a matter of the particular features of that chain, along with the physical laws that govern their interactions. If replication occurs, the resultant amino acid chains will (or won't) replicate, based on those same features and laws – not because some trait or other has been 'transmitted' to it. All of this is independent of teleology. No function needed.

Feser might want to deny this, claiming instead that the replication in question is teleological. However, the challenge for Feser (or Haldane) is to say *why* this is so. The 'pre-replicating' amino acid chain will interact with its environment in various ways – one being its ability to add other amino acids. Should we say of *these* interactions that the chain is 'directed' towards them (for the good of the chain), or rather just say that this is what those chains do, in that environment? What does teleological talk add to that purely causal story? And why should we say anything else regarding the replicating chain? The new chain can do something else, but it's just what it does, not what it's directed towards. The pre-replicating chain wasn't defective, it was just different.¹³

¹³ It might be the case that the replicating and non-replicating chains belong to two fundamentally different natural kinds – replicating chains vs. non-replicating chains. I don't here have a theory of where or how to draw lines between natural kinds, though it might be argued that they are of different types because the replicating chain

To be clear, as Smart points out,¹⁴ the view being defended here is not that biological facts are reducible in total to molecular activity or the operation of physical laws. Both scope and complexity are relevant as to what degree this can be done. If we want one kind of explanation as to why ripe tomatoes are red, evolutionary processes (or something teleological) will need to be brought to bear. But if we're asking what it is about the skin of the tomato such that it reflects red light, we don't need those other tools. Mere reference to physical laws will suffice. Explaining the replication of early amino acid chains requires only the latter.

This is true for some facts about biological features like the human eye. Why the human eye works the way it does, and why light passing through the eye's lens bends the way it does, are questions that call for different kinds of answers. Natural selection explains the one, but not the other.

The point of all this is that the replication in question seems describable, fully, by reference to how amino acids interact with each other in particular environments. There is no need to discuss the 'passing on of traits' (the term 'trait' is already 'biologically loaded'). The first replicating chain doesn't exist because it replicates, or to replicate. Teleology is no more needed for this than it is in explaining why a hydrogen molecule and free oxygen atom can, in the presence of the proper catalyst, produce a water molecule.

One might respond, as an Aristotelian might, that causal laws embody teleology in some sense – and in this case, that the amino acids are just doing what they are directed at doing, by joining together, folding, and replicating. Very reasonable philosophers have defended such claims, but then of course teleology is required to explain life, as would be for everything else – and this entire discussion becomes unnecessary.

It may well be that the supposed situations that could give rise to the 'replication from non-replication' conditions are improbable. Smart admits as much. But Feser and Haldane argue that the hurdle here is not improbability, but conceptual impossibility.

Ultimately, then, premise (3) above reconstructed argument is false – if 'reproduction' is to include the replicative ability of simple amino acid chains. If it does not include that sort of

replication, then the proceeding premises need re-wording, replacing 'reproduction' with replication – and the argument becomes invalid. As will be seen, there is also reason to reject premise (5) on similar grounds.

Replication and natural selection

Feser might respond to the above by saying that he's not denying that a non-evolutionary process could explain the initial appearance of replication, only that natural selection can't do this job. Indeed, he says this:

As I've said, the writers I've been discussing aren't denying that evolution occurred, and they aren't even necessarily denying that reproduction came about by evolution. What they are denying is that natural selection can be the mechanism by which it evolved.¹⁵

and, again,

To appeal to natural selection in order to explain reproduction is like trying to get the cart to pull the horse.¹⁶

The question at issue in this case, 'Can natural selection explain reproduction?', is poorly formed. It would be like asking, 'Can natural selection explain why there are blue eyes?', or even, 'Can natural selection explain why blueness exists?'. These questions make little sense. One could, however, reasonably ask, 'Can natural selection explain why blue eyes exist *in this particular population?*' – about whatever population one is focusing on.

So, it can be asked, 'Can natural selection explain the existence of the particular reproductive processes in human beings?' And the answer to that is, of course, yes. These processes exist because they provided a survival advantage to an ancestor at some point. Of course, the particulars will be very particular, and not about 'reproduction' in general. But it will apply to questions like, 'How did sexual reproduction arise in X?'

The reason why the question needs to be directed at the trait's appearance in a particular population, is because the causal histories that gave rise to the trait may vary from population to population. But natural selection certainly can explain reproduction in at least this sense.

It might be suggested that this sort of explanation isn't sufficient, in that it doesn't explain the first appearance of

is teleological. The task will be to show that the replicating chain is directed as something, as opposed to merely having different causal powers than the non-replicating chain.

¹⁴ Smart and Haldane, p.152.

¹⁵ Feser, p.9.

¹⁶ Ibid., p.8.

reproduction. However, what is odd about Feser's argument (and Geach's and Haldane's) is that it is part of evolutionary theory that natural selection does not explain the initial appearance of ANY trait. Such an appearance occurs randomly – via mutation,¹⁷ and is then either selected for, selected against, or not selected at all, depending on the environmental conditions. But this does not entail that the subsequent existence of, say, blue eyes in a population isn't selected for, or that any (apparent) teleology isn't explained by natural selection. So, we have reason for thinking that premise (4) above, is false. Indeed, a trait might exist in a population for many generations (or in a single organism, for many years), not because it aids in survival, but because it is neutral to organisms' survival, and those organisms already have traits sufficient to survive. Such a trait may become selected for, when the environment changes – when selection pressure presents itself (again, randomly). Only then can it be correctly said to be directed towards some end.

It would be odd to say that, for instance, the first appearance of blue eyes in human beings isn't explained by natural selection, and thus conclude that there is some teleological explanation to which we ought to appeal. But this is just the sort of appeal Feser seems to make for the first appearance of reproduction (or replication).

It does not help that Feser seems to have natural selection not quite correct. Providing another argument that he attributes to Stephen Rothman.¹⁸ Feser says, of natural selection:

In order for natural selection to favor a trait, that trait must confer some survival advantage on the individual organisms that possess it. But reproduction, Rothman argues, confers no such advantage, and indeed if anything works against the survival of the individual.¹⁹

Indeed it does not require this – thus the concept of the 'selfish gene'. It must provide a benefit for enough organisms of that species to survive and reproduce. What matters is not the survival of the organism that has a trait, but the survival of the trait. The replicability of an amino acid chain does not help continue its existence, but it surely does help with the continued existence of chains of similar structure.

Feser appears to recognize this potential reply, and responds:

Some will suggest that reproduction confers an advantage to groups of organisms rather than on individuals, or on parts of organisms such as DNA. But groups of organisms and parts of organisms reproduce only insofar as the individual organisms that make up the groups and possess the parts reproduce, which brings us back to square one.²⁰

But again. This is mistaken. A trait could, in fact, be largely *detrimental* to the survival of the bulk of the organisms (and their offspring) with that trait. But it still is selected for, because the existence of that trait in the population makes it more likely to be passed on. Consider, for instance, that a high rate of reproduction, and subsequent large populations, might well make the individual organisms of a species more likely to be the object of attention of predators, and so get eaten. But if the population is large enough to overwhelm the population of predators (they can only eat so much), that trait is more likely to be passed on.²¹

Selection of replicability in an environment

Something that seems to have been lost in the Feser/Haldane/Rothman discussion of natural selection is the role of the environment. As such, any 'directed-ness' of a trait is a relational, and not inherent, feature. Both replication and reproduction occur only under certain circumstances. As such, not only is the first instance of reproduction explainable by natural selection, it *must* be the result of natural selection.²² The claim will not be that the first instance of replicability is selected for, but rather that reproduction comes after a kind of replicability is selected for – in other words, that reproduction is selected-for replicability. In essence, premise (5) above is false.

Let's try a couple of additional, if fanciful, thought experiments.

Suppose dogs never existed – even that animals never existed. Then, through a near-miracle, a bolt of lightning strikes a swamp, organizing the particles in a dog-like way – beagle-ish, let's say. This beagle-ish Swamp-dog²³ has bits

¹⁷ Also by replication errors, which of course, require replication. Mutation, however, does not.

¹⁸ Rothman S. *The paradox of evolution: the strange relationship between natural selection and reproduction*. Amherst, NY: Prometheus Books; 2015.

¹⁹ Feser., p.8.

²⁰ Ibid., p.9.

²¹ It should be clear that this example doesn't explain reproduction, full stop. What it would explain is why reproduction proceeds as it does in a particular species (as opposed to another method of reproduction). More on this later.

²² That is, it must be so on a Darwinist account.

²³ Apologies to Davidson for theft.

and pieces that would look familiar²⁴ to actual-dog owners, that is, except there are no 'reproductive bits'. Swamp-dog perhaps lives a long and what appears to be an enjoyable life, but eventually passes away. Being the only instance of his kind he never reproduces, and his kind disappears from the universe. Should we say that Swamp-dog was 'directed' towards the end of survival? Was it a 'good' or bad instance of a Swamp-dog? Did Swamp-dog's bits and pieces do what they were directed to do? None of these questions make any sense. Swamp-dog and its bits aren't directed at anything. Swamp-dog wouldn't be *replicable* in any meaningful sense.

Consider then a similar scenario, wherein Swamp-dog is constituted with structures that are structurally much like a male-dog's reproductive bits. Of course, still being the only one of its kind, there is no reproduction, and it again dies out. In this case, there is *replicability*, Swamp-dog could have reproduced, but didn't exist in the proper conditions to do so. But there is no teleology associated with the 'reproductive bits'. Was the existence of the 'reproductive' bits *explained* by their being used to reproduce? Obviously not. They were there purely by chance.

Consider then a final scenario, wherein a similar near-miracle bolt of lightning reorganizes the swamp molecules, creating a female-dog-like creature alongside Swamp-dog, and, Swamp-dogs being similar to actual dogs, offspring are produced. The offspring have similar structures, and we can begin speaking of the 'reproductive bits' being directed at reproduction, because the environment has made it such that these bits are now relevant to the continuance of those bits. These reproductive bits' abilities exist because they have been selected for. The 'directedness' of a physical structure, and in particular that involved in reproduction, is not to be found in the structure itself, but in what it does in the requisite environment. It is not inherent, but relational.

The idea behind this fanciful case is that this is how it might have gone in the case of amino acid chains, only much less fancifully. Consider again the 'organic soup' hypothetical discussed earlier. Suppose that, perhaps improbably, there had been many amino acid chains that had the potential to replicate (over many millions of years or simultaneously), but

they never did (or maybe, only for a short while) – the reason being that the conditions for replication did not obtain. Perhaps there weren't enough amino acids of the relevant type in the immediate vicinity to create the new chains. Or perhaps the 'soup' was too acidic to allow the replication process to finish. Perhaps the enzymes needed to facilitate the replication didn't exist, etc. These chains might all have had different structures and/or replication methods such that they would have replicated, had then existed in different environments. But like the lone Swamp-dog, none of them replicated – until there was one that did exist in the right environment. And we're off and running. These many chains would have had different characteristics of *replicability* – that is, they, like Swamp-dog, would have replicated had the conditions been correct. But they weren't, so they didn't. The existence of their particular replicability was not explained by that replicability. They weren't 'supposed' to replicate. They weren't 'good' or bad at replicating. They just were.

Should we not say of the resultant successful replication method, that it was 'selected for' by the existing environmental conditions (over the only potential replication methods)? The existence of the replicability of 'offspring' chains *would* be explained by the fact that it was selected for. It is worth noting that the replication in question might have been very different from the asexual, and certainly sexual, reproduction we see in organisms today. The intervening billions of years, and widely varying environments, may have resulted in a very different process. There needn't have been any commonality 'passed on' to the reproductive methods of today. Indeed, today's reproduction may be structurally more similar to the replicability of those chains that never successfully replicated – because the environmental conditions of today make that replication possible, whereas those of the past did not.

I suppose it might be argued that all I have done here is move the explanatory burden from 'reproduction' to the dispositional replicability of Swamp-dog's 'reproductive bits' and the replicability of amino acid chains. It's certainly true that natural selection doesn't explain that this sort of replicability. But, why does it need to? It's worth noting the characteristic of replicability is a 'trait' of a very generic sort that supports a counterfactual reading- something like, 'were these structures present in the appropriate environments, they would reproduce in such and such a manner'. But this is so for any physical structure. A document is replicable, when it is placed in a copier. My desk chair might replicate in *some* science fiction-worth hypothetical situations. Surely, being so *replicable* isn't sufficient to imply teleology. That there is a *potential* to replicate can be explicated without reference to directedness.

24 One should be careful not to infer from a structural similarity, a similarity of function. Induction makes this plausible, in many cases, but there is no necessary connection. This is, in fact, the point of Davidson's Swampman example, and Goodman's point that an ant's path traced in the sand resembling Churchill is not reason enough to claim it is of Churchill. See Davidson D. *Essays on actions and events*. Oxford; 2001, and Goodman N. *Languages of Art*. Hackett; 1968.

Of course, there are many theists that are happy to accept that traits, reproduction or otherwise, are relational. This is the point behind, again, Paley-style design arguments. In this case, whether a particular trait has a 'directedness' of some sort is relative to a designer's intentions or plan. Such claims are not implausible, but of course natural selection offers an alternative.

Millikan, natural selection, and teleology

The idea above is that any teleology present in reproduction comes *after* selection. This is not new, especially for those familiar with Ruth Millikan's work. The main goal, in her opus, *Language, Thought, and Other Biological Categories*,²⁵ is to explain representation – especially mental representation – naturalistically. Key to her argument is the idea of a 'proper function'.

Millikan provides two conditions that describe proper functions, it is only the first of these that matters here. An entity **A**, has the function **F** when:

A originated as a 'reproduction' (to give one example, as a copy, or a copy of a copy) of some prior item or items that, due in part to possession of the properties reproduced, have actually performed **F** in the past, and **A** exists because (causally historically because) of this or these performances.²⁶

So, though your heart does lots of things in addition to pumping blood – making thumping sounds, etc. – the pumping of blood is its function, because an ancestor of your art pumped blood, and the fact that an ancestor heart did this explains why your heart exists.

It is a feature of her account is that it applies to artefacts and natural structures alike. So, smoke detectors are directed at detecting smoke, because that is why they exist. Applying this to the initial stage of amino acid chain replication – that sort of replicability had no function, no purpose, no teleology. But the 'offspring' amino acid chains that were its copies did have it. They have it not because of what they can do (perhaps some can't), but because of what the ancestor did. Obviously, the original ancestor has no such ancestor.

25 Millikan RG. *Language, thought, and other biological categories: New foundations for realism*. MIT Press; 1984.

26 Millikan R. In defense of proper functions. *Philosophy of Science*. 1989;56: p.288.

I do not think Millikan's account works for explaining mental representation, for reasons that are not relevant here.²⁷ Her view faces several challenges – not least is how to characterize what counts as an 'ancestor'.²⁸ Neither am I fully convinced that the resultant 'teleology' is real teleology. But her account is at least a plausible story of how teleology could arise from non-teleology. The tools are there.

Replication and life

I have here set aside Fester's conclusions about the role of reproduction in the definition of life. But, returning to Swamp-dog, it seems as though Fester must say that Swamp-dog isn't an example of life, since there is no reproduction. If the response is 'what about the reproductive bits?', consider again the Swamp-dog formed without those, but with everything else (heart-like structures, etc.). What is Swamp-dog doing for the next 10 years, if not living? Conversely, the kind of replicability present in simple amino acid chains (whether they actually replicate or not) is likely not sufficient for life. At some point, we may simply be battling over basic intuitions, but it seems obvious that Swamp-dog would count as being alive, in spite of the lack of reproduction, either in his creation or activity. Conversely, *mere* replicability seems insufficient for life – as with the copyable document. I leave it to the reader to judge my (and Fester's) intuitions.

Conclusions

The idea that we must seek out a teleological explanation of life, because natural selection cannot explain reproduction is unsupported. Natural selection can explain reproduction (replication in living things). Certainly, the many actual methods of reproduction *are* explained by natural selection. The only thing that can't be explained by natural selection is the *replicability* of the earliest amino acid chains, and those instances can be explained in purely causal, non-teleological, terms. This is not to say that non-teleological accounts of reproduction, and perhaps life, are sufficient explanations. What it is to say is that there is no paradox of evolution.

27 Kreider AJ. *On the likelihood of finding a satisfactory naturalistic explanation of mental representation*. Dissertation. University of Miami; 2001.

28 This is a real problem, but it won't do to suggest that ancestors must be identical with regard to all biological abilities. Then, congenitally defective hearts would not even count as hearts at all, and thus could not be defective.