

## Ask a Biologist Vol 003 (Guest Bert Hölldobler)

### **The Social Nature of Nature -**

An interview with, biologist, movie maker, and Pulitzer Prize winning author Bert Hölldobler. Venture into the world filled with amazing facts and feats by an animal that will remain a mystery... at least until you listen to the clues at the beginning of this episode and make your own guess.

### **Transcript**

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**Dr. Biology:** This is Ask a Biologist, a program about our living world. I'm Dr. Biology. I'd like to start our show a little differently today. We're going to have a kind of game. We're going to have our listeners try to guess what animal our guest scientist has spent most of his life studying and writing about.

So let's begin with a few hints. All of these animals live in communities. You know, your school is a community, your towns, cities. These are communities. Also, some of these animals are known to grow gardens and are excellent harvesters.

Some of these animals are weavers of silk, while others are referred to as carpenters. I actually have an uncle that's a carpenter.

There are some that are feared because of their armies, which can be as large as 700,000, while others store sweet nectar similar to honey. There are even groups of these animals that maintain slaves to this day.

Have you guessed it yet? How about, maybe just a couple more hints?

Some of the animals are able to lift things more than 10 times their own weight. For you and I, we could actually lift, if we could do the same thing, 2000 pounds, which would be a ton, literally, and carry it for miles.

Oh, one last hint. Many of these animals can literally walk on water.

So have I stumped you? Have you guessed the animal yet?

If you came up with visions of ants, you're correct. And today our guest scientist is Bert Hölldobler, a professor in the School of Life Sciences and a member of the Center for Social Dynamics and Complexity.

Hölldobler has been studying and writing about ants for more than 50 years. He has authored and co-authored several books, including one simply titled "The Ants" that he co-authored with Edward O. Wilson, and which was awarded the Pulitzer Prize in 1991.

Welcome to our show, Professor Hölldobler.

**Bert Hölldobler:** Well, I'm happy to be here.

**Dr. Biology:** For some of our young listeners, I want to mention about the Pulitzer Prize. It's one of, if not the most prized literary achievements in American literature. It is quite a great honor, and what some people might consider about an unlikely subject: ants.

Can you tell us a bit about writing a book and the collaboration process?

**Bert:** Well, Ed Wilson and I were both professors at Harvard University. We shared several laboratories. We had separate research groups, but we often met for lunch.

From our conversations, of course, we developed a mutual liking. We knew we are both interested in ants. So one day we said - I think it was about 1986. When we said, wouldn't it be great if we could write down everything the world knows about these little creatures, the ants.

In fact, they are little, but you know, many people don't know. If you weigh all the ants on this earth, if you just could calculate this, how much the ants weigh. And you compare it to the weight of all the humans, the ants are almost of the same weight, of the same mass, as all humans.

**Dr. Biology:** Really?

**Bert:** So they are little, but they are quite heavy all together. And there are many, many different species of ants. We estimate about 20,000 species. This is a lot.

So Ed Wilson and I, we have different talents which are very complementary. And we said, look. If anyone can do that, that's us. So we sat down and started writing. We wrote for almost four years, with interruptions. We never thought the book, the final product, will weigh seven pounds. A very heavy book. A large book.

But we made it. And I tell you, sometimes still when I look at the book, and Ed Wilson does the same, we say, how did we ever do it?

**Dr. Biology:** You also collaborated with E.O. Wilson on another book called, "Journey to the Ants." It's a good resource for young scientists. It includes a chapter on building and keeping an ant colony that I recommend to anyone that wants to experiment with ants. What got the two of you to write this book?

**Bert:** Well, this book to write was really fun, because after having written "The Ants", which is a book for scholars. And this is why we were so surprised that we got the Pulitzer Prize. In fact, this is the only scientific work which ever was awarded the Pulitzer Prize, up until now. Because it's a book written for scientists.

This book, Journey to the Ants, we wrote for the interested layperson, and for children. They may not understand everything, but we tell the story of discovery. How we as little boys were interested very early in ants and in bugs, and how Ed Wilson and I never left the bug period.

We are still like kids when we look at the ants and observe them. And we wanted to tell

the people how fascinating this world in the ground is. This was fun to write. So we could write it out of our heads. We didn't need much literature.

And I actually am very happy about this book, and apparently other people too, because it was translated I think now into 13 or 14 languages.

**Dr. Biology:** Wow. 13 or 14 languages. Amazing.

Well, I always like to talk a little bit about growing up with our scientists. Because everybody has a little different path. I recently learned that your father was what we call a classic naturalist of his day. He was trained as a physician, and also very interested in the natural world around him. So my question is, was he your entry into the world of biology and the study of ants? Or was there some other spark?

**Bert:** I think my father was clearly my first biology teacher in many ways. He tried - you know, my father earned his money, as you say, as a physician, as a surgeon. But his love was nature. Particularly the insects. But he was really an all around naturalist, remarkably broad in his knowledge.

I have four siblings, and he wanted to ignite this love for nature in all of us. He succeeded in two of us, and maybe in three. My younger brother loves nature, but he didn't turn on to biology. So it's not necessarily always that you have a parent who is very excited about that. It has to be mutual.

So my interest, very early, as far as I can think back, was biology and especially animals. My father clearly had a great influence.

I remember a key experience I had. I must have been about seven or eight years old. My father was drafted as a young surgeon in the Second World War, and served up in the east front in Finland, Carelia.

And he was home for a furlow and we made a summer, or was it an early spring walk through the Bavarian woods. It was his habit to turn around rocks to look what is underneath.

I literally still remember the spot even, he turned around a rock and there was underneath a wonderful colony, a whole society of the shiny chestnut brown carpenter ants. The largest ant in Europe.

It was just amazing, these ants running around grabbing their larvae and pupae, the eggs, and disappearing underground. A whole society has revealed itself to me and from that moment on I was hooked on ants.

Now my father studied ants, and in fact this big book there are several citations of his work, so he published some remarkable papers in the 20's and 30's. But I kept all sorts of animals, you know, fish, a fox, I tried to cross a fox with a dachshund which of course was a failure.

**Dr. Biology:** [laughter]

**Bert:** But they grew up together this fox and the dachshund and the fox was a great pet. We had birds whenever there was a bird with a broken wing people brought it to my father.

He was not only a surgeon he could also fix broken wings of birds. And the birds were nursed up in our house. So you know, I grew up with animals. Even in the horrible time of the war, nature was my place where the world was sane and peaceful.

**Dr. Biology:** Your escape so to speak.

**Bert:** My escape. The woods, my brook where I caught tadpoles and watched them, released them again into the brook. And when I saw all the sad faces of my adults, relatives, and around us, my happiness was in the woods, out in the woods.

So you see I very early, the biology genes must have been in me you know. I was very early imprinted. Indeed you said it right, my father and a very very tolerant mother.

I must say, without my mother's patience, bringing in all these animals, it would not be possible. And I'm so grateful to my parents.

**Dr. Biology:** I think that's wonderful and it's also rather interesting talking about the escapism. I think a lot of the students today they might escape in a video game.

It would be fun just to get them to go out and try to escape in nature. And even in the big cities nature exists.

**Bert:** Absolutely.

**Dr. Biology:** We'll talk a little bit more about that. While we're talking about this spark and getting students interested, I wonder if you could recommend or suggest a simple experiment with ants that could be done in the classroom or at home.

**Bert:** Yeah, in fact, the most important part is to pick the right ant species which you can easily keep at home in an artificial nest. Because not all animals, all ant species are suitable for that.

The carpenter ants are usually pretty good, the harvester ants, which you have here in the southwest, these are the ones you usually get in ant farms. You know, they can sting in there, for really bad stings, I would not recommend you use them.

But I suggest even an experiment if you are, which you don't have in the lab or in a classroom or at home, if you are out and you see an ant trail, which you often see. Tiny little ants actually walking along long trails, very precise.

Just make a little experiment. Wipe over the trail with your finger three, four times and watch what happens. The ants will stop exactly at the spot where you had your finger,

will turn around, will search in loops, and it takes them quite a while before they can overcome this barrier, invisible barrier which you have created.

Then you wonder, what did you do? In fact what you have done is you have interfered with the language of the ants. The ants have a fantastic communication system. They speak, so to say, not in words or sounds but they speak with chemical signals, with chemical words.

Let me say, ants are little chemical factories. They are full with so called glands where they produce all sorts of substances. And when they want to communicate, to tell a nest mate something, say there is danger, they release a particular substance.

Sometimes we can smell it with our nose, sometimes we don't. But the ants can smell it. Their noses are on their antennae. They can smell these and actually when they receive this particular substance, which says alarm, they will immediately react.

Some rush by to help the nest mate, others will also give this signal to alarm other nest mates. So for example when they have discovered a new food source in your kitchen, for example, a great pie, some ants, some scouts discover it, run home and lay now a chemical trail.

They lay a trail with minute amounts of a substance you don't smell, but the ants do. And then the others, the nest mates rush out along this trail and find the pie. And those which have found it, and love it, will also lay a trail so the trail gets heavier.

**Dr. Biology:** Heavier?

**Bert:** And so when you wipe over this now column of ants you have destroyed part of this chemical message.

**Dr. Biology:** Their phone line so to speak.

**Bert:** And this is actually a nice experiment. Then you can actually try, can I replace this? You may then take ants, you know first you put them in the freezer of somewhere or you kill them softly.

And then you crush certain parts of the ants and with a little wooden stick you draw the crushed body parts over the trail you have interrupted, you will find out where the trail substance comes from.

The lower part, and the middle part, and the head, and find out where the trail pheromone, we call it pheromone, this trail signal comes from.

**Dr. Biology:** I think that, well actually that would be an excellent way to get started, and something that I wasn't aware of, be a fun experiment.

It also explains maybe, at least explains partly, when you go out for your picnic and the ants always seem to show up. Not only do they communicate that way, but they must do it very rapidly.

Because your not there very long and all of a sudden the ants are able to find it. One of the other things I like to do is break down stereotypes. A lot of people have visions of scientists, they describe them as men, and now sometimes they'll put in women.

And they should be men and women and young students. But they're always wearing white coats and they're working with test tubes and beakers. So what I like to do is I like to describe a couple of things, especially a couple of pictures that I've seen of you.

The first one is of you laying flat out on the ground, and we're talking out in the dirt and the grass and you have this cinematography camera and you're filming ants. What I'd like to know is, can you tell me, or our listeners, a little bit more about what you're doing, and are cameras an important tool for your research?

**Bert:** Well, yes they are. You know I'm a behaviorist. I study animal behavior. And behavior is of course motion. And you can make photographs of course but you never catch the motion.

So in order to analyze in detail the motion of these tiny little ants, the best tool is first to film them and then when you analyze it, when you really study it, you slow the whole thing down and you look from frame to frame in the movie sequence. But also the movie work, especially if you do close ups, they tell you a great deal of what the naked eye cannot see, even with a magnifying glass.

The eye of the camera which enlarges the whole scene is so accurate. So when we then look at the movie screen or now of course, we do it on a computer screen, we can see details which the eye would not see without a tool.

So indeed the picture you saw is probably the one where I am on the ground in one of the southwest deserts watching some territorial behavior. And what I do, I'm in the middle of these ants, I lie down and they consider me almost motionless.

Lots of patience is needed, and they consider me as part of the landscape. And I just move slightly and record in close up their fantastic behavior.

**Dr. Biology:** So do you get stung while you're doing this?

**Bert:** I very often do, and you know these field biologists they take all sorts of, countless insects stung me and bit me. [laughter] But you literally forget this when you are in the middle of it.

My work is about 30% in the field and 70% in the laboratory. We get our ideas and the questions we want to ask, to understand life around us, in the field. So I'm a guy who wants to understand the nature of behavior outside, not a laboratory animal like a mouse or a fruit fly.

I want to understand how they interact in nature. But then really to understand what I just said, for example, the chemical communication, the chemical words, I have to bring the

whole system into the lab.

And I'm partly also a chemist. In fact I am, my second major is chemistry. And so I want to know what substances do they use. But this is the laboratory part, or when I want to understand how the brain works.

These ants, these tiny little ants have complicated brains with a million brain cells. Just imagine this little head. But when you really look with a microscope at it, they have fantastic brains.

So this is all done in the laboratory. But I would never want to miss the fieldwork.

**Dr. Biology:** Right, right. I think I hear that from a lot of what we would call field biologists. But I'm also noticing this fusion.

**Bert:** Right.

**Dr. Biology:** Where you want to learn, and I think actually it seems like the spark and all the fun is out in that field. And then the details and the things that you're learning out in the field come to the forefront if you can bring them into the lab.

The other image that I noticed, that I just was fascinated with when I first saw it, it stuck in my mind. You were, basically, it looks like you were on an archaeological dig for some ancient ruins of a lost civilization.

You're standing deep inside a hole, you could be ten feet underground, it looks like, and it's maybe 90 feet around. Just what are you doing?

**Bert:** Well, of course, the ants, most ants species not all, but most have their dwellings underground. And when we want to get colonies, whole colonies, into the laboratory, or at least major parts of the ant society into the laboratory, we do have to get the queen.

Without the queen the colony will not exist. This is the only individual which reproduces, which makes new ants. So in order to get these we have to dig down. This is one reason why sometimes we dig down deep until we find the queen.

Once we have the queen we don't need all the workers but then we have a healthy colony which we can bring into the laboratory and then give them the best settings we can provide.

And they will flourish. But another thing, and this is not my main research, actually there is a wonderful professor at Tallahassee who studies the nest architecture of ants. This is Walter Chinkle.

But we did it for an ant colony which builds gigantic nests. The nests take an area of about fifty square meters and go down eight meters deep. So you have to translate this into foot and inches, but in order to understand the architecture my colleagues did the

following and I was involved in that.

They poured in cement, liquid emulsion of cement. And they used 10,000 liters of water and six tons of cement to pour down.

**Dr. Biology:** Six tons?

**Bert:** Six tons.

**Dr. Biology:** Wow.

**Bert:** Mixed with 10,000 liters of water. And then they waited for three weeks until the whole thing petrified, literally solidified. And then the digging began.

It took weeks and professional diggers, mechanic diggers were needed. But then the rest had all to be done by hand. And the whole fantastic structure, unbelievable structure, came out. Beautiful looking.

**Dr. Biology:** A piece of art.

**Bert:** A piece of art.

**Dr. Biology:** Yeah.

**Bert:** These long channels with highways under, subterranean highways coming in, with living chambers, with debris chambers, just incredible, all now in concrete, a huge edifice.

**Dr. Biology:** I wanted to talk about the movie.

**Bert:** Yes.

**Dr. Biology:** The documentary, and I think this was actually in that.

**Bert:** This is correct.

**Dr. Biology:** So the movie actually called “Ants, Nature's Secret Power.” That was kind of interesting, because it won the special jury prize in 2005 at the Jackson Hole Wildlife Film Festival, which, for those that don't know about it, is kind of the Academy Awards of documentary films.

This is another nice thing about scientists. You don't necessarily always have the same path, and you're not necessarily doing something that could be what some students might think dry or boring.

Here you are, you're making a film. Did you ever imagine you would be part of a documentary about your favorite animal?

**Bert:** Well, I have to say, my research was featured in several documentaries in German television and British, and also some American, Nova programs and so on. But this



movie was entirely focused on my research, and I had to, I was the architect, so to say, of the scientific contents.

What was for me so intriguing - I have to say, I have great ambition for public communication. Some of my books I have written were for the public, and also I like to do that. But I've never done it in the form of a movie with my own total impact.

And so I was interested to make a movie with a fantastic cameraman, Wolfgang Thaler. Outstanding artist. I wanted to show how we scientists, just as I said, go out into the field and get the ideas, the problems, by watching the animals close up.

But then we bring it in into the laboratory, and we use really high tech approaches to listening in to the codes, the secret communication systems. We have the whole society. It's like a Martian coming in from outside and looking at a society which appears alien to us.

And now taking our techniques of physics and chemistry, and figuring out how these little creatures can do all these things. Cooperate to do unbelievable things. And I wanted to show this to the layperson and to children in a movie.

That the movie became such a success is an absolute joy to me, because we accomplished what we wanted to do. But the credit is all to this fantastic cameraman.

**Dr. Biology:** Yeah, it does make a big difference.

**Bert:** It makes a big difference.

**Dr. Biology:** Earlier in the program, I was talking about how much ants can actually lift. I was very, very careful. Actually I underestimated quite a bit. Because we've talked about this, because I said they could lift ten times their weight.

Actually in the movie, you have a nice scene in there where the ants lift, actually, was it up to 100 times?

**Bert:** No, what we have is - this is remarkable. Just imagine. An ant stands upside down, or hangs attached with their claw, on a glass - on the smooth glass, upside down. And we managed to give these ants, in their jaws, a piece of metal which weighs 100 times as much as the ant does. The ant grabs this metal and holds it, hanging upside down on the smooth glass.

**Dr. Biology:** 100 times.

**Bert:** 100 times of its weight.

**Dr. Biology:** Fantastic. And this is what we think about. It's the simple ant, but it's not simple in any way. It's actually fascinating.

When did you know that you wanted to be a scientist, or a biologist?

**Bert:** Well, you know, every child has dreams of what they want to do as a profession. And many people say, I want to be a railway engine driver or a pilot or anything. I had from early on three likings. I still have them. Either to become a naturalist, a scientist naturalist. This was, as I said, very early in me, or to become an artist painter.

I loved to paint as a little kid and I still do. Art is my hobby, or to become a farmer. These were my - and I still am interested very much in farms. I go sometimes into farms, and I like to see a well run farm. I'm more familiar with the German farms.

But I needed a farm, and I had no farm in my family, so I couldn't become a farmer. I didn't want to be a theoretical agriculturalist. With the art, I discovered, fortunately, my own practical talent is not as great that I can make a living on that, but I do love to do art still, or of course, but I love to go to museums and galleries.

And so I chose, luckily, as a profession, biology. And I combined it, biology and chemistry, which, I'm very happy with my profession. And I'm very happy with my hobby.

**Dr. Biology:** For young scientists out there, do you have any advice, simple?

**Bert:** What I always say, to everyone of the young graduate students or young students who come to me, children, I say do what you really love to do, and do it as well as you can.

When I started to study biology, many people said, oh, the market is full. There's not a good chance for biologists, and you should choose something else. And I think that was a little bit the reason why I also picked chemistry. But I am very happy that I did this. It was an ideal combination.

When I finished, there was a need for biologists. So never look at the market, really. Do what you do, and do it as well and with great enthusiasm. Just become a workaholic. Because when you love what you do, you become a workaholic. You don't ever stop doing it.

**Dr. Biology:** Well, it's not work anymore.

**Bert:** Yes, there's no work anymore. I tell you, I just wanted to say: I cannot make true vacations. I cannot sit down or lie on a beach. I have to walk on a beach and collect either stones or shells. And then I take a book and identify the shells.

This is for me, vacation. Going out collecting ants and watching ants, is for me - I get tired when I do the usual vacations. Lying in the sun. But I never get tired being out and collecting, watching, making notes.

**Dr. Biology:** Excellent. Thank you for visiting with us today.

**Bert:** It was my pleasure.

**Dr. Biology:** You have been listening to Ask A Biologist. My guest has been Professor Bert Hölldobler from the ASU School of Life Sciences. The Ask A Biologist Podcast is produced on the campus of Arizona State University.

Even though our program is not broadcast live, you can still send us your questions about biology using our companion website. The address is [askabiologist.asu.edu](http://askabiologist.asu.edu). Or you can just Google the words "ask a biologist."

I'm Dr. Biology.