

An Introduction to Evolutionary Biology

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Week 1 Lecture 6

Tying it all up_Back to the two questions

Hi, welcome to the last discussion of the first module. But before we get there, let us have a quick recap of what we have already done. So, in our first discussion, we surveyed the general properties of life, you know, through the eyes of an alien. And we defined what evolutionary biology is all about, and then we asked a couple of questions. Then, I told you that in order to answer those questions. It is going to be better if we look at the history of evolutionary thought and how those thoughts have evolved over time.

So, that is what we did in our second discussion, where we looked at pre-Darwinian evolutionary thought. Then, in the third discussion split over two videos, we looked at how Darwin and Wallace arrived at their thoughts. And what exactly were Darwin's thoughts about evolution through natural selection? Then in the fourth discussion, we looked at what happened in the field after Darwin. and we continued our discussion all the way until the beginning of extended evolutionary synthesis.

And finally, with all that information and all those insights with us, in the final discussion, which is this one, The one where you and I are talking, we are going to go back to the two questions that I talked about. We are going to deal with those two questions using two different analogies. So, let us start with the first analogy. So, let us assume that you go to a certain place, a certain room, and you find a person lying dead on

the floor. And you ask the question of what has led to her death.

Now, obviously, whom will you ask this question? You will ask these questions to the people who are there, the kind of experts who are investigating this particular death. And there are two kinds of experts who will actually give you slightly different kinds of answers to the same question. So, the first expert is going to be the forensic expert, and when you ask her what led to this lady's death, She will tell you something like, you know, it was caused by a bullet injury, a knife injury, or whatever. Basically, she will tell you about the mechanistic reason why this lady is dead. The other kind of person to whom you will ask the same question is the investigating officer of the case.

And she is going to talk to you about what the possible reasons behind or leading to this lady's death can be. Is it a suicide? Is it a murder? What caused that? What was the motive? And so on. So, you can see that the same question about a phenomenon can be answered in two slightly different ways. And this is what is known as the so-called proximate versus ultimate dichotomy. So, a proximate reason for a phenomenon is the underlying mechanistic reason for which the phenomenon happened.

In this particular case, the cause of her death. But the ultimate reasoning talks about the context within which that particular phenomenon has emerged. In other words, what has led to this thing happening? So, with this analogy in mind, let us move on to our first question. What was our first question? Our first question was when we tried to define evolutionary biology. And we said that evolutionary biology tries to understand how the tremendous biodiversity we observe came about.

And it also asks why the organisms are the way they are. And then we picked up this second phrase, the one that is highlighted over here. And we asked, "Isn't that supposed to be the domain of molecular biology or genetics?" And now, with the analogy that we have in mind, We realize that what we are talking about here is the proximate-ultimate dichotomy. So, yes, if we are asking a proximate question of why the organisms are the way they are, That is what molecular biology and molecular genetics deal with. But if we

are asking an ultimate question about it, then that is the domain of evolutionary biology.

So, to give you an example from biology, Let us say you are asking the question, "Why is my skin so dark?" Now, at one level, I can simply tell you that the darkness of my skin is due to the presence of this pigment called melanin. That is a proximate mechanistic answer. At the same time, you can also ask the questions. how you know why exactly this skin has become dark due to the presence of melanin And for that, the answer is going to be okay; I am a human being. You know I evolved in Africa.

In Africa, the solar radiation was very intense; solar radiation contains UV. UV, when it interacts with the skin, leads to skin cancer; in order to protect from that, you know. it is important to have melanin therefore, organisms which had melanin were at an advantage etcetera, etcetera, etcetera. So, that is the ultimate reason, the contextual reason for which I have melanin, and hence I am dark-skinned. So, evolutionary biology essentially deals with the ultimate reasonings for every phenomenon in biology, and therefore, evolutionary explanations actually permeate into every single sub-discipline of biology. That is why evolution is, I mean, the processes that we study in evolution are obviously, you know. Something that belongs to the domain of that subject, but the outcomes or the things that we study. The patterns that we seek to explain actually permeate the entire subject. So, this is the first question.

In order to understand the second question, we again need to look at a slightly different analogy. This is a slightly more involved analogy. So, just bear with me. So, the second analogy is, let us say, about a slightly dystopian future. wherein you go inside a library and find that it is full of torn pages from books, something that looks like this.

And then you start looking at the page. And you realize that, for some reason, you are not able to read the page numbers of any of the books. And therefore, you have no idea how many books there are; you have no idea which page belongs to which book. All you have is the information that is available on individual pages, on both sides of individual pages. So, you start reading those pages, and you start noticing that many of them mention a

certain character called Harry.

And you notice that sometimes, as Harry said, it looks like he is behaving like a kid. Sometimes he behaves like an adult; you can tell that sometimes Harry is sad and sometimes he is angry. Sometimes he is afraid; sometimes, you know, he is generally, you know, almost desperate, and so on and so forth. So, as I said, you do not even know if it is the same Harry or not, but you see, you know Harry in different forms. And the same is true for some of the other characters that are interacting with Harry.

So, you find this very strange character called Snape, who seems to be trying to protect Harry at some points. At some times he is trying to kill Harry; at other times he is fighting with Harry, and at other times he is teaching Harry. And again, you know it is a completely bewildering array of things that this character is doing. And ditto with all the other characters; they are behaving in very peculiar ways. Now, from any given page, you can understand what the character is doing on that page.

But you do not really have a clue as to why exactly the characters are doing different things in different places. And as I said, you do not even know whether they are the same character. Or they are different characters who happen to have the same name. Now, at this stage, somehow somebody waves a magic wand, and you are now able to read the page numbers on each page. So, you quickly sort all the pages by their numbers and you see that There are seven sets of pages, which are all called 1, 2, 1, 2, 1, 2.

So, you think that maybe we are looking at not one book, but 7 books over here. So, similarly, you arrange all the pages that have 3 and 4; you arrange all the pages that have 4, 5, and so on and so forth. Now, you take a particular 1-2 page and you look at all the 3-4 pages. And very soon, depending on how the sentence continues, You are able to piece the correct 1, 2 page with the correct 3, 4 page. Then correct the 5th and 6th pages with the 1st, 2nd, 3rd, and 4th pages, and so on.

And once you do this, before long you will see that you get this. And once you get this,

you realize that these are seven books in a series and there is a certain character arc. So, in each book, Harry ages by 1 year; in the first book, he is 13. In the second book, he is aged 14, and so on and so forth, and that is when you try to start realizing. why is it that Harry was sometimes behaving like a 13 year old kid and sometimes he was behaving like an adult.

You understand how Snape's relationship with Harry evolves over time. And then suddenly you start understanding why Snape was behaving so differently in all the books. And the same is true for all the other characters that you have. In other words, all the information that was there in the pages remains the same. But suddenly all that information fell into place in context with each other.

And once that happens, then all the information that you had on the pages suddenly makes a big story. They suddenly start making sense in the context of each other. And it is in this way of looking at the word "sense" that Theodosius Dobzhansky, you know, made that famous comment. So, if you remember, we started by saying that here is this famous statement by Dobzhansky. Nothing in biology makes sense except in the light of evolution.

And we asked, why is it that such an enormous, sweeping statement is being made, right? And if you remember, over the last one or two discussions, we saw that there are so many patterns in biology. There are so many observations in biology, all of which start interacting with each other. Start falling into one coherent narrative once we appreciate that all organisms are related to different degrees. And there is a certain pattern in which they are related; there is a certain pattern in which they have, quote unquote, evolved. So, evolution actually provides a unifying framework for understanding both how life forms Why the life forms are diverse and in what way they are interconnected with each other.

And it is this notion that allows us to link all those disparate observations that I was talking about. If you do not have the framework, then all the biological information that you have is incomplete. They will still stay, but they are all going to remain as isolated

curiosities, right? And in that sense, they will simply be like, you know, stamps in your stamp book. Sure, you can arrange them by country or you can arrange them by color, but that is about it. You would not be able to find too much of a relationship between various stamps that have been issued in or from a particular place or during a particular period, but that in some sense is not very satisfying. This binding thread of evolution is what differentiates biology from being simply a collection of observable facts. Now, here is the other very important thing. We discussed some of those patterns, and I alluded to a few more without really telling you what they are. I just said you know molecular data; I just said DNA data without actually telling you what exactly we observe there.

Some of those patterns we are going to look at in our next discussion. Next module, we will look at the evidence for evolution. But there is no known pattern and no known observation in modern biology, to the best of my knowledge, to date. that is inconsistent with the evolution of life forms. So, we are actually talking about everything known, and when I say known, I do not mean known at the time of Dobzhansky.

I am talking about what is known at present day in 2025; there is nothing that is inconsistent with the evolution of life forms. And again, the same thing that you know. This is why evolutionary biology ends up being a connecting subject for every sub-discipline in biology.