Is the Theory of Macro Evolution a Mythology?

From: Mohanan K P

In a public zoom conversation with Satyajit Rath (IISER Pune) yesterday (22nd August 2021) I took the position that

> if a ***secular*** theory of intelligent design is a pseudo science, then under that criterion of 'pseudoscience', Darwin's theory of biological evolution as articulated in his book *Origin of the Species* is also a pseudoscience.

("Mimamsa Talk Series | Satyajit Rath | K P Mohanan | Potential Scientific Theories or Pseudosciences?"
(https://www.youtube.com/watch?v=pxK5PrS_EeM&t=1154s))

Unfortunately, the English word 'intelligence' conjures up a concept that is close to the concept of human intelligence, and 'intelligent design' conjures up the image of a Deity (= a humanlike supernatural entity) (e.g., God or a god) that designed life. No matter how clearly I pointed out that this is not the concept of intelligence that I was assuming (the concept of artificial intelligence does not assume a supernatural being.) those who responded to me ascribed a position that I do not subscribe to.

This was an emotional reaction to an English word, not a rational response to a proposition that I was asserting. But given that human beings are disposed to emotional reactions to words, I now realize that it was a bad idea on my part to use the word 'intelligence' in my assertion.

During the conversation, Satyajit said something to the effect that the mechanism of constraints and repair that I was proposing as a the concept of the intelligent universe as proposed by people like Stefan Wolfram or Ray Kurzel is a mythology or a non-empirical mystical idea. I don't know what Satyajit meant by the words 'mythology' or 'mystical', but I would like to change my initial question about Darwin's theory as follows:

> Is the current theory of macroevolution as taught to students through textbooks prescribed in undergraduate and graduate courses in biology in universities and colleges a ***mythology***? (a mythology dressed up as a scientific theory is pseudoscience.)

To answer that question, we need to explicitly state the characteristics of mythology such that those who say yes and those who say no can agree on whether a body of propositions constitute a mythology or not. So let me begin by proposing that

> A ***mythology*** is a set of propositions which do not make ***any*** predictions which cannot be proved wrong no matter what the 'facts' (observational generalizations') are.

By 'predictions' I mean

> '*logical consequences* of a set of propositions,

as in the case of *theorems* in mathematics which are the logical consequences of the axioms and definitions of a mathematical theory. I do not mean

> *statements about the future,*

as in the case of *weather forecasts*, or

> *conjectures* that have not yet been deduced from the axioms and definitions of a theory,

as in the case of mathematical conjectures.

To prove that a given proposition is a prediction, we must demonstrate that it is derivable from the propositions of the theory.

If we agree that the above statement is a good approximation of the meaning of the English word mythology, then I would say YES, the current theory of macroevolution as taught to students through textbooks prescribed in undergraduate and graduate courses in biology in universities and colleges IS a mythology.

If you think that the above assertion of mine is wrong, I would like to challenge you to

> explicitly state the propositions of theory of macroevolution in biology,
> derive at least one prediction from those propositions,
> in such a way that you and I can agree if an alleged fact (= alleged observational generalisation) were found to be true, it would show that the prediction is incorrect.

I am NOT a nay sayer to the ***idea*** of biological evolution. I am an 'evolutionist' in the sense that I subscribe to the idea of biological evolution. But I think the ***theory*** of biological evolution as taught to undergraduate and graduate students IS a mythology. If you disagree with me, I would like to challenge you to prove me wrong.

Mo

From: **Vigneshwar Ramakrishnan**

Here is my response to your challenge:

My version of the theory of evolution:
1. There occurs random variations in individuals
2. Variations that do not contribute to fitness of the individual are eliminated (and hence not inherited).
3. Fitness is defined in terms of the number of progenies produced by the individual organism. Greater thr number of progeny, greater the fitness.

Case 1:
Let us say, there are two vertebrate individuals A and B.
Let us say that both A and B initially produce equal number of progeny, say 100.
Now a variation occurs in A that makes it withstand lightning, but that also reduces the number of progeny it produces to 50. According to the theory (logical consequence) since the variation leading to withstanding lightning reduces fitness, it will be eliminated (and not inherited).
When i look around for instances of individuals who can withstand lightning, i don't find any. Therefore i conclude that this variation has not been inherited and the theory makes correct prediction.

Case2:

Let us assume that you take a bunch of bacteria and put it in a medium with antibiotics. One of the bacteria undergo variation that allows it to produce progeny

in the medium filled with antibiotics. The rest of the bacteria don't produce progeny. According to the theory (logical consequence) the variation that allows producing progeny will be inherited. And this is what we observe.

Therefore in both the above cases, the theory is valid.

Can you show me one logical consequence/prediction of the given theory that is wrong?

From: **Madhusudan Raghunathan**

Dear all,

Caveat emptor, my knowledge of biology is limited to the first four semesters of IISER Pune education (with an average grade of C among all courses taken). But here goes.

The way I see it, macroscopic evolution, defined as kingdoms, species, genuses, etc having branched off in the past, and certain organisms having been present in the past but not so much now (and also vice versa), is mainly a coherentist account of the "facts", i.e. it only aims to have a story that does not lead to any fact not being covered, and the story not having contradicting portions. To me, it is not immediately obvious why such a story should be unique. It seems right (to my very limited knowledge) that it does not also make predictions, i.e. we can never predict the shape or form of animals that will exist a million years from now. And it also does not seem that we can verify any predictions made for macroscopic organisms within the timescale of human lifetimes; there just seems to be too much noise in short timescales. However, it does seem that one can check for a few things for small macro-organisms, such as small insects, like small and limited properties like wingspan or bodysize (both making no judgment on the final shape or form of the insects after the generations studied), under small, but, limited hypotheses. Nonetheless, there is a gap between how you create hypotheses for small and limited properties in lab settings, and explaining the entire evolution tree which includes dinosaurs and various other cretins.

Vigneshwar's cases can be individually dealt with. In case, is there a reason to believe that the variation occurred in A at all? Because irrespective of whether the variation occurred or not, you won't find any specimens today with that variation. It seems that it would be essentially impossible to prove whether the variation occurred or not. And it seems you can only "disprove" the inheritance of such properties in cases in which you won't find them at all. That opens up the bag to other uninheritable properties. For example, let's say eating lays chips results in decreasing progeny; you look around in the forest and do not find any vertebrates eating lays chips, thus one concludes this variation has not been inherited. Why prize lightning immunity over lays chips cravings, I'm not sure. In case B, it seems it is an instance of micro-evolution, again with the same small and limited properties mentioned earlier. As to how this relates to there having been dinosaurs 65 million years ago is far from clear.

One more issue, that I can see, is starting from the animals you see today, take all the genetic information or whatever is available, and can you "time reverse" the theory of evolution and find animals that went extinct? Or even, take all the reptiles

and play the movie of evolution in reverse, would you be able to find dinosaurs? It seems from the theory of fitness, no such reverse movie playing to recover the states of any organisms during evolution can be recovered. I admit, this is me being a little pedantic, given that I know biological theories are not built that way. But the point is, if you have a theory that can't explain the future, it definitely should be able to recover the past starting from the present, at least (since a theory explaining the past from present is only essentially time reversed to one that is predicting the future from the present). The way I see it, current genetics or environmental/behavioural modelling cannot really aim to do that. Thus, there is a gap between microscopic evolution and macroscopic evolution that I don't really see surmounted.

I strongly feel macroscopic evolution is merely a coherentist affair. I can still feel that general evolution occurred, that dinosaurs existed in the past, etc., and I can even conclude it happened, but how it relates to fitness, heritability, etc is not something I see as that clearly illustrated. And I definitely don't see why such a story has to be unique.

I also suspect there are vague Latourian networks at play here in which some notion of fitness takes multiple forms in different places concerning different organisms. These networks only are weakly connected to each other, but the very presence of these networks makes the feeling of "truth" stronger. E.g. fitness as being interpreted differently in microscopic and macroscopic evolution differently, with some definitions of fitness being circular, such that there is a vague agreement between these two completely different theories. However, these vaguenesses are great engines for generating new hypotheses that can be tested on limited bases, which is probably where their effectiveness lies.

I have the same qualms about astronomy and astrophysics.

With warm regards,
Madhu

From: **Vigneshwar Ramakrishnan**

The way I see it, macroscopic evolution, defined as kingdoms, species, genuses, etc having branched off in the past, and certain organisms having been present in the past but not so much now (and also vice versa), is mainly a coherentist account of the "facts", i.e. it only aims to have a story that does not lead to any fact not being covered, and the story not having contradicting portions. To me, it is not immediately obvious why such a story should be unique.

I don't understand coherentism - so, I am sorry, I have to side-step this. I also don't get the idea of a unique story - probably because I don't understand coherentism.

It seems right (to my very limited knowledge) that it does not also make predictions, i.e. we can never predict the shape or form of animals that will exist a million years from now.

Just to clarify, I didn't mean to use the word predictions to foretell the future (or the past). I meant it only as deductions/consequences from/of the statements/theory. Perhaps prediction is a confusing word in this context.

In case, is there a reason to believe that the variation occurred in A at all? Because irrespective of whether the variation occurred or not, you won't find any specimens today with that variation. It seems that it would be essentially impossible to prove whether the variation occurred or not. And it seems you can only "disprove" the inheritance of such properties in cases in which you won't find them at all.

But isn't this what the theory of natural selection (at least in the way I had articulated) say? It says no variation that leads to reduced fitness will be inherited. Therefore, it implies that in the extant organisms, these variations do not exist. Isn't this a consequence of the theory I had given?

From: **Rohan Dharwadkar**

Hey, everyone.

I wasn't really planning on participating in this discussion, as I figured that my non-specialist comments would probably simply muddy the waters further rather than elucidate things. However, there are a couple of thoughts I have regarding Madhusudan's post that I think could prove to be useful contributions. So here goes:

It seems right (to my very limited knowledge) that it does not also make predictions, i.e. we can never predict the shape or form of animals that will exist a million years from now.

I'm not sure this is true. It seems to me that once you specify a starting environment and the ongoing changes in that environment (i.e. evolutionary pressures), you should be able to make at least some predictions about how the living beings in that environment, if any, are likely to evolve; as the description of the environment and the changes becomes more and more detailed, the specificity of our predictions and/or the likelihood of their coming true should also go up.

For instance, to take a very dry example, if you were to tell me that a million years hence, the Earth would have lost its atmosphere completely, then I'd predict that all life that was still around then would almost certainly be wingless (excluding vestigial wings, of course).

The fact that there is still some element of uncertainty in these predictions need not faze us, in my opinion. For one thing, natural selection depends fundamentally on random mutations, and mutations that don't negatively impact fitness will often stick around, even if they don't actually increase fitness, and will thus pretty much be impossible to predict, given that they have nothing to do with the organism's environment.

Also, uncertainty per se is not a deal-breaker: an electron's position is inherently fuzzy, and "collapses" to correspond to a specific point only after we measure it. According to quantum mechanics, it is impossible to say with certainty which of the many positions (an infinite number of them?) that an electron could be in will actually be "picked out" by a measurement; the best it can do is provide the probability with which an electron will be measured to be in a particular point. This means that in this case, uncertainty is baked into the prediction itself: the theory

predicts that the outcome of an electron position measurement experiment CANNOT itself be predicted with certainty!

One more issue, that I can see, is starting from the animals you see today, take all the genetic information or whatever is available, and can you "time reverse" the theory of evolution and find animals that went extinct? Or even, take all the reptiles and play the movie of evolution in reverse, would you be able to find dinosaurs? It seems from the theory of fitness, no such reverse movie playing to recover the states of any organisms during evolution can be recovered. I admit, this is me being a little pedantic, given that I know biological theories are not built that way. But the point is, if you have a theory that can't explain the future, it definitely should be able to recover the past starting from the present, at least (since a theory explaining the past from present is only essentially time reversed to one that is predicting the future from the present). The way I see it, current genetics or environmental/behavioural modelling cannot really aim to do that. Thus, there is a gap between microscopic evolution and macroscopic evolution that I don't really see surmounted.

You're probably right, it'd probably be impossible to predict the appearance of dinosaurs before they emerged: perhaps the closest we could've come would've been to say that in that environment, large, tough, armoured, and spiky creatures would have an advantage. But I think that's simply because, once again, natural selection is inherently random, with a lot of irrelevant-to-fitness side effects thrown in, so we couldn't have precisely predicted how those desirable properties (largeness, toughness, etc.) would actually have been instantiated, and it's probably the details of those instantiations that make dinos dinos and distinguish them from other reptiles.

To tie this in with what I said above, this is somewhat similar to going back in time with all the information we have today and trying to accurately predict the outcome of an electron position measurement experiment: you still can't, because that process is still completely random. The best you can do is get a ballpark estimate.

Best regards,
Rohan Dharwadkar.

From: **Jeevan Mendonsa**

I too am an outsider to biology as Madhu.

But I find evolution nothing less than fascinating. Nevertheless, I admit that how exactly another species evolves from a so-called lower species is not clear to me too. in terms of genes, this is explained i suppose in textbooks. but how about behaviour? how exactly these first ones of the species then separated so to say from their group to form a new species? With the so-called lower animals it could be explained but as you go higher, I wonder how it could be explained especially with the intelligent social species in terms of behaviour.

To my knowledge, these points are not even mentioned in textbooks, forget about discussing. so I agree that evolution becomes a pseudoscience the way it is done in university education.

well, for that matter, most things are done this way isn't it in our schools and colleges? Bombardment of information with no rational discussion, no connecting the dots. just an example that i came across today in 8th class science textbooks about the atomic model. The meaning of the term "model" is assumed.
no explanation that a model is just a theoretical construct and then there is always the possibility of a better model.
It would be natural for students to identify the model with the reality, not realising that once any model conflicts with evidence, then it has to to abandoned.
not a word mentioned in this regard in the textbook. shocking to say the least.

Jeevan, sj

From: **Jeevan Mendonsa**

Dear Madhu,

I was quite struck by your statement that you have the same qualms with regard to the vagueness in astrophysics and astronomy.

if m not mistaken, in this case, you are an insider and despite that, you admitting it is courageous indeed.
in a way, you are saying that vagueness or uncertainty helps us to arrive at a better understanding instead of being an obstacle.
most scientists will avoid this issue, at least the popular ones whom the mass media upholds.
if possible, could u give an example from ur field and preferably, an example whom the popular scientists present as if it was the absolute truth.
thanks

Jeevan, sj

From: **Chithra Warrier**

Hello everyone,

This is the first time I am engaging in a discussion of this sort so please bear with any blunders that I make.

I recently finished my twelfth standard and I can agree with what Mo said about evolution being taught through textbooks. As I think back on evolution as in my textbook, I can say that it was simply a few pages of facts stated that we were supposed to take for granted and definitely not question.

Coming to the matter at hand, Mo, correct me if I'm wrong. You would like to challenge Darwin's theory of evolution. Or rather the way it is presented. You oppose the theory of intelligent design. From what I read about intelligent design, I gather that it is a theory that uses scientific back up to prove the existence of God or a higher being that is responsible for evolution at a greater level. I do not think that this can be proved either way. More over proving or disproving God's existence is not something I want to get into. What I understand is that when people are desperate, the belief that some higher power is watching over everything gives a certain kind of

relief. If such a belief is productive then arguing that it is false creates needless complications.

I tend to agree with Vignesh on the points of evolution. Characteristics or traits that are useful tend to be passed on to a new species through similar genes. However once it is no longer needed it is eliminated. The closest example I can list is the absence of tail in humans. It is proven that humans evolved from apes. All apes have tails which play an important part in the life. Yet as we evolved it slowly disappeared. The only reasonable explanation is that for humans the tail was simply not a necessary thing for our continued existence. Similarly, the human embryo at an early stage has gill slits which points to the fact that we share some DNA with the fish.

Evolution is indeed a fascinating process and we have yet to discover many factors that make up evolution. The Miller - Urey experiment presents a probable scenario as to the begining of this process. Maybe in the future we might also be able to create life from scratch. The prospect is definitely exciting. This reminds of a fantastical story I once read of two scientists who managed to create a miniature living being in a laboratory. The story was from a collection of stories by Satyajit Ray and featured his character the eccentric Professor Shonku. This experiment might someday become a reality.

In reply to Jeevan I would say that indeed many gaps are yet to be filled. Evolution is a very gradual process and all we have are speculations as to how it would have happened. However these speculations are based on evidence from fossils. Certain creatures existed that are not here now but certain others that exist today share features with these extinct creatures. The extinction could have happened in two different ways; either a gradual 'phasing out' of a creature or mass extinction. For want of a better word I say 'phasing out' because the way I understand it, it is a lot like how we change our electronic devices and update to the latest version. This sort of extinction is nature's way of upgrading life. The second one that is mass extinction as in the case of dinosaurs is caused by natural disasters. This is not something that was 'planned' by nature and as a result the natural balance is upset. This would call for drastic measures. However, as I said before all this simply speculation as to what would have happened millions of years ago.

In response to the way this is taught in school, I agree that it is wholly inadequate. Yet it also begs the question, how much should be taught for a comprehensive understanding. For a student who is not interested in learning biology in depth, the best thing to do is just study the textbook. At school level, when a student takes science, they are supposed to learn Physics, Chemistry and Biology. That is, fundamental concepts of all three subjects. For a student to understand physics, chemistry and biology at such a level simultaneously is not an easy task. The easiest way out that both children and teachers use here is to simply stick to the textbook and not stray from that. Due to time constraints, even this cannot sometimes be fully completed. As a student, I can say that twelfth standard was a stressful experience. The Indian education system is in simply outdated and needs a major makeover.

To conclude I would say that I support the theory of intelligent design just not in the way it is presented. In respect to evolution, I would say that rather than the existence of a higher being that controls or watches over everything, evolution happens because of a certain consciousness inside ourselves, our cells that causes

our genes to identify what is useful and what is not and then to eliminate the useless trait and thus create an upgraded version.

Chithra Warrier.

From: **paul kamoun**

On of the problems to reverse the process is that we are not even able to reverse the environmental/ecological processes with some accuracy because of the quantity of parameters which could have played a role in the last billion years including asteroid and other impacts on Earth as well as the very complicated energy exchanges between Earth interior, Earth atmosphere and land and oceans that we do not even really understand in detail today, and where the slightest deviation in parameters could create drastic changes in the overall environment!,

From: **Vigneshwar Ramakrishnan**

@Rohan:

For instance, to take a very dry example, if you were to tell me that a million years hence, the Earth would have lost its atmosphere completely, then I'd predict that all life that was still around then would almost certainly be wingless (excluding vestigial wings, of course).

Thanks for this example - clearly illustrates what we mean by prediction.

@Chithra:
You would like to challenge Darwin's theory of evolution. Or rather the way it is presented. You oppose the theory of intelligent design. From what I read about intelligent design, I gather that it is a theory that uses scientific back up to prove the existence of God or a higher being that is responsible for evolution at a greater level.

No, Mo is not challenging Darwin's theory or opposing the theory of intelligent design. He is simply trying to say that these "theories", as it exists now, do not make any predictions and hence are ***not*** theories but mythology. He brings our attention to a crucial nature of theories - theories have to make predictions. Mo argues that the Darwin's theory does not make any predictions and hence it is not a theory at all (and he calls them mythology by way of his definition). I am trying to challenge Mo by listing out the propositions of Darwin's theory and I am trying to show him that it indeed makes predictions.

By the way, if you carefully watch the video that Mo shared, he defines intelligent design theory in a secular form. He does not refer to the popular notion of intelligent design that presupposes an intentional agent.

From: **Vigneshwar Ramakrishnan**

these points are not even mentioned in textbooks, forget about discussing. so I agree that evolution becomes a pseudoscience the way it is done in university education. well, for that matter, most things are done this way isn't it in our schools and colleges?

Jeevan, agree with you very much. However, would like to clarify that just because we don't teach the rationale for Darwin's theory in the classroom, it does not become pseudoscience. Mo's challenge is open to all - not just biologists - but to all educated people who believe in Darwin's theory of evolution or Intelligent Design theory or other theories. He contests that what is regarded as the Darwin's theory is actually not a theory at all - it does not adhere to the academic norms of a theory.

My response is - he is flawed ,- there exists Darwin's theory of evolution that adheres to the academic norms. My request to all is to help me construct the theory - if you find flaws or can add on to the propositions i listed, would be much obliged.

From: **Mohanan K P**

Dear all,

Some of you are members of Living in the World of ideas but not Introduction to Research, and some of you are members of Introduction to research but not Living in the World of Ideas. So some of you missed some of the postings. To overcome that problem, I am sharing a doc file that contains all the postings in all the groups as of now.

What follows is a somewhat longish response to some of the issues which have comed up in these exchanges, with an eye on biology students.

PART 1: THE CONCEPT OF PREDICTION IN SCIENCE

In the context of scientific inquiry, the term prediction means "The logical consequences of a set of premises".

Consider the following premises :

1) Athena is taller than Zeno.
2) Zeno is taller than Apollo.
3) Apollo is taller than Plato.

Given (1)-(3) and the rules of inference in deductive logic.we can derive

4) Athena is taller than Plato.

Likewise, given the premises (axioms and definitions) of Euclidean Geometry, and the rules of inference in deductive logic, we can derive (5).

5) The sum of angles in a triangle is 180 degrees (two right angles, where a right angle is a one quarter of a full rotation.).

And given the premises (definitions and laws) of classical mechanics and the rules of inference in deductive logic, we can derive (6).

(6) If you throw a stone straight up, it will go up in a straight line and come down in a straight line. It will not go up and stop there, go up and come down in a spiral, go up and come down in a slanting path, ...

We say that (4) is a prediction derived from (1)-(3), that (5) is a prediction derived from Euclidean Geometry (what mathematicians call a theorem), and (6) is a prediction from classical mechanics. To show that something is a prediction from a scientific theory, you need to articulate the premises (axioms and definitions) of the theory, and derive the alleged prediction from the premises using deductive logic. I

have not seen a single derivation/proof of this kind in any published research or textbook in macro evolutionary biology.

Notice that I am not talking about 'proving' that evolutionary theory is true. That requires non-deductive logic. I am talking about proving that an alleged prediction is indeed a prediction. That requires deductive logic.

Notice also that I am not talking about forecasting. e.g., Does evolutionary theory say whether or not humans will lose their legs by CE 4000? Prediction in the sense outlined above concerned only with deriving one set of propositions from another set of propositions. It has nothing to do with foretelling, which is predicting future events, as distinct from predicting past events, or predicting the weight or height of a person from the age of that person.

I mentioned deductive logic in deriving predictions. The deductive logic can be classical deductive logic, probabilistic deductive logic, or defeasible (non-monotonic) deductive logic. In situations that demand non-monotonic logic, we may get the effect of what is called 'chaos' , 'non-linearity, 'strange attractors' or 'sensitivity to initial conditions'. For instance at the beginning of the twentieth century Poincarre discovered what is called the three body problem in classical mechanics. Even though the laws of classical mechanics are deterministic laws, the application of these laws to a situation in which a planet is caught in the gravitational attraction from two stars (instead of a single star) makes it impossible to predict a single trajectory/path for the planet unless we have infinite precision in our knowledge of initial conditions. (https://en.wikipedia.org/wiki/Three-body_problem)

Given that life is a Complex Adaptive System, it is impossible to make unique predictions of the sort made in classical mechanics with exactly two bodies. All that we can predict is the space of possibilities, and the most probable states within that space.) This is what we are asking of a theory of biological evolution worthy of being called a 'scientific theory'.

For instance, can we state the premises of a theory from we can derive the following results?

1) If a taxon has vertebra, it has eukaryotic cells.
2) If a taxon has a central nervous system, it has an alimentary canal.
3) If a taxon has feathers, it has a beak.

PART 2: VAGUENESS AND AMBIGUITY

What do we mean by 'natural selection', 'selection pressures' or fitness? Can we express the propositional content of these words such that we can deduce testable predictions. For instance, consider the following specifications of 'fitness'.

A1) Fitness is ***reproductive*** fitness as an attribute of ***individual organism or a group of individual organisms*** such that the greater the number of progeny for that organism/group of organisms, the greater its fitness.

A2 Fitness is the ***reproductive*** fitness as an attribute of a ***species*** such that the greater the number of progeny for that species, the greater its fitness.

B1) Fitness is ***adaptive*** fitness as an attribute of ***individual organism or a group of individual organisms*** such that the greater the fit between the structure (anatomy), function (physiology) or behaviour of a the organism/group of organisms, the greater its fitness.

B2) Fitness is ***adaptive*** fitness as an attribute of ***individual organism or a group of individual organisms*** such that the greater the fit between the structure (anatomy), function (physiology) or behaviour of a the organism/group of organisms, the greater its fitness.

The choice from among A1, A2, B1, B2 has empirical consequences (that is the logical consequences (predictions) of the theory matching what is observed. If we specify a threshold for low fitness, we can predict under what conditions of structure-function-behaviour-habitat a species becomes extinct, and we can test that prediction.

Suppose we define fitness as B2. we obviously need

I) A theory of anatomical structures
II) A theory of physiological functions
III) A theory of behaviour, and
IV) A theory of habitats, and
V) A theory of the fit between (I)-(III) on the one hand, and (IV) on the other.

At a broad level (IV) can be achieved by distinguishing between water (aquatic species), earth (terrestrial). But each needs subdivisions. We need to distinguish between salt water (marine, back water) and non-salt water (rivers, lakes, ponds). We need to distinguish between locomotion under the earth, on the surface of the earth and in the air.

On the basis of such a classification, we can propose the parameters the classification of taxa:

i) those taxa that thrive in water vs those die if submerged in water vs those that die when taken out of water
ii) those taxa that thrive on land surrounded by air vs those that die when surrounded by air
iii) those that thrive in salt water vs those that die in salt water
iv) those taxa that thrive in air with oxygen vs those that die when there is no oxygen in the air
v) those taxa that need animals for food vs those that need plants as food.

Such taxa-habitat pairings can be viewed as ***fitness laws*** for a given taxa (e.g., fitness laws for butterflies, fitness conditions for insects, fitness laws for mammals, fitness laws for lions vs deer...). Some of these laws are inviolable while others are violable. And within the violable ones, there would be laws that state a given combinations of traits are obligatory. (e.g. For frogs, presence of oxygen either in air or in water is obligatory. Given such taxa specific fitness laws, we can state the general laws of fitness as follows:

The violation of the obligatory fitness conditions would result in the extinction of taxa or individuals.

The greater the number of fitness laws that are obeyed, the greater the fitness of a taxon/organism,

To take an example taxa specific fitness, we find that prawns can live in both fresh and saltwater, . lobsters live in saltwater and brackish water but not fresh water, and shrimps can live in freshwater, but are there shrimp taxa that cannot live in salt water?

The kind of context specificity that Satyajit talks about is simply the configuration of structure-function-behaviour-habitat of a species. Such context sensitivity does not rule out the enterprise of theory construction that provides predictions with rigorously formulated definitions and laws.

Classical mechanics is a theory with empirical substance. Because terms like 'selection', 'selection pressure', 'random mutation' and 'fitness; are not unambiguous and sufficiently clear, evolutionary biology of the kind presented in education and research has no empirical substance. Hence that theory does not qualify as science, even though experimental biology is indeed a scientific enterprise.

PART 3: COHERENCE

Each of Vignesh's questions/comments (on coherentism, prediction, and natural selection) on Madhusudan's posting reveals something important about the nature of academic knowledge and the epistemology of academic inquiry (academic ways of 'knowing'), as distinct from commonsense knowledge and the ways of knowing in the commonsense paradigm of knowledge, and they also lead to the status of the theory of biological evolution in terms of the epistemic norms of scientific that I articulated in the conversation with Satyajit which I think are important for biology students to understand. I have already commented on prediction and natural selection, so let me turn to the issue of coherence in coherentism.

I am aware that most 'science' students switch off when they hear words like 'epistemology' and 'norms', but I am also aware that there is a small minority of students who are committed to a deeper understanding of scientific inquiry leading to research that makes a significant contribution to knowledge. What follows is meant for the latter group.

Vignesh says that he doesn't understand what is meant by the English word 'coherentism'. That is because it is part of the specialised vocabulary of philosophy. I am pretty sure that if I used the term "binding condition C" in any of these postings, most members of these two groups would not understand it, and even those who have come across the term (grad students in linguistics) won't have a clear understanding of the term.

Let me copy paste three extracts from three encyclopedia entries on coherentism. The first is from the Internet Encyclopedia of Philosophy

> "Coherentism is a theory of epistemic justification. It implies that for a belief to be justified it must belong to a coherent system of beliefs. For a system of beliefs to be coherent, the beliefs that make up that system must “cohere” with one another. Typically, this coherence is taken to involve three components: logical consistency, explanatory relations, and various inductive (non-explanatory) relations. Rival versions of coherentism spell out these relations in different ways. They also differ on the exact role of coherence in justifying beliefs: in some versions, coherence is necessary and sufficient for justification, but in others it is only necessary."(Internet Encyclopedia of Philosophy (https://iep.utm.edu/coherent/)

The second is from the Stanford Encyclopedia of Philosophy:

> "According to the coherence theory of justification, also known as coherentism, a belief or set of beliefs is justified, or justifiably held, just in case the belief coheres with a set of beliefs, the set forms a coherent system or some variation on these themes. The coherence theory of justification should be distinguished from the coherence theory of truth. The former is a theory of what it means for a belief or a set of beliefs to be justified, or for a subject to be justified in holding the belief or set of beliefs. The latter is a theory of what it means for a belief or proposition to be true. Modern coherence theorists, in contrast to some earlier writers in the British idealist tradition, typically subscribe to a coherence theory of justification without advocating a coherence theory of truth. Rather, they either favor a correspondence theory of truth or take the notion of truth for granted, at least for the purposes of their epistemological investigations. This does not prevent many authors from claiming that coherence justification is an indication or criterion of truth." (https://plato.stanford.edu/entries/justep-coherence/)

And the third from Wikipedia

> "In philosophical epistemology, there are two types of coherentism: the coherence theory of truth; and the coherence theory of justification (also known as epistemic coherentism)." (https://en.wikipedia.org/wiki/Coherentism)

As you can see, the term 'coherentism' is a ***theory***. What I have quoted above gives you a rudimentary understanding of the theory, but to gain a deeper understanding, you would need to go through the three encyclopedia entries.

To add to that understanding, it might be useful to define the concept of ***coherence***. Let me define it as follows:

> A set of propositions is ***logically consistent*** iff it does not carry a logical contradiction. (Logical inconsistency results in incoherence.)
> Given a set of logically consistent propositions, its coherence increases with the relation of ***logical consequences*** in between the propositions. (This is what is called 'deductive tightness' that does not allow you to change one piece in the theory without changing the other pieces, as distinct from a bunch of unrelated propositions which have no logical contradictions because they are not connected.)

If the propositions of a scientific theory includes observational generalisations, the demand for coherence includes the demand for making correct predictions.

PART 4: TOWARDS A SCIENTIFIC THEORY OF BIOLOGICAL EVOLUTION

In his most recent email, Vignesh disagrees with the statement that what is regarded as Darwin's theory is actually not a theory at all as it does not adhere to the academic norms of a theory.

According to him, there exists a Darwinian theory of evolution that adheres to the academic norms, and requests the members of these forums to help him develop that theory by finding flaws in or adding on to the propositions he listed.

His position is in the spirit of the position that Satyajit took in our conversation. Whether Einstein's theory of gravity and motion is an alternative (competitor) to Newton's theory of gravity and motion or is a further development of Newton's theory is a matter of which propositions in Newton's theory we regard as non-

negotiable. For instance, if we regard Einstein replacement of the Euclidean geometry with Riemannian geometry and replacement of the concept of space of space and time with a four dimensional space-time in which space and time interact as an essential a variant of the academic species that we call Newton's theory, what Einstein did was to add to Newton's theory. Vignesh is picking up on this line of thinking.

I agree. To further concretise his request with an example, let me give another demonstration of the art and craft of theory construction to create the Darwinian theory of the evolution of birds, bats, and flying insects.

Let me begin with a theory of phenotypical structure at macro level that articulates correlational laws on wings, beaks, feathers, and legs.

> Law 1: The number of legs in animate entities is always even. (There are animate entities with zero legs, two legs, four legs, six legs.... but none with one leg, three legs, five legs, ...)
>
> Law 2: Any taxon that has wings has either two legs or six legs. (Parrots and bas have two legs, butterflies have four. There are no winged taxa with zero legs)
>
> Law 3: Any taxon with feathers has two and only two legs. (Parrots have two legs and feathers, bats of two legs and no feathers, butterflies have six legs and no feathers; there are no taxa with feathers and zero legs, four legs, six legs, ...)
>
> Law 4: Any taxon with feathers and has beaks and vice versa. (Parrots have feathers and beaks, bats and butterflies do not have feathers or beaks; there are no taxa with feathers and no beaks.)

When we propose these correlational laws of biological structure, it is imperative that we actively look for alternative formulations as well as counter-examples. For instance, is it a good idea (or a bad idea) to replace the formulation of the constraints on legs with limbs? Does the taxon of star fish constitute a counterexample? Do flying lizards, flying squirrels, and flying snakes constitute counterexamples? (Do these creatures fly or glide? Should the organs performing the function of gliding but not flying be defined as wings?)

If there are counter-examples, the prohibition of logical contradictions discussed in part III requires that we eliminate them. (Theories with logical contradictions are unfit as academic taxa.) I would leave this part of theory construction to the biology students in this forum.

After modifying and expanding these correlational laws, the next step is to ask why these correlations exist. That question calls for causal explanations, supplementing building a ***causal theory*** on top of the ***correlational theory***. One way of doing that would be to construct a theory of process that takes the molecular input to yield a phenotypical output. For instance, it might turn out to be the case that it is the same molecular configuration that yields the tissue material for both beaks and feathers. (Law 4) It might be the case that there is a control gene for the number of legs. (Law

1). This would come under developmental biology. I leave this too to biology students.

But the causal mechanisms of developmental biology that tissues and organs with molecules (as illustrated above) may not be sufficient. We may also need a story of the evolution of wings, beaks, feathers, and legs.

Let us try the following conjectures:

> Conjecture 1: There are genes that are needed for both beak material and feather material.
> Conjecture 2: These genes are found only in creatures with beaks and feathers.
> Conjecture 3: There are genes that are needed for both bone material and feather material.
> Conjecture 4: Taxa with wings with bones evolved from taxa with feathers.

If such conjectures turn out to be true, they will constitute the beginning of a predictive theory of the evolution of wings, legs, bone, and feathers. This too is work for biology students.

Mo

From: **Mohanan K P**

I forgot add this.

Madhusudan says that he has "... the same qualms about astronomy and astrophysics."

I don't know what Madhu's qualms arebut if the qualms are about conceptual clarity and rigour of reasoning, I would say I share his qualms about all academic domains, including my own area of specialisation, namely, theoretical linguistics of the Chomskian lineage. However, my qualms about theoretical linguistics is way beyond those about astronomy and astrophysics, and my qualms about evolutionary biology are way beyond those of evolutionary biology, and my qualms about fashionable cultural studies and fashionable interpretive sociology are way beyond those of evolutionary biology. As for the kind of stuff fashionable humanities of the kind that Dennis Dutton warns us about ("Language Crimes: A Lesson in How Not to Write " (http://www.denisdutton.com/language_crimes.htm) and represented by the extracts at Dennis Dutton's website (http://www.denisdutton.com/bad_writing.htm) and critiqued by *Higher Superstition* by Levitt and Gross and *Fashionable Nonsense* by Sokal and Bricmont, I would say that that kind of stuff cannot be called 'academic' by any stretch of human tolerance.