



George Poinar Oral History Interview, October 23, 2014

Title

“Studying Ancient Life Preserved in Amber”

Date

October 23, 2014

Location

Poinar residence, Corvallis, Oregon.

Summary

In the interview, Poinar discusses his grandfather's immigration to the United States from Romania, his father's career in music, his own early interest in natural history, and an influential summer job that he held on a farm in Iowa. From there he recounts his decision to attend school at Cornell University, his academic progression from ornithology to botany, his early scientific mentors, and his first academic position at the University of California, Riverside.

Poinar next describes an important trip that he took to Europe in the early 1960s, during which time he collected his first amber specimen, and speaks also of other memorable travels, including a visit to the Soviet Union later on in the 1960s. From there he recalls his move to the University of California at Berkeley, his involvement with the school's Insect Disease Diagnostic Service, and additional trips that he took to Africa and various tropical countries to conduct studies on nematodes. He notes the environment at Berkeley during the years of the Free Speech Movement and likewise discusses Berkeley colleagues that were important to him during his years there.

The session then shifts focus to Poinar's groundbreaking research on long-extinct insect and animal species preserved in fossilized amber. In this, he shares his memories of the means by which he came to focus on ancient amber as an area of study, recalls some of the adventures that he had while travelling the world in search of amber specimens, discusses his process of selection while on location, and likewise shares the details of his techniques of analysis once returned to the laboratory. He also reflects on his specific pursuit of DNA samples and recalls his encounters with Michael Crichton during the author's writing of *Jurassic Park*.

As the interview nears its conclusion, Poinar reflects on his retirement from Berkeley and his relocation to Corvallis, his collaborations with OSU scientists, and his work with the OSU arthropod collection. He also shares his thoughts on specific discoveries that he has made - including his research on extinct flowers and on the biology of ancient termites and giant fleas - as well as the theories that he has put forward, particularly his idea that insects and parasites contributed to the extinction of the dinosaurs. The interview ends with Poinar offering his perspectives on working closely with his family members, changes in his methodology over time, and possibilities for the future of paleoentomology.

Interviewee

George Poinar

Interviewer

Chris Petersen

Website

<http://scarc.library.oregonstate.edu/oh150/poinar/>

Transcript

Chris Petersen: Okay, Dr. Poinar, if you could introduce yourself with your name, and today's date, and our location?

George Poinar: George Poinar, Corvallis, Oregon, October 23rd, 2014.

CP: Great. Well, we'll begin at the beginning. Where were you born?

GP: I was born in Spokane, Washington.

CP: Oh, yeah. And you grew up in Ohio, is that correct?

GP: Yes, yes I did. My father was a musician, and his first position was out here in Spokane, and he actually started the Spokane Symphony Orchestra. He worked at Woodworth College up there, and so that's where I was born. And then at the age of three he took a position back in Berea, Ohio, at Baldwin Wallace College, and he was a Bach scholar. And he led the Bach festival there, and he was also an excellent violinist. He had studied with people all around the world, including George Enescu, who was the Romanian violinist and musician. And they had something in common, because Enescu was Romanian, and my father was born in Romania, up in Transylvania.

So my grandfather actually had a very interesting way of coming to America. He was a farmer up in Transylvania, and this was back in 1913, when Hungary owned Transylvania. One day he was out in the field, and a young boy came running up to them, he and three other workers, and said, "The Hungarian army is coming!" And the Hungarian army would come and induct Romanians into the army, and they had no choice. And so, they quickly ran down to the nearest railroad station. They decided that they had to get out of town, because they would be followed. So they made a pact they would get on a train, and see if they could—they didn't have any money for tickets, but they would get on a train, and see if they could make it down to—out of Romania, and preferably down to Trieste. And they made an agreement that if any one of them was caught, they would not tell on the other one.

My grandfather just happened to see that there was a wealthy man with a number of bags sitting there, and some attendants that were holding some of the bags. So he grabbed one of the bags, put it on his shoulder, and walked behind the others onto the train. And he was placed in one particular section. In those days, like here, you got on, you took your seat, and then the ticket man came through. So he sat there, watching, and he was able to see one by one his friends being caught and led off the train. When they came to him, he was with this group, and the conductor just assumed that he was part of this contingency of this wealthy man, and he made it out.

And he got down to Trieste, and there, there was kind of a Romanian underground for immigrants to get to America. The point was that he had to sign a paper that he would work two years free in America, just for room and board, and then they would put him on a passage, and give him papers and everything. So that's how he came to America. His first job was a chicken plucker in Philadelphia. And then from there, he went to the rubber factories in Akron, Ohio, and then finally he ended up as a coal miner in Pennsylvania. So he had quite an interesting story on how he came. After three years working, he had enough money to send back to Romania to bring his wife and my father, who was then just five years old, over to the New World.

CP: Wow, that's fascinating. And from that family sprang a Bach scholar and a concert violinist?

GP: [Laughs] Yes, that's right. My father always was interested in the violin, because he said in the village where they lived, even as a little kid, the gypsies would come around, and he said there was a gypsy violinist there that could play wonderfully. He was fascinated; he used to sit there and watch his fingers. And ever since then, he said that period, he had a desire to play the violin. [0:05:00] So when he came to America, he went to school in Akron, and he was able to get a violin, and he practiced and worked on it, and actually became quite good, and even gave student concerts when he was in high school. Then he continued his violin work and his interest in Bach. At one time he went to Germany to travel around to visit all of the institutions where Bach had played the organ, and had done this and that.

And so he spent a lot of time studying Johann Sebastian Bach, and so when I came along my father naturally wanted me to be a musician. So when I was four or something, I got my first little violin, and I started practicing. And my father was

a disciplinarian, and so it was two hours a day, and then later he added a piano to that, that I should—all musicians should know how to play the piano, so I spent another two hours a day on the piano. After a while it just became too much, and as I got older I told my father that, no, I really was interested in natural history, and I really didn't want to practice that much.

It led a little bit to strain in the family, and that's when I left home and went to a farm, worked on a farm in Iowa for a while. I was fifteen or sixteen then. And that played an important part also in my interest in nature, because this was a farm in Lisbon, Iowa, where we did everything the old-fashioned way. We milked cows by hand, we cut fields with scythes, we fed the pigs, we collected the eggs ourselves, and it was a very interesting experience. I remember today the details of working with the animals, and growing plants, and things like that.

CP: How did you identify this farm in Iowa? What made you go there as opposed to somewhere else?

GP: Oh, someone actually, a contact in Ohio, told my mother that they knew someone in Iowa that was looking for some summer help, and so I was—I wanted to get away, because I wanted to kind of develop myself. And so I hopped on a Greyhound Bus, went out there, and I never knew the people. They met me at the bus station. But it turned out to be a wonderful family of Germans who had immigrated and had a farm out in Iowa there. So I kind of became part of their family for a while, still have contact with them, with the sons, today.

CP: So this was a summer job?

GP: It was a summer job. Yeah, I came back for school, and then the next year went back again. After that, things had settled down at home, and then I always continued my interest, actually, in music. When I came here to Corvallis, I did play violin in the little Corvallis Symphony that they had, and I still play piano today as a hobby.

CP: What was your mother's background?

GP: My mother's background was very interesting. She actually could trace her family back to 1633, on the boat, Mary and John from England, that arrived in Ohio, that arrived. They all lived in Ohio, and her father was a superintendent of schools in Akron, Ohio. And so he was very good in debating, very good in his work in teaching, and my grandmother was an assistant to him. So they got married, and then I always had contact with them. I was lucky, because I always had wonderful contact with both grandparents, all of my grandparents on all sides, so I was fortunate that way.

CP: Do you have any siblings?

GP: Yes, I have one sister.

CP: Well, what were you interested in as a boy? You obviously had a lot of time that you were focusing on music, like it or not.

GP: Yes, yes. When I wasn't, I became interested in birds, and I started as a birdwatcher. [0:10:00] And so I used to go out in the woods wherever I could, and look at birds, and I'd set up little box cameras next to the bird feeders and take pictures of them, things like that. So when I went to Cornell, I went first as a—I put down that I wanted to be an ornithologist, and I went there to work with Allen and—Professor Allen, who is an ornithologist there. And that was very interesting, because about after the first year, Allen took me aside and he said, "Look, George, there are not many jobs out there for birdwatchers. You really need to develop a secondary interest."

And so there was a Botany professor there at Cornell, Professor Petri, who was very stimulating. I always have been interested in flowers, too, because my mother was interested in flowers, and interested in plants. We used to go out together and collect plants, and bring them back, grow them. And she, when we were down at the Cape, we would go down to the Cape and follow in the dunes, and look for the dune plants and things like that. So it goes back quite some time. Anyway, I decided then to pick a major in Botany, and I did that at Cornell.

CP: You have written about your first very early interest in amber through a book in your mom's collection, or books.

GP: Ah, yes, yes. My mother was an avid reader, and one of the books that she had on her shelf was this *Dragons in Amber*. I was fascinated with it. It's not just on amber; it's on fossils in general, written by Willy Ley back in 1951. And I used to stare at this picture, and I thought, "That's marvelous, that amber preserved these things so in detail!" And I decided then that I wanted to find my own insect in amber, just like that, especially a weevil. So after many years, this is a specimen from my collection—I did find one.

CP: [Laughs]

GP: [Laughs]

CP: That's fascinating to me, that this was an idea that was instilled in you so early on in your life, and it became, obviously, a very important piece of your life much later on.

GP: Yes, yes.

CP: Well, it sounds to me like you were really interested in nature and science from a pretty early age. I assume in high school you probably were a good student, I'm guessing?

GP: Yes, I was a student, a good student in high school, but I tended to be a loner, and spent most of my time often out wandering around in the woods around school. I mean, I was on the tennis team and in the choir, things like that, but I wasn't that much—I wasn't very social in high school. I preferred to—I had a friend that, similar interests, and we would actually go out and look for birds and animals, and things, in the neighboring woods. Sometimes we'd ride our bikes, and in those days the bikes were these balloon tire things that didn't have any gear shifts on them. [Laughs] We'd ride our bikes around, stopping, looking here, looking there.

So that was how I spent most of my time, except that after school I had a paper route. And it was the *Cleveland Press*, and so every day after school, got my bicycle, filled my paper sack with papers, put them on the front fender of the bicycle, and then spent the next hour delivering them. So that was kind of my social contact. [Laughs]

CP: What was it about birds, do you think, that appealed to you so much as a boy?

GP: I think the beauty and the freedom, the fact that they had this—they were able to fly off, and up in the sky, they could make such wonderful sounds, and they were just beautiful. I was fascinated with the different types, and tried to learn them, learn as many names as I could.

CP: Hm. Why did you decide to go to Cornell?

GP: Because of the ornithologists that were there. In fact, Cornell was the only school I applied to. Everyone said, "You're crazy, because Cornell may not accept you, and where are you going to go then?" I said, "Well, I want to go to Cornell." [Laughs] And actually, at that time, Ornithology was in the Agricultural School [0:15:01], and in order to get into the Agricultural School there you had to pass farm credits. It was interesting; you had to have worked on a farm. And of course, I had worked on a farm, so that came in handy.

And then you had to pass tests. One of the tests was, I remember, you had to get into a tractor, and the tractor had a hay wagon attached to it. And then they showed you a barn with the barn door partially open, just enough for the tractor to go in. The final test was for you to pull around, [laughs] back the tractor into the farm door! Now, it wasn't as easy as you think, because every time you turn right the tractor, the trailer goes to the left. [Laughs] So that was interesting.

CP: Uh-huh.

GP: And then they requested that I get some extra credits doing some other kind of work, and so one summer I got a job working on a sailboat, and they allowed me to collect material from the ocean, from off of the sailboat. The owner of the sailboat wasn't that keen, actually, because it was a racing boat, and he didn't like to have people coming aboard, and see nets and things hanging off the side of his boat. But we lived on the boat. I was mate, and then the captain lived there. And so we lived on the boat, so most of the time we had it to ourselves, and we were scrubbing it down, getting it ready for the next race, or something like that. So that's how I finished my agricultural credits for Cornell University.

CP: Huh. People forget sometimes that Cornell's a Land Grant school.

GP: That's right. [Laughs] They did have the Arts and Science, and I could have gotten into either one, but it was just that the Ornithology was in the Land Grant part.

CP: Hm. Well, we've talked about your switch from Ornithology to Botany. You mentioned Professor Petri, Laurent Petri.

GP: Yes.

CP: He was an influential person for you, was he not?

GP: Yes, oh, yes. Very much so. In fact, I think it was partially he was philosophical in his lectures. You would ask questions, and he was there with a little beard, a little white beard. And so you would come up after the class and kind of debate with him. And it got so we became friends. And even with my parents, we used to all go down and visit him after he retired, on the Cape. We would go out together, and he had led nature walks down at Barnstable, on Cape Cod, so we would go down there afterwards and take these nature walks.

But it was through him that I became interested in Entomology, because an Entomology professor called Prof. Petri one day, and said, "We're looking for someone to study the effects of insects on different species of plants. We have a leafhopper, and it carries a virus, and we want to know how many plants this virus will infect. Do you have anyone that you can recommend?" He recommended me, so that took me into the field of Entomology. And I worked at a summer lab in upstate New York, testing this, as an undergraduate. The professor came along one day, and I explained what I was doing and everything, and he said, "Oh, would you like to become a graduate student? I'll be glad to take you on. I have an assistanceship which will pay for everything." Well, that was wonderful, because I didn't have anything else in mind at that time.

So this was Prof. George Gyrisco, at Cornell University, and I became his graduate student, and then got my master's, and then my PhD under him. And my PhD involved studying a nematode parasite of the alfalfa weevil, which was invading New York at that time. So that's how I entered the field of Nematology, through that. And I developed an interest in the family of Mermithids, Mermithidae, which is a group of nematodes that attack insects. And so this kind of led me into the field of insect pathology and biological control. [Laughs]

CP: Hm. So, you've gone from birds to bugs?

GP: [Laughs] That's right, exactly.

CP: And what was it about the insect world that appealed to you?

GP: Remember, I'm kind of a naturalist, and so I would collect insects. As soon as you begin to collect insects and learn about them, you can't help but be fascinated. There's so much about them, and there is also [0:20:00] much interest in them from the standpoint of the economic entomology, controlling the insects. And so I entered the field actually by way of the economic field, studying insects that affected humans and their crops, and then studying the nematodes that affected the insects.

CP: So, at what point had you decided that you thought you might want to be an academic, for your profession?

GP: Oh, well, I think that was natural, going up there, because after I finished the Mermithids, I looked around for a position. And then there was a job opening in Riverside, California, and that was on the biological control plant. And so I had studied plants before, and so I applied and I got the job, so my first position was at University of California, Riverside. I was to study the insects affecting—nut grass insects. Nut grass is a kind of a weed, resembles grass, but it's really a sedge, and it was kind of spreading throughout southern California, and you wanted to find something to control it. So there were some insects that were there and so I went out to study them. This took me over to Hawaii, because they also had the problem, and they had some insects over there.

So then I came back to Riverside, and then at that time, we decided, I decided that I would change my field. I said, "This is interesting, but I really prefer to work with the parasites of insects, and pathogens." And so I decided in order to build up a good background in nematology, I need to get some experience, foreign experience. So that's when I applied for a grant to go to England, to study nematodes at the Rothamsted Experimental Station.

CP: Okay, so the Riverside job came between Cornell and Europe? I didn't know that, okay.

GP: Yeah.

CP: That's good to know.

GP: Yeah. [Laughs]

CP: That was an important trip for you, wasn't it?

GP: Oh, yes, that was a whole year there, and I studied with some of the top people in the nematology field, Basil Goodey, Freddie Jones, others who are now not with us anymore. But it was a wonderful experience, and it was a good experience for me also, because I can remember some of the comments the English made when I was there, and I decided to join one of the field natural history clubs. And as they came up to me and said, "You're an American and you're walking?" [Laughs] "You like to walk?" "Yes." And there were all kinds of comments, and I didn't realize how the British regarded Americans at that time.

Well, it was very interesting. I think I moved seven times in that year, going from house to house, trying to find something, because it was very difficult to find lodgings, and a lot of people wouldn't rent to Americans, because Americans had a bad reputation of being sloppy and messy, and not good citizens, I'm afraid. I think that stemmed from the occupation during the war, when the soldiers were there.

CP: Huh.

GP: Anyway, it was wonderful; the sciences were wonderful. I learned a lot, and then when I came back I applied for a position at Berkeley, because Berkeley had an opening in Insect Pathology, and they were looking for a nematologist. I was fortunate enough to get that position, and that's how I ended up at Berkeley, back in 1964.

CP: You spent a little time in Scandinavia during that England trip, did you not?

GP: Yes, yes, I did. When I was in England I also went up to Denmark, and the interesting thing about that is that I spent some time over at a little cape town called Blaavands Huk in Jutland, and that was where I found my first amber. And that was fascinating because [laughs] I had some things to learn about getting up early in the morning in order to get this amber. I finally found some and one of them had a tiny insect in it, and so that kind of started me off. That was my first insect collected in amber.

CP: So this was something that stuck with you from when you were a child, though, is that correct?

GP: Yes, yes.

CP: You had been looking for amber before then? [0:25:00]

GP: I had only seen it in museums and things like that, so whenever I had a chance to go to a museum that had some amber in it, or go in some of the stores that had amber in it, yes, that was it. The next time I was fortunate enough to examine amber was when I was working in Russia, at the National Academy Institute there. They had a wonderful collection of Baltic amber. So although I didn't go there for the purpose of studying amber, I did spend a lot of time in a museum with a paleontologist, looking through amber pieces.

At that time—this was in what was then known as Leningrad, now St. Petersburg, there were these shops called beryozka shops. They were dollar shops. And it's not the same as a dollar shop here, where everything is for a dollar. The dollar

shops in Russia had been set up in order to get foreign currency. So there were things in there that were a thousand, two thousand dollars, but you could only buy them with dollars, not rubles.

CP: Is this the 1969 trip?

GP: Yes.

CP: What was it like, just more generally, to be in the Soviet Union during that time?

GP: Oh, it was fascinating. It was fascinating. First of all, it opened my eyes to how people had suffered during the war, and how difficult it had been, and how people had managed to survive. I remember, I think I lost 20 or 30 pounds there, because first of all, there wasn't much time to eat. Second of all, it took so much time to eat. Thirdly of all, there wasn't that much food available at that time. I remember standing in a long line in the street, waiting to buy five little apples that were scaly, and had the apple colic moth in them, but they were apples. So I think it taught me the value of food, and also especially the value of an apple, and oranges, because they were the things that were very difficult to get, fruit like that.

So it was a fascinating experience. Not only did I meet these wonderful people, wonderful scholars, but I had a wonderful chance to study amber and to just see how people lived, and learn a little about the history, especially during the path of the last war, and survival during the siege of Leningrad. And at that time it was the hero city of Lenin, because Lenin was kind of—that's why it was named Leningrad. Only later, it was changed back to St. Petersburg. It was originally called St. Petersburg, and then Petrodvorets, and then changed to Leningrad, and then went back to St. Petersburg now. It's a fascinating, fascinating city, wonderful city.

CP: You mentioned how you were perceived as an American by the English. How were you perceived as American by the people in Leningrad?

GP: [Laughs] As someone having money, and trying to get anything they could from them on the streets, especially fountain pens. There was a desire for pens. I think I lost almost all of my ballpoint pens when I was over there. And at that time, when scientists would come back, you'd say, "Well, what should I take over there?" It was, "Take pens." [Laughs] It was interesting, very interesting. I had to go to language class before, and so I had to study Russian, and I knew just enough Russian to get by, to ask for things on the street.

Everything was different there. First of all, everything was so crowded. You took buses. I mean, very few people—or bicycles—but there were very few cars. And the buses were really packed with people. You would get on the bus, and there was no chance ever of sitting down. You were standing. And when the bus stopped and this was your stop, you would yell, "Wait, wait," and you would push yourself through. I often would lose buttons off of my coat, just simply scraped off in order to get through. And I thought, "Oh, this is going to cause some problems. There are going to be fights because of this." But they were very patient; they were used to that, and so they would just stand there, and you would push through.

The other interesting thing was when you went to restaurants or something like that, there were usually very few seats, so it was common to sit down at tables with other people eating. Even though you didn't know them, you just sat down at the table and ordered what you wanted to. [0:30:00] It was quite an interesting lifestyle.

CP: Yeah, I'm sure. Well, back to Berkeley. You mentioned in 1964 you arrived there. You were in the Department of Entomology, the head of Insect Disease Diagnostic Service. Is that correct?

GP: Yes, right.

CP: Tell me about that time period.

GP: Well, that was very interesting, because I started my investigations on insect parasitic nematodes. The Diagnostic Service was something that had been set up by Edward Steinhaus before, and he had gone to Irvine. It's a service that I don't think it exists anywhere, anymore. Free of charge; we would say anyone who had a diseased insect, they could send it to us, and we would examine it and then tell them what pathogen it was, and maybe culture the pathogen for them, and send it back to them so that they could study it further, and do tests to see how it killed the insects and things like that.

And so we continued that for a number of years, and actually, we wrote a little book as a guide for workers, so that they could help them to determine what these pathogens were themselves, when they found a diseased insect. And then the services, because of funding, the service was stopped.

But then my work with insect parasitic nematodes took a number of twists. First of all, because I was working with nematodes, a group of nematodes that happened to be found, associated with, some of these large beetles, especially the rhinoceros beetles, they asked me to take a trip around, and see if I could find these nematodes in rhinoceros beetles in different parts of the world. And hopefully then, we could, if they weren't there, we could reestablish them, and these nematodes would have an effect maybe on the fecundity of these rhinoceros beetles. Rhinoceros beetles are large, black beetles that feed on coconuts, and they damage the coconut leaves, so it's a pest insect.

So I started out going to Samoa. There was a lab there in Samoa, and it was a wonderful experience, because you got to see all of the plants and creatures there in Samoa. Then from there I went down to New Caledonia. That was, again, a wonderful experience. And then from there into northern Australia, which again, collecting different kinds of these rhinoceros beetles. And then over to Thailand, and then to Malaysia, and Borneo, and to all of these kind of wonderful tropical countries, that under normal circumstances I'd never have been able to visit. So it gave me a background in tropical entomology. Then later—

CP: Who funded this trip?

GP: This was funded by the World Health—Food and Drug Organization, FAO.

CP: Huh.

GP: And of course, all of this time, when I would go to tropical countries I would look for some special trees called agathis, or the cowry trees, because I knew that they produced the resin that turned into amber later, and they are only found in the tropics now. So this gave me a wonderful chance. In Australia and a lot of these other countries, they had species of—agathis was the name; scientific name of it. They had them growing. So I used to collect some of the dried up resin that was on the bark of these trees, and started my collection of resin. [Laughs] And so that was very interesting, that trip.

Later, I was asked to go to Africa in order to investigate the nematode parasites of some of the medically important insects, and that was funded by World Health Organization. This started out in West Africa, in Ivory Coast. And the insects to be investigated were mosquitoes, black flies, and tsetse flies. So this again, completely new area to me. [0:35:00] It was dangerous, too, because I knew that there was a chance of getting bit myself, and some people, some scientists just were very paranoid. In fact, we went; we were forming a team. We went to the Abidjan Airport to collect a scientist that was coming in from Canada. The scientist got to the door of the airplane, looked down at the community and at the field, and turned around and refused to get off the plane, and said he changed his mind; he's not coming to work there. [Laughs] So we were short one person.

And it involved going out in the field a lot, spending our nights in the field, and we carried our sleeping bags and slept in these nets, hammocks that had netting on the side. I remember one morning I woke up, and I had turned during the night over, and my arm had gone against the netting, and all of these mosquito bites were on my arm. A couple of weeks later I came down with malaria myself, and so I had to go into the hospital to get treated. But we went to all of these villages, and examined all of the people, and tried to determine what was affecting them. At that time, Ebola was unheard of, and so we didn't expect to see anything that serious. It was mostly sleeping sickness, malaria, and onchocerciasis, a river blindness that we met. And so we studied the nematodes, described them that were infecting these vectors, mosquitoes, black flies, and tsetse flies, and that was kind of all we had time for. But it was an eye-opening experience, being over there in Africa.

CP: I'm sure, yeah.

GP: Yeah. I went to Liberia, also—Monrovia, in fact, some of the hospitals there, because I had a friend, an old high school friend who worked with CARE, and he was working in the hospital in Monrovia. It was an interesting experience, because we were there when they brought in a boy who was dying, and they said, "He's dying. What he is dying from?"

So the doctor's looked at him. He saw, first of all, his esophagus, throat, had been filled with seeds of some plant that the local doctor put into him to cure him. By the time they got those seeds out, the child had died. And then, of course, the local doctor would say, "You see, European medicine isn't any good. The child died," but it was really due to treatment that he had done previous to that. Then Dakar also was interesting. We looked at some insects that were affecting the peanut plantations over there. And so that was kind of a separate event also, but. Then after that, I went back to Berkeley to lecture. [Laughs]

CP: [Laughs] This perspective you must have gained from worldwide travel is valuable.

GP: Oh, yes, yes. It was. It kind of gives you a feeling, also, that you can't really say what's bad and what's good. It's just what's out there, and humans are going to be the same. They're going to react, respond, depending on what conditions they're placed under, and there's good and bad everywhere. It's interesting how things have developed and grown, and yeah, different races have different ways of solving problems.

CP: Yeah. Well, obviously, you were traveling an awful lot, but you were at Berkeley at least some of the time, and you were there during a very interesting time in Berkeley's history. I wonder if you have any memories of the Free Speech Movement—

GP: Free Speech Movement.

CP: —and student unrest.

GP: [Laughs] Yes. Yes, that was a very interesting time at Berkeley. It kind of polarized the faculty. There were those there that were for the Free Speech Movement, and those that were not. [0:40:02] And I'll always remember the big convocation with Mario Savio speaking. Actually, he wasn't asked to speak; he jumped up there and started speaking, and then they, the police went up to grab him. They grabbed him by the tie and pulled him off the stage, and it was interesting, because the next day, apparently a number of people sent him these ties that could be removed easily when you pulled them [laughs], clip-on ties.

But yeah, no, I was with the majority of the faculty that was kind of, supported the Free Speech Movement, and because I thought they were—that was tied also against the War in Vietnam. And so it kind of polarized the faculty for a while, which was too bad, and very, very exciting. I think with all of the things going on, you were kind of pulled along, and I just remember also that there was tear gas used, because I remember being in the library and all of a sudden having to run out, because the tear gas that had been used to dispel students outside was being taken in through the air intake, and into the library.

CP: Who were some colleagues that were important to you at this period in your career?

GP: Oh, I think that—let's see. Colleagues at Berkeley, or colleagues around the world?

CP: Yeah, around the world, or Berkeley.

GP: Oh, yes. I think, well first, Marshall Laird, who was up in Newfoundland, was important in helping me obtain travel grants to travel around the world. And then there was people in—well, wherever I went, there were people that were kind of in charge of the research that helped me establish myself, find living quarters, and laboratory facilities, and things like that. So it all depended upon where I was, really. And at Berkeley, it was—I can't say there's any particular one person. I mean, I was in kind of in my own world there, in the insect diagnostics, and in insect nematology. And so after Ed Steinhaus left, there were just colleagues; no one in particular that I can think of.

CP: Had you sought out the ability to travel for your work, or did it find you? I mean, you applied for these travel grants. Was that part of your thinking, was you wanted to do some traveling in support of your research, and in support of these initiatives, or was there just a need for it, and you were somebody who could fill that ably?

GP: Sorry, I didn't quite catch that.

CP: I'm interested in if—you were at Berkeley and you travelled a bunch—if that was something that you were doing intentionally, or if it kind of came the other way around, if there existed this need and it found you?

GP: Oh, no, these were mostly invitations. People would invite me here to this conference or that conference, ask me to go. I was asked to go to Africa; asked to go to Southeast Asia. So, after the trip coming back, I think that the next phase of studies at Berkeley were the ambers, amber studies. Those were accomplished with my wife Roberta, who was an electron microscopist at the time, there at Berkeley. We decided to examine one particular specimen, a fly in Baltic amber, and we noticed that it seemed to have some tissue remaining in the abdomen. And so Roberta took it and sectioned it for the electron microscope, and we discovered that actually there were cells and nuclei, and all kinds of other things that we could recognize, were still present there, so that was very interesting. [0:45:00] And then that began the whole group of the extinct DNA studies, and even formation of a group, the Extinct DNA group, at the time.

CP: How did you make the decision to make this big shift in your career? I mean, obviously, amber is something that had been fascinating to you for a long time. Was it always something you thought you might want to do?

GP: Yes. Well, yes, yes. I always wanted to get back to the amber, but never really had a chance, because I was travelling around doing these other things. So I decided that this would be a good chance now to start a side project. And the side project—hopefully the administrators wouldn't notice that I was doing something that wasn't listed down in my [laughs], in my title. So the amber started as a kind of a side project, but then it gained momentum. Then after that, it was just, we just continued working on it, and no one—there wasn't any problem. No one objected to us.

CP: Yeah.

GP: Yeah.

CP: And you met Roberta at Berkeley?

GP: Roberta?

CP: Yes.

GP: Yes, I met her at Berkeley, right. Yeah. And so, yes, she had worked, was an electron microscopist for the group there, the Insect Pathology group, and did a number of projects with several different professors. And the amber study was one which was, well, unique. No one had done that previously, and led to some interesting studies after that.

CP: I'm sure. My notes indicate that an early study was one that was instigated by Joe Peck. Is that correct, with nematodes in Mexican amber?

GP: Ah, yes, yes, right. I spent some time over at Paleontology, because they had a large collection of Mexican amber that they had collected. Ray Smith, and Joe Peck, and others had gone down into Mexico, into Chiapas, and they had collected this material. And Joe Peck called me and said, "You work on nematodes. Why don't you come over and take a look at this? We think we have some nematodes in Mexican amber." And I looked at it and said, "Yes, yes, there are." So I decided to describe them, and study them further. Then that kind of took me into the Mexican amber field, and I decided to go down and visit the mines in Chiapas, and went down there, visited the mines.

That was on another trip, tied in with another trip, to go down and study the assassin bugs, the reduviidae bugs that were attacking humans. There's a lab down there to study them, and these are called kissing bugs, and they transmit trypanosomes to humans. And they wanted to control these with nematodes. So I thought, "Well, here's a wonderful chance to combine nematodes and amber, because the lab is down in Mexico not far from the amber mines, the parasitology lab." So we went down to examine the kissing bugs, and then at the same time took off to the amber mines. In fact, they helped to lead the expedition there.

The Mexican amber mines at that time were hard to get to, and you had to be careful. You had to have someone with you, because a lot of—there was a lot of theft going on, and so the miners all carried guns; they were armed. But the funny thing was that when you got to the entrance of the mines, you could tell how many miners were in by counting the number

of rifles that were leaning up against the [laughs]—against the opening of the mine. And so they weren't armed inside the mine; they just left their rifles out there. But we got along fine, and were able to get some amber for further study.

CP: Uh-huh. You did a great deal of travel in pursuit of amber. In my notes I have Ivory Coast, Poland, Morocco, Dominican Republic.

GP: Yes.

CP: Do you want to talk about some of your adventures as you travelled around the world in search of—?

GP: I think the Dominican Republic one was probably the one which is most notable, because that's where we collected most of the amber. [0:50:00] We led an expedition; Roberta and I led an expedition in the Dominican Republic with about ten people from the states, and it was tied in with the University of California Expeditions Program. We went to all of the mines. We met an amber dealer down there by the name of Jake Rodzinski, who was a wonderful man, and very knowledgeable. And he would be—he was retired, and decided to go into the amber business. So he made a lot of contact with people, and he sold a lot of amber. I had known him through correspondence, and so he came down and went with us on the tour, and helped us very much, and we couldn't have done it without him. So we went to all the different amber mines, collected specimens, and, yeah, that was very interesting.

We were able to then climb down into the mines. It wasn't all that exciting when you're climbing down into a small hole that's half filled with water, and in order to get to a particular spot, especially if you go down several hundred feet there, after a while—I didn't realize that I was claustrophobic, but actually [laughs] in that mine I became a little bit claustrophobic, because there were stories about how there would be earthquakes during this period, and the mines would collapse, and the miners would be trapped inside, and had no chance of survival. But fortunately, we all survived, and were able to bring back some very interesting specimens for future study.

But there's a lot of things we had to—one time there was a strike, a general strike, and there was—they were angry at the Americans for some reason I forget, and so we all had to kind of hide away at a house down by the coast. It was interesting, because in the middle of the night, one of the women who were sleeping downstairs started screaming, and we thought, "Oh, my gosh! We're broken into. They've found us." But it was just that she had been snoring, and her roommate had gone over to shake her awake, and then when she woke up she saw this figure looming over her and thought she was being attacked. So that was cleared up, and everything went fine after that.

CP: Tell me about the process of selection. You're in the mines and you're—I mean, how are you deciding what you're trying to target in terms of your samples, and what you're bringing back with you?

GP: We wanted to—yeah, we had these little hammers for this, geologist hammers. We'd go in, and we'd chip away some of the amber with the attached bedrock. It was important to get the attached bedrock, because the dating of the amber is based on fossils in the bedrock, foraminifera fossils, coccoliths fossils, and anything else that we could find. So actually it became quite heavy after a while, because you were collecting bedrock along with the amber samples. Yeah, sometimes we would—sometimes the miners even had to dive down into the water in order to get under an opening, in order to get up on the other side and collect the samples. But they did it. [Laughs] So that was interesting.

The amber was in two different sections. There was amber in the northern part of the Dominican Republic, and then also amber in the eastern part of the Dominican Republic. We wanted to see how to relate that with each other, to see whether some might be older, produced by different types of tree. Then there was also some, what is called copal, or young amber, that was in the southern part of the country. So fossilized resin in the Dominican Republic is complicated. There are a lot of sources for it, and probably different ages as well.

CP: So, you would gather this material. You would get back to the United States, and you were in your laboratory. What would happen at that point in those early years? [0:55:01]

GP: Well, a lot of it we sent off for analysis, and some we would try to analyze directly, using nuclear magnetic resonance spectra to determine the age. And then, of course, we would go through it all and sort it out according to the types of insects that were there. We were very much interested in any biting insects, for instance, mosquitoes, or assassin

bugs, or things like that, that we could find there, that we could relate to the present day forms. And then we became interested in looking for pathogens that might be inside these present day vectors.

Eventually we did find some malarial, remains of the malarial parasite, associated with a mosquito. We found some other kind of protozoan parasites associated with kissing bugs. This proved to be very interesting, because now I could use the experience that I had gained from the Insect Diagnostic Service, examining present day microbes. I could use that in looking at pathogens inside the insects in amber. One of the most recent studies I finished was finding a spirochete in a tick in amber, and the spirochetes, I believe, are related to the present day Lyme disease, maybe early ancestors of the present day Lyme disease pathogen. So it shows many of these pathogens have been around for a long time.

CP: Well, you were doing this—essentially you and your wife were the only people doing this in the '80s. Is that true?

GP: Yes, we started out—we started out to ourselves. We kind of broke open the field, and then after that many people followed. So now there are amber collections all over the world, and many people studying amber fossils all over the world, and it's kind of brought back the interest. I remember, at the time, talking with Joe Peck about it. He says, "I can't get entomologists interested in studying these, because they say, 'This is amber. This is for paleontologists, not for the entomologists.' And the paleontologists would say, 'We're not interested in these, because they're insects. These are for the entomologists to study.'" So it was strange, because really, they're just insects; it's for the entomologists to study. And then that became established, and now entomologists all over the world are studying these.

CP: Yeah.

GP: And there are many different amber deposits that have been discovered. We started with the Mexican, and then the Dominican, and so the neotropical amber. But then we became interested in Burmese amber. There was a chap, Ron Buckley, who actually was collecting this amber, and we asked him to send specimens to us that seemed to be of interest, and he did. We've described a number of things together from that deposit. I never had a chance to go to Burma, which is now Myanmar, to examine the amber, but other people have, and it dates back to 100 million years. So it's quite interesting to see the creatures, plants. I worked with Ken Chambers here in the Botany Department, and together we've described a number of plants from amber deposits, including the Burmese amber deposits as well.

CP: It must be extremely gratifying to know that you and your wife started a discipline.

GP: It's interesting to see how it's grown so rapidly.

CP: Well, you mentioned the switch towards pursuing ancient DNA. Tell me about how that came about.

GP: Well, once we were able to get the cells, we wanted to know whether there might be some DNA remaining. At that time, our son Hendrik was working down at Cal Poly, getting a degree with Raul Cano. [1:00:00] We gave him some of the bees that were in the Dominican amber, and told him to try to see if he could get some DNA from them. He did get some snippets of DNA from that. And then later we had, actually, a weevil from Lebanese amber, and he was able to get some snippets. He and Cano worked together, and they were able to get some snippets of DNA from that insect, also. The results, though—people question the results, because others weren't successful.

At first they were. We had people getting DNA from plants and things, but afterwards people couldn't get the DNA out, so we don't know how to interpret these early results. My feeling is that they still could be—it's possible that they could be correct. And when you say replications, it's very hard to replicate something, because no amber piece is the same. So you just have to—you have to use some other piece. It's not that you can duplicate one piece, and replicate it so many times. But at any rate, it caught the interest of a number of researchers, and it also caught the interest of writers, too.

And that was when, one day after we had published a paper in *Science* on the structure, Roberta and I published that, we had a visit from a tall chap who introduced himself as Michael Crichton. At the time, I didn't know who Michael Crichton was. I didn't know he was writing a book. Anyway, he was very much interested, and asked questions about whether DNA could be present, or something, in vectors. And then it wasn't until a little bit later, when we had a call from Universal Studios, who said, "We'd like to come up and film your lab." I said, "What for?" He said, "Don't you know that Michael Crichton's writing a book called *Jurassic Park*, and reconstructing a dinosaur based on DNA from an amber mosquito?" I said, "No, I didn't know that." [Laughs]

CP: [Laughs]

GP: And so that book came out, and I read it. I thought, "Well, it's a very interesting [laughs] book." And then the movie came out, and so there was a lot of discussion then about this. They were very interesting times, exciting times, and Michael Crichton was kind. I think he did a good job writing the book. And Spielberg did a good job, certainly, with the movie, too.

CP: What was your reaction to the book or the movie, besides interesting? Did it seem far-fetched to you?

GP: Oh, no, no, I realize it's fantasy, and I took it for what it was. Yeah, yeah, I thought it was a good idea. He did a good job with it, and they did a good job with the movie also, tying everything together, and making it what it was, Sam Neill and the other actors did. But that was—it was interesting times [laughs], because we had so many people writing us and saying, "Could this be true? Could this be true?" I said, "I doubt it would be possible to bring back an entire organism from DNA that you extract from a vector in amber." But, it makes a good story.

CP: Yeah. How did the all of a sudden attention impact you? Were you able to garner more funding, perhaps? Or did it impact you in any way, besides being a nuisance?

GP: [Laughs] No, no, no. We didn't ask for any more—get any more funding, or ask for it. We just simply went on with our work, and yeah, simply went on with our work. [Laughs]

CP: That was that.

GP: Yeah, that was that, right.

CP: Well, in 1995, you moved to Oregon. Why did you make that decision?

GP: Yes, yes. Well, at that time I could take early retirement from Berkeley, and we decided we wanted to go to a place that wasn't quite so crowded as the Bay Area. And there was several people up here that I wanted to work with. One of them was Art Boucot, who was a paleontologist, a wonderful paleontologist, with a broad range of knowledge. And he was working on the fossil behavior [1:05:02], records of fossil behavior, and so I wanted to go up and work with him on that, because we had a lot of evidence of fossil behavior in amber, insects in amber.

So I came up here, and then became established with Oregon State, continued the amber studies, and Boucot and I recently wrote a book with that title, on fossil behavior, and in it, a number of cases of behavior revealed in amber, amber insects, and amber arthropods, and things like that. So from then on, it was simply kind of going through all of the amber that I had collected in the past, and a number of specimens, also. A colleague at Berkeley, actually, a person who supplied me with a lot of specimens over the periods, Alex Brown. It turned out that he was my tennis instructor at Berkeley. At one time I happened to take some amber out of my pocket and showed it to him, and he said, "Oh, that's fascinating. That's fascinating. I'll tell you what. Why don't you pay me in amber for the tennis lessons, in exchange, amber." Well, I had some material that I had recently got, and so I said, "Well, I will just give you a few pieces, so you can see what they are like."

And then he became interested, and built up his own collection. And we worked together describing some specimens, describing specimens over the years also. So what we're doing now is that, continuing to describe specimens with people, actually researchers around the world. I try to get specimens, and then find out who was working on this group, who's the specialist, contact them. And recently, I've been doing a number of studies on the weevil, because as I showed you before, I was fascinated, always fascinated, with weevils, and weevils in amber. There's a Russian expert called Andrei Legalov, who works on weevils, and we've been working on them together, and describing the collection that I've built up over the years in a number of separate papers. So it's a matter of trying to get things described and studied while I can, and of interest to other workers.

CP: You mentioned Boucot. Tell me a little bit more about other contacts at OSU, and the connection that you've had with OSU?

GP: Well, I worked also with Gerry Krantz in Acarology. He's helped me a lot with the identification of mites. And Norm Anderson, who's a trichoptera specialist, has assisted a lot in some of the caddisflies in amber. Whenever I find something that happens to be, I know that so-and-so is working on this group, I'll contact them to see if they're interested. And if they are, fine; if they're not, that's fine too, just put it aside. Some people are interested in describing things in amber, and other people, not so much, so, whatever.

CP: You've worked with the OSU arthropod collection a little bit?

GP: Yes. Yes, we compared mates and comparisons of the insects. That's a very good collection now, and it's very useful, actually, in comparing with other things. Actually, I've used it also in studying some of the recent insects, because one of the projects I have since I came to Oregon is to study the insects along the dunes. That's one of my hobbies, too. My mother and I used to walk the dunes back at Cape Cod, maybe along the same route that Henry David Thoreau did, in writing his book, *Cape Cod*. And we'd collect flowers and things. When I went out to California, I continued that interest. Whenever I had a chance, I'd go over to the coast and look at the dune insects, and the dune plants, and the relationships.

And when I came up to Oregon, I continued looking at those [1:10:01], because I thought that the dunes are such a difficult place for survival, and only a few plants can survive there. The salt, the winds, and then the insects—what insects can survive there, under the plants? It's something that—I don't know; I found it fascinating. So it's something that I was working on, I had been working on for a while. And then when I find something I don't know, I take it to the arthropod collection and see if I can identify it. So it's come in quite handy for that purpose.

CP: Now, is your amber collection housed at OSU, or is it some—?

GP: Yes, yes, housed at OSU, and then eventually it will go to the California Academy of Science.

CP: Do you have a favorite specimen?

GP: [Laughs] A favorite specimen? There are a number of favorite specimens. I suppose some of the weevils; some of the weevils might be some of my favorite specimens. They are so delicate. And I always—ever since I worked on the alfalfa weevil, I have had a love for weevils, just the curvature of their eyes, large eyes, and a little snout sticking out. I thought it would make an excellent children's book, also. [Laughs]

CP: Well, I have some notes, just on the work that you've done since you've been at Oregon, that I would like to ask you about. You've worked on extinct flowers from the Cretaceous Period?

GP: Oh, yes, mm-hm. Yes, I did that with Ken Chambers, and several specimens that we put together. The interesting thing about these is that often, you can't assign them to any present day families, they are so strange and different, especially some of these—the last one that we studied was a whole branchlet of flowers, and they were just beautiful. We've also found the earliest known bee from the same deposits. So it shows that the bees back there were very tiny, and then the flowers were tiny, too—not all of them; some were certainly larger than the others.

I think one of the studies that I did that I found fascinating was finding the grass, some of the earliest known grass, in amber, from the mines in Myanmar. Up till then, people felt that the grasses were, at most, early Cretaceous, were not that old, but my feeling is that many things are a lot older than we imagine. [Laughs]

CP: [Laughs] Well, you mentioned the bees. You found 100 million-year-old spiders, flies, and geckoes, as well.

GP: Ah, yes, that was a wonderful piece, to find something in action in amber, where a little spiderling had come down to attack a wasp caught in its web, and at that moment a drop of resin fell on them, and entombed them for 100 million years. Some of these pieces are just, well, one of a kind. You just wonder how that could have happened, and how lucky we were to find that.

CP: Hm. You did work on the biology of termites?

GP: What?

CP: Biology of termites.

GP: Ah, yes, yes. That's another interesting specimen, because the—as most people realize, termites have a number of symbiotic protozoa in their guts, which actually digest the cellulose of the wood. And here is a termite in amber that had been attacked, and its body had been ripped open. To a lot of people, a lot of collectors, they looked at that piece, and said, "That's a damaged termite. I don't want that. I want a complete termite." Well, we have complete termites, also, but a damaged termite was especially interesting, because out of its body came a number of different protozoa, showing termites 100 million years ago had the same type of biology. And these protozoa were recognizable, often, to order, and sometimes even to family. So it was very, very, very exciting to find these [1:15:00], and show the symbiosis, ancient type of symbiosis.

CP: Mm-hm. How about the giant fleas?

GP: [Laughs] The giant flea was actually something that the Chinese published on, and I simply wrote—talked about it, and wrote a comment about it. And those were interesting, too. Great, large insects which resemble today's fleas, and certainly would have been very painful if they had bitten you.

CP: [Laughs] Well, one piece of work you did that made a splash was the theory that insects and parasites may have contributed to the extinction of dinosaurs. Do you want to talk about that?

GP: Ah, yes, yes. Well, Roberta and I wrote a book, *What Bugged the Dinosaurs?*, and we felt that certainly diseases were an important cause for the demise of the dinosaurs. So we pointed out some of the insects that have been found in the amber that were carrying pathogens, and how these pathogens might have affected the dinosaurs. Other people hadn't looked at this before, because these diseases hadn't been found. So when we found these diseases, we thought, "Well, what are they infecting? They have to be infecting something. What's around?" Well, the largest animals around would be the dinosaurs, the most diverse, and so naturally the question arises: what would have been the effects of these diseases on dinosaurs? And we felt that the effects could have been enough to cause their demise, maybe not completely at that one time, but over a period of time, and in conjunction with other events that were going on at that time, environmental events, and the meteor strike, as well.

CP: And how has that theory been received?

GP: Oh, some people challenged it, some people said, "Well, it's interesting." It's seen mixed reaction. [Laughs]

CP: Well, what has it been like for you to do so much work, important work, with your wife, and then later on with your son?

GP: Ah yes, well that was—no, no, that was very good, because Roberta added so much, another element to it, and she was able to analyze things. She's an excellent writer. She's an excellent artist; she made the drawings for the book, for our books too, first *The Amber Forest*, and then the *What Bugged the Dinosaurs?* But especially in *The Amber Forest* she made some beautiful illustrations, piecing together the ecology, little bits of ecology, as we surmised they would have looked like.

Yeah, and then Hendrik has done a tremendous job. He's gone on to work with the mammoth DNA. He's gone on to look at diseases also, plague especially. Gone to dig sites and burial sites all around the world. So we kind of keep up. He's the modern; I'm the ancient! [Laughs] The ancient pathologist who uses a microscope, and he uses molecular methods. So, but it's a combination of the two. I mean, it's nice to have both, and we keep in constant communication, back and forth, over what's happening in the fields.

CP: And where is he based now?

GP: He's based in Canada, in Ontario, at the university there.

CP: Well, you mentioned methodology. Has your methodology changed over the years, or is it still—?

GP: No—well, certainly, methodology for looking at the, has changed regarding the nucleic acids and things like that, but in amber you can still utilize the old methods, the microscopic methods. It's examination, and morphology, and fortunately, because that still works, I'm still in business. [Laughs] If it didn't, I'd probably be out of business, or I'd have to be working in a lab with some molecular biologists. But this way I can continue. And a lot of people feel that it's very easy to work with amber insects, but this isn't the case [1:20:00], because first you have a raw piece of amber, and then maybe in the center there's a little insect that you want to study.

All right, well, first of all you have to cut it. You have to know how to cut amber. Then you have to know how to polish it. While I was at Berkeley I actually took a class in gem cutting, in order to perfect my ability to cut pieces of amber, and learn how to polish them, and then sand them without destroying them. You want to get within, say, a fraction of a millimeter next to the insect, in order so you can see it. And you're standing there, then, at the sander, and you either can go so far, and then you have to go to hand sanding. And it's hand sanding, examine it, hand sanding, examine it; see how close you've gotten. Then polish it, knowing the right type of polish to use. It varies in the summer and the winter. So there's a lot of other things involved other than just looking at the—looking at a piece of amber and seeing this insect just there. And I spent a lot of time, and I have a lot of scars on my fingers and thumbs to show for it, holding amber against sanders.

CP: [Laughs] Well, my last question for you is one of possibilities for the future. When you think about the discipline going forward, what excites you?

GP: Well, I think there are a number of—I think it will continue as it is, and there are a number of new, and even microscopic, inventions that have come along, allowing people to see, to kind of get closer to the amber specimens, and to see certain characters on the amber specimens. I think that eventually it may be possible to actually look through an amber specimen and see what's inside it, without having to cut it open, or do any damage to it. And this would be very interesting from a disease standpoint. As I said, new inventions are being made all the time, and so the methods that I'm using, simply the old microscopic methods, may someday be out of date.

CP: And the field continues to grow.

GP: And the field continues! [Laughs] That's right.

CP: Well, Dr. Poinar, I want to thank you very much for this. This has been very interesting for me and I appreciate you spending your time and sharing your memories with us. Thank you.

GP: You're welcome.

[1:22:44]