

An Introduction to Evolutionary Biology

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Sexual Selection: Part 1

Hi. So, when we were discussing the phenomenon of selection, we said that Any trait that ends up reducing the overall fitness of the organism. Overall survivorship or how many babies it can produce. That trait is going to be selected against, and the frequency of that trait is supposed to go down in the population. However, it is well known that there are several traits that seem to be exceptions to that rule. So, for example, look at this: the tail of a male peacock.

You can see that it is very long, and if you see a peacock in flight, you will realize why I am talking about this being detrimental. Due to the weight of that tail, that bird can hardly fly. You know, it flies at a very slow speed; it has very little maneuverability in flight. And it can very easily be seen that, for this bird, this is a big detriment in terms of escaping from predators.

Similarly, look at the antlers of this particular deer. So, in many cases, you know, obviously, first of all, the weight of that whole thing on its neck is very high. And secondly, in many cases, it has been seen that, you know, particularly when they are moving through forests. Sometimes these horns get stuck in low-lying branches, and when that happens, this organism gets pinned. And obviously, then it is a very easy target for the predators.

So, if you have structures like these that seem like they are detrimental to the organism, Then how exactly can such traits nonetheless evolve and persist? Why have they not been weeded out by natural selection? So, that is the major question over here. And of course, as you can guess, the answer is That may be what looks like a disadvantage to our eyes but has some underlying advantage after all. Now, then the question is going to be, what can that advantage be? That is the topic of this discussion. And the next one, which in technical wording is known as sexual selection. So, normally, whenever we have discussed anything, I have taken things from multiple sources to create a narrative.

But in this particular case, the treatment in Zimmer and Emlen (2015) Zimmer and Emlen's 2015 book is so nice that I have taken much of the information we are going to discuss from that source. Of course, there will be a few things from other sources as well, but that is the primary one. So, like many things in evolutionary biology, the concept of sexual selection originates from Charles Darwin. And Darwin very famously said that whenever he looks at the tail of a male peacock, it makes him sick. And the reason it made him sick was that it looked as if this was going against his theory of evolution by natural selection.

But very soon he figured out that there was a way out, something else could be happening, and his solution was that Characters that seem to be non-adaptive might still be selective if they end up providing an advantage in the context of reproduction. So, his specific quote, a very famous quote, is that sexual selection depends not on a struggle for existence, but in a struggle between the males for the possession of the females. The result is not death for the unsuccessful competitor, but few or no offspring. So, essentially, if something is giving a reproductive advantage, Then, even if it is a disadvantage in another context, it can still be selected. So, a technical definition of sexual selection is that it involves the differences in reproduction.

That arises from variation among individuals in traits that affect success in competition over mates and fertilization. Now, the obvious question is whether, if you think about reproduction, it is in the interest of both the male and the female. So, if it is in the interest

of both parties, then why exactly should competition arise to begin with? There should simply be cooperation. And when you are talking about selection, obviously there has to be some kind of choosing happening. In the context of sexual selection, who is doing the choosing? Remember, in the context of natural selection, the selective force is whatever is happening in the environment.

The context in which the organism finds itself. So, in the context of sexual selection, who exactly gets to choose? So, these are the questions that we are going to answer in this discussion. Now, in order to answer these two questions, You have to realize that there is a fundamental difference between reproduction in males and reproduction in females. Now, in this particular context, I have to remind you that for this course, Male and female are defined in terms of biological sex and not in gender or any other context that we humans use. And the same is going to apply to the pronouns.

So, you know, if I am talking about a male deer or a male seal, I am just going to call it he. For a female deer or a female seal, I am just going to call it "she." So, that is something that has to be understood. So, just to refresh your memory about the definition of biological sex, it is a binary classification of anisogamous organisms. Anisogamous means the production of two kinds of gametes.

So, those organisms that produce a large number of small gametes are the ones we call males. And those that produce few but large, resource-rich gametes are the ones that we call females. Now, there exist constraints on both males and females in terms of how many offspring they can produce. But, because of the anisogamy that I talked about, the sources of these limitations for the two sexes are very, very different. So, if you look at the male gamete, the sperm, it is very numerous.

Therefore, in terms of resources, they are extremely cheap and easy to produce. Therefore, males can typically produce trillions of sperm. I mean, this is true more or less across the entire, you know, living world. Wherever you find isogamy, the male gamete is typically produced in enormous numbers. I mean, for example, it is well known that the

number of sperm produced by one human male is Over his lifetime, it is sufficient to fertilize every single female on this planet multiple times.

However, if you look at the eggs, they are larger; they have to pack in more resources. Why do they have to pack in more resources? Because after fertilization occurs, the zygote needs to divide. You know. It needs to grow, and the initial resources that are needed for that are all coming from the egg cell. And because these eggs are richer and more resource-rich, they are more difficult to produce.

In the sense that they need more investment from females, they are seeking additional funding. And that is why any female will typically produce a much smaller number of gametes, female gametes, over their lifetime. Now, with this background, let us first look at the female story, and then we will look at the male story. So, if you look at the female, because sperm are numerous, females are typically never limited by sperm availability. So, their reproductive output is limited by the number of eggs they can produce.

And how many eggs they are able to provision is where they can provide a sufficient amount of resources. Therefore, the more successful females are typically those who can produce more eggs than the other females. And there is one other thing that happens in the context of females. Particularly the ones where fertilization happens internally means inside the body of the female. What is that? Remember, in almost all species, males and females mate multiple times.

Even in so-called monogamous species, it has been shown that extra-pair matings are quite common. If you have multiple matings and fertilization is happening inside the female's body, then the female knows that it does not really matter how many male sperms are inside me, The egg over there is mine, and therefore the offspring that is coming out, the baby that is emerging, is also mine. A female is always sure of her maternity, isn't she? Therefore, if the female knows that the child is mine, it makes evolutionary sense for her to invest in post-birth care. Now, this is a very, very important point: it is not that the female is making a conscious decision to invest in anything. It

simply means that if the female invests in post-birth care and that rate is genetic, then that will be it.

It is evolutionarily favored because it ultimately increases the number of offspring that the female can produce. Now, if you look at the male story, it is actually very different. So, in the context of the male, the number of eggs produced is limiting. On the other hand, the male can produce, you know, almost an infinite number of sperm. Therefore, the reproductive success of the male is limited by how many eggs he is able to fertilize.

And therefore, how many females the male is able to access. So, just to give you a concrete example of this, this is a particular bird known as the Great Reed Warbler. As you can see, it has a reed in its name, so it essentially inhabits reed grasslands filled with reeds. And what it ends up doing is making a territory its own and defending that territory. Basically, it ends up creating harems in its territories.

And the reproductive success of the great reed warbler depends on how many females are in its harem. So, this is a study that was done in 1998, and it was clearly shown. That as the number of females in the male's harem increases, the number of fledglings, the number of young birds that you have in the nest, goes up almost monotonically. As you can see, the number of fledglings has gone from about 3 to about 12.5 or so. So, even as we discussed, even if a female mates with multiple males, she is always assured of her maternity. However, that is not the case with males. The male is always aware that the female could possibly have mated with multiple males. And therefore, a male is never sure whose sperm ended up fertilizing that particular egg inside the female's body. Therefore, a male is never sure of his paternity, and as I said, even in monogamous species, it has been shown that extra-pair copulation is actually very common.

So, even in those cases, the male is not sure whether the baby that is coming out of the female is. Do you know whether the baby is male and if it has the male's genes? Therefore, in terms of increasing its reproductive output, a much better strategy for the male is to leave a female after copulation, after mating, and then use that energy to

mate with as many females as possible. You know, it's like many of you might have seen those waffle games, right? Where you buy a ticket. And then that allows you to put one chit in a big box, and the more tickets you buy, The greater the chance that you know when they pull out a chit in a lottery, the more likely it is that your chit will be the one. And therefore, obviously, you know that you keep buying more and more tickets.

But at the end of the day, the person who is running the waffle stand is going to give it to just one person. So, that person does not lose. Anyway, that is the same thing over here for males. It makes sense to mate with as many individuals as it can and, therefore, leave as soon as mating is done. And that is one reason for which, generally not universally, Generally, when it comes to parental care, much of the time it is provided by the female and not the male.

Now, just to give you a human example of this discrepancy, if you look at the maximum number of children born to a human female, Then the record is held by this lady called Valentina Vassilyeva, who was an 18th-century peasant from Shuya, Russia, and Over a period of about 40 years, she gave birth to 69 children. Now, obviously, you can imagine that. You know, in 40 years, 69 children, and a human pregnancy period of 9 months, that does not add up. The reason it adds up here is that this particular lady had the capacity to produce multiple babies in a single birth. So, she ended up having 16 pairs of twins, 7 sets of triplets, and 4 sets of quadruplets, which is 4 babies at a time.

How is that possible? That is because, in human females, a female normally produces one egg during a particular menstrual cycle. But there are some females who have the ability to produce multiple eggs. And obviously, Valentina Vassilyeva was a person who had, you know, this multiple-egg production capacity. was extremely high in her, which is why she ended up producing 69 kids over her lifetime. Now that is impressive; it is very impressive.

But compare it to the Guinness record for the maximum number of children born to a human male. And that record is held by this man, Moulay Ismail Ibn Sharif, who was a

sultan of Morocco. And he, in his lifetime, fathered 1,127 children with 500 wives. Guinness quotes the number at 1,042, but there was a more recent study; you know, the one that I am showing you over here. which used, you know, primary sources to calculate the number of kids.

And they also asked a very simple question: Is it even possible that 500 kids were born to this person? So, they conducted a very detailed study on this, including some simulations, as well as all kinds of parameters. Based on the social conditions in Morocco at that time, they actually ended up coming to the conclusion that it is very, you know. Biologically, there is nothing impossible about this man having 1,127 kids; he could have produced more. So, how did this man manage it? Obviously, he could manage it because he was the sultan, the king; he had a harem, and he had extremely strict rules. About you, no other male ever went into his harem; he was the sole person doing all the reproduction, and so on and so forth.

Being the king, of course, he had the money to provide for 500 wives. So, this straight away tells you the order of magnitude difference. Between what males can do in terms of producing babies and what females can do. Now, with this background, we can see two concepts. The first concept is the degree of investment that males and females make biologically in terms of reproduction are very different, and therefore what maximizes their reproductive success is also different. And secondly, the females typically invest a lot more in parental care, and because of that, even after, let us say, mating has occurred, There is a much longer time before the female is available to produce a second baby. That is why even if the number of males in a population equals the number of females, the sex ratio is 1:1. The number of females that are available for mating and producing babies is typically much lower. That is why there is a concept called the operational sex ratio (OSR) which is simply the number of males available for mating divided by the number of females available for mating. And this number can actually deviate quite a bit from 1:1, even if the actual sex ratio, the biological sex ratio, is 1:1. Now, these two things lead to the third component of our story. The third component of our story is the variation in reproductive success. Reproductive success is simply a fancy term for how many babies

you produce.

Now remember, in a sexually reproducing organism, Each zygote is formed by the fusion of one sperm and one egg, right? Basic biology. Therefore, in a population, the total number of babies produced by all the males has increased. to be equal to the total number of babies produced by all the females given. Also, if the sex ratio is 1:1, which means there is an equal number of males and females, then The average reproductive success, which is simply the total number of babies produced by the males divided by the total number of males, is calculated. or (the total number of babies produced by females) divided by (the total number of females).

The average reproductive success of the two sexes has to be equal. What ends up mattering, therefore, is not the average, nor the mean. What ends up mattering is how this reproductive success is distributed among males and females. Is reproductive success equally distributed among all individuals of a given sex or not? In other words, are all of them producing roughly a similar number of babies, or is there a huge variation in that? So, I will just give you one example: this is from a species called the southern elephant seal. Elephant seals are of two types, two species: the southern and the northern, so I am showing you the southern one.

So what you have here on top is the male, and what you have below is the female. Now, I am showing you the variation in the annual reproductive success of seven colonies of southern elephant seals. So this is somewhere near the Falkland Islands, close to the South Pole. Now, here on the x-axis, you have the number of males, and here you have, in a given year, the number of pups that are born to that male. Now the first thing that you see is that you have a peak over here, and that peak is at 0, which means that most of the Males in this southern seal population actually produced nothing; they did not give birth to any pups.

Another peak over here: there was one male who ended up producing 32 babies on his own. And then in between, you have a variation. So there are about 16 or 17 males who

ended up getting one baby each. There are about 4 or 5 males who ended up having 2 babies, and after that, you know it is just a spread. Why is this happening? This is happening because seals have a harem system.

The largest elephant seal typically ends up fighting with all the males, cornering all the females, and mating with them. Now, if that were to be the case, then you actually expect that almost, you know, the 0 part is expected. This high number is expected. Why am I getting a variation? You are getting a variation because there are some males that are much smaller than the large alpha male, but they are sneaky mates. So, while the male is fighting, another male will go and mate with the female.

So, some of these sneaky mates end up getting some reproductive success, but otherwise, it is pretty bimodal. If you are a harem owner, you have lots of babies; if you are not a harem owner, you have nothing. So this is in the context of just one year. Is this what happens over a lifetime? Because, after all, what matters is lifetime fitness, right? So if you want to look at lifetime reproductive success, now we are looking at the northern elephant seals, the other species that happens to be there in the northern hemisphere.

So, there again, most males will produce zero offspring. Some will produce between 1 and 20, a few will produce between 40 and 50, and a few will produce between 80 and 100. So the range is between 0 and 100; that is a huge range. Now, what happens to the females? Again, most females will also produce 0 offspring, but others are going to produce between 1 and 10 offspring, as you know. Falls off like this: more will produce 1 baby, fewer will produce 2 babies, and even fewer will produce 3 babies, etc. But everybody else is going to produce between 1 and 10, so the range is between 0 and 10.

Now, because of that, what is happening? The variation is less in females; the variation is greater in males. Remember, for any trait, the larger the variation, the greater the scope for selection. Similarly, even in this context, the trait here—I mean, it is not a trait; the thing that is really being operated on is what selection is operating on. There is variation

in reproductive success, and therefore There is a greater scope of selection in males than in females in this species. And this leads to our concept 3 that you remember we asked: you know, who is being chosen, which sex is going to face the music of sexual selection? And the answer is that the sex with the greater variation in reproductive success is. will be the one that experiences the stronger sexual selection and will be the one on which the choice operates. Often, not always, but very often, these are males. Of course, the converse of that is that the sex with the lower variation in reproductive success will experience weaker sexual selection. And they are the ones who will more often end up choosing; often, but not always, it is the females.

And this concept is that who chooses and who gets chosen depends on the variation in reproductive success. This is what is known as Bateman's principle, named after Angus John Bateman. Great. So, given Bateman's principle and what we discussed, there are two major types of sexual selection. One is what is known as intrasexual competition, where the competition is between members of the same sex.

Typically, the members of the less limiting sex, who are usually the males, They end up competing with each other for mating opportunities with the limiting sex, which is typically female. So, because it often happens like this, it is often referred to as male-male competition. But remember, you can also have intrasexual competition among females. Similarly, you have what is known as intersexual competition, where members of the limiting sex. Again, females usually end up discriminating between members of the less limiting sex, which means males.

In this particular case, the female ends up choosing which male she wants to mate with, and that's why it is very often called female choice. Again, remember that you know this is not always a female choice. Sometimes, if the female becomes the less limiting sex and the male becomes the limiting sex, this can end up reversing. But typically, intersexual competition takes place in the form of female choice.

So, now what we will do is look at a bunch of examples of sexual selection. In the

process, discuss the patterns that they end up explaining. Remember I told you that sexual selection will, you know, be the answer to many things that we observe in the natural world. So, the first thing that we are going to look at is the context of direct fights. So, again, going back to the northern elephant seals. So, here in this picture, this big thing over here is the male, this one over here is the female, and this one over here is the pup.

Now forget about the pup; it is a juvenile, but just look at the male and female. Can you see the huge difference in size between the male and the female? So, in this particular species, the males can be up to three times larger than the females. Now, one can obviously ask why that is so and what is leading to it. So, as we talked about, the males fight each other to establish harems of females, and these are very brutal fights, you know, with lots of blood, gore, and everything. Now, generally, it is the size of the body that matters in the context of these fights. So, the bigger males have a much greater chance of winning this competition, which is why it is thought that they will succeed. There is a very strong selection for increased body size in the males; therefore, they have been selected for that. If you want to see what I mean by saying that you know the fights are brutal, Here is a YouTube video that I would like you to check out; it is very well done, and the fight is really awesome. Another major observation in the biological world is the presence of oversized organs.

In many organisms, we find it; so, I will give you just two examples. So, what you are seeing here is the so-called harlequin beetles. So, these are neotropical beetles, and what you can see over here is insects, right? So, all insects have three pairs of legs. So, these are the two hind pairs of legs, but look at the front pair; look at how enormously large these legs are. So, why exactly are these eggs so large? So, it turns out that the females of these particular species end up feeding on sap that comes out of fallen fig trees.

And these trees, you know, are very far apart from each other in the forest. So, when a female comes to eat the sap from a tree, it essentially ends up mating with whichever male is available. Therefore, these males actually compete with each other to take control of the territory, which in this case is these trees. And it turns out that when they fight with

each other, the males that have longer legs, They actually end up having a greater chance of winning the fight. So, the long legs essentially allow the males to establish territory. The establishment of territory goes hand in hand with obtaining females in this particular case.

Similarly, these are the famous elk or wapiti, deer in Europe, Asia, and America. So, you can see that they have extremely elaborate horns, which they use to fight each other to establish the harems. So, many deer have a harem system. So, these bulls can maintain the harems only if they are able to win the fights. And in order to win the fights, they need those very elaborate and dangerous-looking horns.

Now, it turns out that there is a very serious cost to having these hordes. It is not simply, you know, mating; therefore, it is otherwise costless. So, just to show you the cost of fighting in one species. So, this is the red deer, *Cervus elaphus*; this is *elaphus*, and this is what the male looks like; you can see its antlers. If you look at the mean number of calves per year for the males, this is on the y-axis; on the x-axis is the age of the males. So, what you see is that during the first four years of its life, it is still sexually immature.

So, you know it is not producing any offspring. Then around this time, it becomes sexually mature, but it is still small in size; the horns have not yet grown properly and therefore, All it can manage are some sneaky matings, which is why it has a very low, you know, number of babies it is able to produce. And then you can see a huge jump over there, right? This is the period during which it has grown up, its horns have become bigger, and It has now started fighting with the other dominant deer and has begun edging it out. So, this is the duration during which they will typically end up getting a lot of mating. But then, during this period, they also end up sustaining all kinds of injuries.

And also, this speaking period does not last very long. There are other males who are doing the same, and once those males defeat these guys in battle, they become sneaky masters. So, their reproductive success goes down, and most of them actually cannot live with the injuries for very long; therefore, By year 13 or 14, their reproductive success has

decreased significantly, and essentially they do not survive beyond that point. So, again, you can see the huge variation in terms of how many babies the males are producing year by year. Now, let us look at the case of the females. So, this is what the females, or the hinds, look like, and if you look at their reproductive success, Again, this is the sexually immature part; not much is happening over here.

This is the sexually mature part, and if you look at it, they attain it around the age of 4. After that, it is more or less a straight line. So, they end up having a more or less constant reproductive output from year to year. And, more importantly, look, it is going up to age 17; actually, you know they live even slightly longer. So, they are able to produce babies for a much longer time simply because they are not getting injured. So, these two things that we saw are the eye-catching stuff, whereas much of the sexual selection is not.

Much of what is happening in the natural world is due to the female's choices. In many cases, when the female chooses, there is a very direct benefit that she receives. So, you know, part of today's discussion is mostly taken from Table 11.2 of Zimmer and Emlen's book. They have extensive references for each one of them, but since we do not have that much time, we cannot go into the details of everything.

I am dropping the references; I urge you to go back and check out those papers if you want to. Or you can simply take the names of the species that I am talking about and, you know, do some Google searches. You will get very nice videos, photos, etc., for most of the things that I am going to talk about. So, what are the various kinds of direct benefits that females can get by choosing? Again, going back to elephant seals, remember I told you that there are these big, heavy alpha males? The harem owners and there are others, the sneaky guys, right? Now, the sneaky guys are always trying to mate with the female, and they are always, you know, basically troubling her. They are basically harassing the female, and in the process, they actually end up injuring her in many cases.

So, if the female gets associated with a large protective bull seal, then It can actually protect itself from all these injuries, which will obviously increase its reproductive

success. So, protection is a straightforward and simple benefit that females receive. The second major benefit is in terms of the territories on the nests. Remember that if the female has to raise her babies, she is going to need the resources, or if it is going to raise the babies, it will need a nice protective nest. And in many cases, the males try to entice the females by providing them with the best nests or the best territories. So, for example, male frogs end up assessing the quality of various sites, and they try to get the biggest and the most productive site and then they hold that territory and then females come. Judge the various frogs based on the territories they hold and the ones that have the best egg-laying sites. Very often, they end up being chosen, and therefore, they end up getting a greater number of mates.

Similarly, Baya Weaver birds in India, most of you would have seen them. Here, the females come. Inspect the nests that the males have made, and whoever makes the best nest will end up getting the mate. Similarly, in the case of deer, the issue in this particular case is about how much forage is available. How much food is there in the territory, and which antelopes end up holding territories with the best forage? They end up getting more attention from the females. Then it comes to food, a direct gift of food.

So, there are certain species, for example, the scorpion flies, where the males will actually present. The female has a dead insect or some other food item, and she will inspect it. and if she likes the quantity and the quality she is ready to mate otherwise it is not happening. An even bigger example is the hanging flies; they are amazing. So, they copulate while hanging and the male has to give some dead insect or dead insects to the female. Now turns out that the female is going to copulate while she is eating that insect. And as soon as the dead insect is gone, she will fly away.

So, the larger the insect or the greater the number of insects that the male hanging fly gives to the female, the longer she is going to spend in eating and the more the opportunity that the male is going to get to copulate with her. So, in this particular case, the female is directly, you know, choosing or rather giving greater mating opportunities to them. Who can give the female a larger amount of food? Similarly, in many cases, the

males offer their bodies or parts of their bodies to the females. So, in crickets, for example, it is the fleshy hind wings of the males that are significant.

Female crickets like to chomp on which during the process of mating. And this, of course, is taken to an extreme. Sorry, this is another version of this in the context of bush crickets. I mean many insects do it; katydids do it, and bush crickets are good examples, where the males go. Actually, produce proteinaceous blobs known as perimetophyllax, and then present them to the females. So, the females eat them; this increases the protein content of their bodies, and of course, You know, in return, they allow the males to mate with them.

And this process of, you know, offering a part of their body is taken to an absolute extreme in praying mantises and redback spiders. Where, you know, as soon as mating starts, the females actually start eating the males, and the males actually do not object. In fact, it keeps the female busy eating the rest of it. While the male genital organ is still continuing copulation and pumping sperm inside the female, So, it ends up, quote unquote, looking like it is sacrificing itself, but evolutionarily speaking, it does not matter.

Because it has the chance to mate and pass its genes to the next generation, it will do so. Then help in parenting comes. Many females choose based on whether the male is able to assist in raising the babies or not. So, for example, sculpins are fish, and in these fish, the males need to. The males tend to guard the eggs laid by the females. And typically, there is a strong correlation with body size: the larger males are the ones who are able to become better bouncers.

And it turns out that the females end up preferentially mating with those that are larger in size. Will become better egg guardians; a similar phenomenon is seen in stickleback fish. Here, the physiology is such that the eggs cannot be simply laid on the surface of the pond's soil. So, what happens is if you keep the eggs just like that, then A) they will not get oxygen, and B) there will be algal growth on them. Therefore, in this species, it is the

duty of the male to continuously stand on the eggs.

And basically just fan its pectoral fin like this, and in the process, you have a stream kind of being produced there. It is exactly like what happens in the aquarium. You have seen those bubbles, right? There is a motor that produces the bubbles, and the whole idea is to increase the oxygen supply. The same thing happens over here. By doing this, it increases the oxygen supply to the eggs.

Also, by continuously agitating the water with its fins, the male does not allow the algae to grow. Now the point here is that you have a chicken-or-egg situation. How will the female realize who is a better egg fan before mating? Because, obviously, once you have done the mating, if the father turns out to be a poor egg fanner, that does not help the mom. So, in this particular case, it turns out that there is a very strong correlation. With how much the male shakes its body while courting the female before mating, and how much it is able to do the egg fanning. So, if it is able to move its body more during the courtship behavior, then it is going to become a better egg fanner; therefore, The females end up choosing those males that are able to, you know, gyrate more during the courtship process.

A similar thing happens in the context of pied flycatchers. These are birds, and here the males have to provide for the females and the babies while they grow up. When the babies are growing up, females tend to prefer individuals who are likely to provide more food for the babies. But how will you figure out who is likely to provide more food before mating? So it turns out that older males who are more brightly colored are more attractive. They are the ones who end up doing a much better job of feeding the babies.

And it looks like the preference in this particular context is for the females to prefer the more brightly colored males. who also happen to be the ones who are, you know, in tough physical condition and the ones who are older. Therefore, the ones who end up feeding more to the babies are. So, the females are choosing for the color; as far as you know, we can see brighter colors. The color itself is an indication of the age, which indicates how

good it will be in terms of feeding the babies.

So, at the end of the day, the female is perhaps making an indirect selection. But it is helping to get the female a greater amount of food for her babies. And finally, in many cases, it is very important to have healthy partners because only they can protect you. Only they can end up giving food to your babies and so on, and it turns out that there are situations where the females end up choosing traits that are actually indicators of their partner's health.

So, for example, if you look at the jungle fowl, they have nice red combs on their heads. So, the females end up choosing the males that have larger combs or more brightly colored combs. And people have shown explicitly that the size and color of the combs depend on the parasite load of the male birds. So, those birds that have a larger parasite load are not able to maintain a large comb or a bright red one. And therefore, just by looking at the color and size of the comb, you can make a reasonable guess of what is the parasite load in the males.

And that is what it seems the female has chosen. When it chooses larger birds with larger combs, it actually ends up gaining access to healthier males. So, in all these cases, it is pretty obvious what kind of benefit the male is receiving and what kind of benefit the female is getting; it is very direct. Therefore, although these are very interesting observations and their explanations, conceptually speaking, they are simple. Females receive a benefit, and therefore, they choose that benefit.

However, there is a large number of cases in the context of sexual selection where the benefit that the female is receiving is not easy to figure out. So, for example, you know that in many species, the males are doing very elaborate dances or courtship rituals, or they have very showy ornaments. So, I will give you a few examples. This is the Indian Paradise Flycatcher, and you can see the long tail that it has. It looks absolutely beautiful, but from an aerodynamic perspective, it is absolutely terrible for this flycatcher: the male flycatcher.

Similarly, you know that many lizards have this flap-like thing below their necks, which is known as the dewlap. And what they do during mating, as you can see over here, is swell this thing and make a display. Now, as far as one can see, there are no known benefits to choosing a male with a longer tail or choosing a male with a larger dewlap. Of course, in some cases, as I showed you with the jungle fowl, you know there is a correlation, but what we are talking about is the fact. That there is no known correlation between this size and, you know, the body condition or anything else in the female or the male.

This is an even crazier situation. So, what I am showing you here are flies known as stalk-eyed flies. Now, in this particular case, you can see that the rest of the insect looks very simple, but. In the head, it has two stalks, and the eyes of the insect are actually at the ends of those stalks. That is why they are called stalk-eyed flies. And it turns out that, I mean, you can see it right here, right? The size of this stalk or the total length of this stalk, end to end, can be larger than the entire body length of the males.

And it turns out that females actually prefer males who have longer stalks. Why? I mean, what benefit is having a longer stalk giving to the female? And then you have these tremendous displays; this is the, you know, male peacock trying to woo the female peahen. And I am sure many of you have seen that this is a male bird of paradise doing its courtship dance. So, these are cases where they are doing it singly, and then you have this craziness. So there is a very nice video that shows you the courtship display of birds of paradise.

If you have not seen it before, I strongly recommend you go and have a look at it. It is beautiful, absolutely beautiful, and amazing. And what is even more amazing is the second part, which shows you the preparations. Which goes on before the male does that dance, and that is, you know, another mind-boggling piece of work. So, all this stuff that I showed you is when the birds dance by themselves.

But there are certain situations where they actually display in groups. So, this is what is known as lekking. So, here I am showing you a bird known as the Greater Sage-Grouse. So, you can see that there are two kinds of birds: those that are standing with their tails, which are organized in spines like these. These are the males, and then you can see that these ones are much smaller and not at all flashy or showy; these are the females.

So, it turns out that these males gather together in an area like this. And it is a shared display area; this area is what is called a LEK. And then all these guys are just going to do very intricate moves, dances, and so on. And the females are going to visit these leks; they will inspect each male very, very closely. And then, at some point, they will choose their mates. So, again, if you have not seen lekking before, I strongly urge you to take a look at these two videos from the Cornell Lab of Ornithology.

And what you will see is that it is not mere showing off; you know there are very intricate patterns. There are very intricate things that the male bird is doing, and they also show how the female is responding to all of this. So, it's very interesting. However, the question that this leads to is a rather problematic one. As I said, as far as we know, many of these flashy organs or dances do not seem to benefit the female.

In any direct way, and in many cases, it is not even certain what information the female is receiving from them. So, if that is the case, we know that the female is making an active choice. It is choosing the one in many cases you know has the brightest feathers or the longest feather or whatever. Why exactly is the female making these choices? Is it really the case that there are no benefits? If that is the case, then why has this thing evolved to begin with? So, there has to be some benefit or some mechanism somewhere. This will explain why this particular thing is so prevalent in the species. What that benefit can be is what we are going to discuss in our next meeting. See you, bye.