Shifting Seasonality and Its Impact on Urban Beekeeping

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Sponsor: CALENDARS Project

Appendix A. - Sponsor Description

The seasonal changes bees and beekeepers need to make due to climate and environmental changes is not well understood. Large disruptions to the bees' habits can severely affect the health and productivity of honey, thus affecting the beekeepers. The CALENDARS Project is a group of researchers studying this effect and looking for ways to limit the negative environmental effects of seasonal bee behaviors. Due to changing climates and increased human intervention, many new issues are arising. This has come in the form of an increase in global temperature, new pesticides' causing unknown long-term issues, and decreasing green space for beekeepers to farm on. We plan to work with local beekeepers and the CALENDAR project representatives to reduce the impacts from these causes. The CALENDARS project has begun working on this already, they have been working with researchers across the world, such as India, Norway, Germany, and New Zealand to track local bee populations, and how the seasonal practices are being changed. This shift in seasonal practice adaptations is one of the ways the CALENDARS Project hopes to adapt to the world's ever-changing climate.

CALENDARS Projects mission in part encompasses understanding historic and present-day beekeeping practices. By furthering our understanding of this subject, they will be able to observe how past practices have been modified to suit the climates of varying regions. Gathering this data will then allow them to better understand the components that are important to a beekeeper's practice, the technologies that are most valued in particular climates. This information can then be shared openly with other beekeepers, allowing for smoother seasonal practice transition for both the bees and their keepers in hopes it lowers negative effects on hives across the world.

CALENDARS organization works on examining transformations in seasonal cultures within groups during difficult times. With a focus on understanding how the aftermath of changes in seasonality has affected traditional practices and emergences of lifestyles. The CALENDARS organization works with specific communities and institutions like schools, gardens, and various artists. The work involves the collaboration of researchers, people in the community, and various artists to reshape the greater cultural understanding and practices around seasonality. The main goal is to produce a revised calendar and enhanced understanding of seasonal engagement for each community that they work with.

In 2019 the CALENDARS organization was awarded the ERC Starting Grant by the European Research Council. This grant was awarded for 5 years to fund the researchers in the organization to complete their research into the changing of Seasonality. Since 2019, the CALENDARS organization has released many scientific publications about how climate change has affected the seasonality in different countries. The CALENDARS organization has also been releasing media to help inform the greater population about the changing of seasonality. In Bergen, they have worked to build a Virtual Reality simulation, and in New Zealand, they supported filmmakers to document seasonality in the region.

Since the CALENDARS organization was funded by the ERC STARTING GRANT in 2019 and given €1,459,426 for the next 5 years, the project is fueled by a dynamic team,

including researchers, professors, and experts with diverse backgrounds such as PhD candidates and postdoctoral researchers. Scott Bremer, in his role as coordinator and project leader, brings a wealth of experience in climate adaptation governance. Elisabeth Schøyen Jensen, a PhD candidate based in Bergen, specializes in Sociology and Science and Technology Studies, contributing a sociological perspective to the project. Simon Meisch, an interdisciplinary social scientist, leads a sister project with a focus on changing water cultures. Arjan Wardekker, an interdisciplinary environmental scientist, draws on 17 years of experience in urban and community resilience. Mathias Venning, also a PhD candidate based in Bergen, merges post-colonial history and development experience for research in East Africa. Kerstie van Zandvoort, a PhD candidate based in Coromandel, provides insights from her background in landscape architecture and environmental planning. Paul Schneider, the postdoctoral researcher on the Coromandel Peninsula, specializes in climate change adaptation, coastal risk, and resilience governance. Finally, Mark Thomas Young, a philosopher leading a sister project at the University of Vienna, delves into the exploration of how artifacts acquire agency in automated technologies.

The CALENDARS project places a critical emphasis on addressing the seasonal changes that bees and beekeepers must navigate in response to climate and environmental changes. Recognizing the urgency of these challenges, the project aligns seamlessly with its core values, emphasizing the inclusion of diverse cultural perspectives when addressing the impacts of these changes. A central focus of the project revolves around understanding how these seasonal shifts impact the intricate dynamics between bees and their keepers, necessitated by ongoing environmental changes.

To gain a comprehensive perspective, the project actively engages with climate researchers, whose insights illuminate the broader implications of environmental changes on ecosystems. However, the primary emphasis remains on the invaluable input from beekeepers, who, with their firsthand experience, provide essential knowledge about the specific seasonal adaptations required in response to climate and environmental shifts. This collaboration ensures that the CALENDARS project is uniquely positioned to comprehensively address the challenges faced by bees and beekeepers, offering tailored strategies for navigating the seasonal nuances brought about by environmental disruptions.

This organization focuses on reviewing the yearly calendar to fit the changing seasons due to climate, environmental, and social changes. As the temperature rises each year and the Earth continues to get warmer there is a worry as to how this will affect the future of seasonality. CALENDARS is working to redefine the seasons and review the yearly seasonal calendar to adjust to these shifts. These changes could help to find the most beneficial times for crop growth or to prepare for certain weather conditions. This relates back to bees and their keepers as it could shift the seasons in which bees are most active which could help crop pollination during the most ideal crop window. With a new seasonal calendar, beekeepers could find the most opportune times to allow for their bees to pollinate and determine when securing their hives for the winter is optimal.

This project is important as it challenges how individuals view seasonal patterns in different communities and fields of activities. The current seasonal calendar has been used for centuries, and due to not only climatic change but environmental and social changes, this organization hopes to shift people's perception of the current seasonal structure. As these rapid seasonal changes occur, the response of the public can support or restrict the cultural calendars that this project aims to implement. For example, these seasonal calendar changes could allow for bees to pollinate crops at a more ideal time, but it could disrupt the crop seasons that are currently in place. Changes made to the seasonal calendar could provide a wide range of benefits to communities especially as researchers continue to make efforts to find the best calendar to benefit the planet's future. This project explores numerous possibilities to review how future seasonal shifts may affect local culture with a focus on the climate of beekeeping.

Appendix B. - Interview Protocol

The project will take an in-depth look at seasonal timings and how these changes affect Urban beekeepers to produce a final deliverable of a dynamic calendar. To produce results, the team will perform interviews to understand urban beekeeping practices. To accomplish the goals set, the team will obtain informed consent from the interviewee to state the purpose of the interview and the subject matter that will be discussed.[57] Those above the age of eighteen will be asked for consent to interview as minors cannot give informed consent. Also, the team will ask for consent from the interviewee to record the conversation to be translated later. Throughout the interview, the interviewee will be given the opportunity to opt-out of the interview at any time. This will be stated before the interview begins to notify the interviewee that they have the right to opt out or not answer specific questions within the interview process. Also, the interviewee's name use in the final report will be discussed after the interview. Interviewees will have the option to have their names omitted from the data, interview recording, and final report. These individuals also can have their data removed from the project at any time during or after the interview.

Interviews will be conducted in person, with an option for a virtual interview if that proves more convenient for the interviewee. If held virtually, the interview would be held either on Zoom or Microsoft Teams. If held online, an option will be presented to the interviewee to have the session recorded. The interview structure will be semi-structured to allow for adjustment and flexibility to information given by the interviewee. Unless the interview is held online, in person conversations will be recorded with an audio recorder.

Each interview will have at least two team members present. One team member will act as the primary interviewer who will be responsible for guiding the conversation, asking and adjusting questions, and clarifying or explaining details as needed. The second team member will act as a scribe and be responsible for recording the interview, taking written notes, and acting as a secondary source of information as needed to assist with the interview.

The recording and written notes will be compared and synthesized into a transcription of the interview, noting and highlighting key information and details. The key information will then be transferred to a central interview data document, where we will store and organize all relevant information to project objectives, allowing for easy and clear access to information. This will be stored in the team's OneDrive, where permitted access is restricted to team members.

Appendix C. - Beekeeper Interview Questions

Participation Agreement: We are the CALENDARS Team, a project coordinated between Worcester Polytechnic Institute and the CALENDARS Project. The goal of our project is to create a deliverable that will help inform beekeepers of potential effects from climate change and shifting seasonality on their hives. Our hope for this deliverable is to give beekeepers another resource to refer to when deciding how they should manage and care for their hive. This interview's focus will be surrounding your experience beekeeping and ways in which changing seasonality has affected you. As this project progresses, we will draw from these interviews for firsthand experiences and testimonies, with or without your name, depending on your preference. Do you consent to having your answers recorded for this purpose?

Question 1: How long have you been a beekeeper and how would you define your practice, i.e. a hobbyist, commercial business, or somewhere in between?

Question 2: Which bee species do you keep and have you kept any others, how did they perform on average, specifically in reference to weather conditions?

Question 3: Have you connected with other beekeepers or have done your own research to improve the outcome of your hives, if so how do you go about this?

Question 4: What was your reasoning behind setting up your colony in the city versus somewhere more green outside of the city?

Question 5: Walk us through a typical year of beekeeping for you. What are the major events that happen throughout the year? What are the typical times that these events happen at?

Question 6: What steps do you take in these periods to ensure your hive is successful?

Question 7: If you could control the weather, how would you space out the seasonal periods?

Question 8: In the past five years, have there been any significant weather events or periods that have greatly affected your colonies (a drought for example).

Question 9: What weather-related problems do you encounter during the winter and summer months?

Question 10: What issues do you have that relate to your geographical region/climate?

Question 11: How do you measure what makes a successful beekeeping season, honey, survival, or another metric?

Question 12: Has there been a difference in the goals that you have been trying to achieve?

Question 13: What resources/recommendations would you give to new beekeepers when they encounter weather-related problems?

Question 14: We are working on developing a dynamic calendar* that you can use when beekeeping. In what form would this be helpful to you? (i.e. physical, digital, on your computer, on your phone, etc.)

*dynamic calendar: “Seasonal calendars are often used as a participatory tool to find out community perceptions on time-related variations in indicators such as weather patterns, time

spent on labour and other activities, level of food security, nutrition, illness (in people, crops or livestock), cash availability, and production patterns and yield".[58]

Appendix D. - Beekeeper Survey Questions

Participation Agreement: We are the CALENDARS Team, a project coordinated between Worcester Polytechnic Institute and the CALENDARS Project. The goal of our project is to create a deliverable that will help inform beekeepers of potential effects from climate change and shifting seasonality on their hives. Our hope for this deliverable is to give beekeepers another resource to refer to when deciding how they should manage and care for their hive. This interview's focus will be surrounding your experience beekeeping and ways in which changing seasonality has affected you. As this project progresses, we will draw from these interviews for firsthand experiences and testimonies, with or without your name, depending on your preference. Do you consent to having your answers recorded for this purpose?

1. Where have you been a beekeeper and for how long? Please include your name here if you would like to be cited.
2. Have you always kept the same species, if not, can you elaborate on which ones you have kept and why did you change?
3. Are you a hobbyist, commercial business, or somewhere in between? (Hobbyist being 0 and purely commercial being 100)
4. Divide the beekeeping year into units (seasons) based on major events and explain these events.
5. What are the typical times that these events happen at?
6. Bees are cool!
7. How do you measure what makes a successful beekeeping season, honey, survival, or another metric?
8. What challenges do you encounter in your geographical regions?
9. In the past five years, have there been any significant weather events that have greatly affected your colonies (a drought for example).
10. What steps do you take during weather events to ensure your hive is successful? Do you use any technologies in your practice, such as internal thermometers to monitor hive temperature?
11. Climate change has been shifting the seasons of beekeeping. How much are shifting seasons negatively impacting your hives? [rank 0-5 with 5 being severe]
12. What resources/recommendations would you give to new beekeepers when they encounter weather-related problems?
13. We are working on developing a resource about the effects of shifting seasonality on beekeepers. In what form would this be helpful to you 1-5 with 5 being the most helpful? (i.e. physical, digital, on your computer, on your phone, etc.)
14. Would you prefer anything else?

Appendix E. - Professor Landgraf Interview Questions

Participation Agreement: We are the CALENDARS Team, a project coordinated between Worcester Polytechnic Institute and the CALENDARS Project. The goal of our project is to create a deliverable that will help inform beekeepers of potential effects from climate change and shifting seasonality on their hives. Our hope for this deliverable is to give beekeepers another resource to refer to when deciding how they should manage and care for their hive. This interview's focus will be surrounding your experience beekeeping and ways in which changing seasonality has affected you. As this project progresses, we will draw from these interviews for firsthand experiences and testimonies, with or without your name, depending on your preference. Do you consent to having your answers recorded for this purpose?

Questions

1. Are you a beekeeper? If so, would you consider yourself more of a hobbyist or a commercial beekeeper?
2. From reading your publications you research primarily into machine learning and animal behavior. I've read through your research into beekeeping and modeling bee behavior and development of the robotic bee. Would you be able to give a summary of your research in relation to the practice of beekeeping? Why are you researching bees specifically?
3. In your work with Hiveopolis would you be able to explain about the work that you have done with bee dance robots? Are there results of this study that can be applied to the average hobbyist beekeeper?
4. In our interview with Jonas from Stadtbienen we discussed that beekeepers are using different temperature and humidity readings in their hives and the vast amount of data that beekeepers are collecting but not utilizing properly yet. With your experience in machine learning, what are some ways that the average beekeeper can utilize and analyze the data that they collect in a more efficient manner?
5. Would there be any technology that the average beekeeper should implement in their hives to improve the survivability or production of the hive in response to climate change?
    a. Is there any technology, either your own or something from elsewhere, that you think more beekeepers should use?

Appendix F. - Interview Transcript with Heinz Risse

Interviewee: Heinz Risse, Mellifera Berlin
Interviewer: Benjamin Penti
Scribe: James Teague
Recorder: Saida Bahtierova
Date of Interview: 21 March, 2024
Location of Interview: Fräulein Wild in Dresdner Strasse

Participation Agreement
We are the CALENDARS Team, a project coordinated between Worcester Polytechnic Institute and the CALENDARS Project. The goal of our project is to create a deliverable that will help inform beekeepers of potential effects from climate change and shifting seasonality on their hives. Our hope for this deliverable is to give beekeepers another resource to refer to when deciding how they should manage and care for their hive. This interview's focus will be surrounding your experience beekeeping and ways in which changing seasonality has affected you. As this project progresses, we will draw from these interviews for firsthand experiences and testimonies, with or without your name, depending on your preference. Do you consent to having your answers recorded for this purpose?

Interview Transcription
Ben: *reads participation agreement*
Heinz: No Problem.

Question 1
Ben: Okay. So our first question is, how long have you been a beekeeper, and how would you define your practice? Are you more of a hobbyist, commercial business, or somewhere in between?
Heinz: Okay. I started beekeeping when I was nine years old with my father. And I helped him catching swarms and all these things. He looked at eggs of the queen and could not see them because he was not, his eyes were not very well, so I helped him. But I was not a beekeeper by myself, just helped him. And when my father died, I had a problem with all his bees, all the bee colonies. So I took them to Berlin because my father lived in the middle of Germany. So I took them to Berlin, and I wanted to see if beekeeping is possible in Berlin. And that was 2009. In 2009, I found a nice place, which is next to this place. It's Prinzessinnengarten, it's at Moritzplatz. It was the old Prinzessinnengarten, and now it is where I invited you to. It's the cemetery down to Neukölln. But due to the weather conditions, it's better to meet here and answer these questions. So in 2009, I started beekeeping here in Berlin with some of the bees of my father from Saarland. And I met a group there, which is called Mellifera. Mellifera is down south, in south of Germany, the headquarters. And I found a regional group of Mellifera. So we

are doing things different. We're not like commercial beekeepers or conventional beekeepers, we're totally different. We are beekeepers who are more biodynamic beekeepers. So our focus is the bee, the honeybee, and not the honey. Because most beekeepers, conventional beekeepers, they ask for honey, and we are asking for how is the bee. Because we all belong to the same environment, bees, humans, and so on. So that's my background.
Ben: Okay. Thank you.

Question 2
Ben: So in the last five years, has there been any significant weather events or periods that have greatly affected your colonies?
Heinz: Yes, of course.
Ben: Could there be any examples of major events that you've experienced?
Heinz: Yes, the last few years, they were just too hot. And due to the drought, it was that the bees suffered. And sometimes I had to feed the bees because they were starving. So when you look at them, and I need to explain a little bit, because we have boxes where bees live in where we can look at it. But we have also trunks, so trees where bees live in. We can look into the trees, except if we have built a tree ourselves. It's called tree beekeeping. In German, there is an expression called Zeitlerei, and with this Zeitlerei, we are making experiences as well. I don't know if you've been at the new princessing garden where we have log hives there, these log hives.
Ben: Yeah, we haven't been there yet, but I'll look into it.
Heinz: I wanted to show them to you, but it's too complicated due to the weather. So when you look at them, and you see that they have very less storage, very less food for winter, then you need to feed them. You don't want to...lose them. So in nature they would disappear, they would not survive, because it's just not possible. So we fed them. And the last year was alright, because it was changing all the time, wet and dry. But three years before were very, very dry. And there were fires around Brandenburg, around Berlin. It was very, very hot. The bees suffered, yes.
Ben: What do you typically feed the bees with? I know there's different types of sugar, water, depending on...
Heinz: Yeah, we have a separate food from the conventional beekeepers. So we use an old Demeter recipe. The Demeter recipe is mainly lots of honey, camomile, sugar water of course, a little bit of salt and caramel. This is a food which the bees accept, and it's not pure sugar water, and it's better to adapt for the bees. So it's a recipe, it's an old Demeter recipe, which we use all the time. And the best is if we have enough honey, we feed them honey.

Question 3
Ben: So you mentioned you use the honey bee, is there any other species of bees that you use, or is it just made right now?
Heinz: It's just the honey bee. We don't know exactly which bee we're working with, because we're not breeders. We're not breeders, we are not focused on a special type of bee. So Apis mellifera, for example, it's rare to find. So most beekeepers in Berlin, they work with Apis

mellifera canica, or Apis mellifera bacfat. So Apis, the bacfat of bees. So there are some beekeepers. And we don't know exactly where they mate, when they mate, when the queens go up in the sky when they mate. So we don't know exactly, but we think it's a mixture. So you've talked about feeding your bees to make sure the hives stay alive during drought.

Question 4

Ben: Is there any other practices that you use to improve the outcome of your hives?
Heinz: Yes, the bees have usually a very thin insulation. So the boxes have a very thin insulation, which is not suitable for winter. So we insulate them for winter, which is then thicker than the boxes you can buy at the market. And in summer, it's the same actually. To have a good protected hive against the heat, it's also necessary. So we're using shields against the sun. We don't put bees, the boxes directly into the sun. We use shade. And if there's no shade from trees or something, we are using, yeah, just shade to make shade with shields.
Ben: What kind of material do you use for your installation?
Heinz: Well, natural material, which is available in basically newspapers. Wood. Newspapers work the best, and they suck the humidity. But we're using strong wood, thick wood. We're using material which is called, in do-it-yourself shops, which is called Holzwaldfaser. This is a material which insulates very good. That we're using in winter to put it on top. Yeah, that's the material.
Ben: Yeah.

Question 5

Ben: I mentioned this, but what are your thoughts on urban beekeeping practices? Do you think an increase in urban beekeepers is good for the environment?
Heinz: I think awareness is good, so that we're training people as well. So we have education courses for beekeeping, beekeeping classes. The next one starts in April, and it's good to...make people aware that it's good to work with nature, with bees, and learn how nature reacts. Because the bees are strong, indicating they're strong ambassadors for the environment. If the environment is bad, then you would see it immediately at the bees. If they have lack of food, if it's too dry, if it's too hot, if it's too wet, if they can't fly, and so on. So we have very good ambassadors to show what's going on in the environment. And therefore, we train all these students, these people who come to us, to see it as a whole, and not as a car where you can repair things, like changing tires, exchanging this and that, and the other, and
making new paintings. It's combined, it's something you can't take out the environment and put other things in. Therefore, we're not in favor of queen breeding, or putting queens from other countries into there when we lost a queen. So we try to, when there's swarming season in May and in June, we're letting them free, we're letting them decide which drones to meet. And we're not that strict, so the thing that nature has itself, it's best. And not to influence too much from humans.

Question 6

Ben: So, what resources do you access when you encounter problems or challenges with beekeeping? Do you go within Mellifera and talk with people in there, or go more outside?
Heinz: Well, we're using our distribution list. There are about 200 people on the distribution list. And we're exchanging information regularly. So six times, every six weeks we meet, and it's an open group where beekeepers can visit us and ask questions according to the problems they have. And sometimes if we have problems ourselves, then we try to use the internet, try to contact other beekeepers. We're well connected to other beekeepers, even to conventional beekeepers, which are important. And it's especially open to other beekeepers, because they can come to us and ask questions. Which are important, and it's especially old beekeepers who have experience. That's also important. And so, due to this tree beekeeping, we have international contacts, in the direction of Poland, even into Russia, and to America. We have contacts in America. And we're well connected with Thomas Seeley. Maybe you've read the book, Honeybee Democracy. It's a very nice book. Honeybee Democracy is written by Dr. Thomas Seeley, who is in the US, north of New York, in Ithaca. And he wrote this lovely book called Honeybee Democracy, where bees decide which home to choose when they're swarming.
Ben: Okay.
Heinz: So, even there, we try to get opinions, and to get exchange of information.

Question 7

Ben: You started talking about the seasonality aspect. What would be an ideal beekeeping season for you?
Heinz: That's a difficult question, because in former days, it was cold in winter, and this is no longer the case. Winters are getting more and more warm, and sometimes they need more honey in winter. So, sometimes they have lack of storage of honey, so they die even in March and beginning of April, if the beekeeper hasn't a close look to check. So, that's a problem. And in summer, it's also a problem, because the queen lays eggs all the time because it's warm and so there's no real stopping of the clean laying eggs and that's a problem because of the Varroa. The Varroa will develop much better if there is no brood stop. If there's a brood stop, the Varroa mite, they don't know where to go because they can't, they're outside because they need the cells of the larvae to reproduce themselves and they can't, so that's very important. Therefore,
when there is swarming season, there's a gap of about four weeks where there are no eggs, no larvae and no brood, so that's good. But this should be in December as well. In December, when the queen stops laying eggs and when she's continued breeding, then the Varroa mite will have a chance to survive as well.

Question 8

Ben: So currently, the biggest climate issues that you're facing is the increase in temperature during the winter and also the summer. Is there any other regional climate issues that you're facing?
Heinz: Yeah, usually it's a little bit warmer inside the city than in the countryside. It's about one or two degrees, but I think it's affecting the base as well.
Ben: Yes.
Heinz: Could be, but I don't know, I'm not a scientist.
Ben: Yeah, we've been finding similar results in our secondary research that we're conducting with the city being like a heat island of sorts. That's been negatively affecting the bees, so that's what we're trying to research currently.
Heinz: It's better in the countryside. I'm not a professional beekeeper. I'm a hobby beekeeper because I need to earn money and with beekeeping you can't earn money. It's very hard to earn money as a professional beekeeper. You need to have lots and lots of beehives. I'm an electronic engineer and this is my part-time, my free time, I'm working with the bees. I love it because my father started it. I took all his boxes, all his hives with me to Berlin and yeah, that's important for me.

Question 9
Ben: So what events make up the seasonal calendar for your beekeeping practice? So what are the indications that the changing of a season is happening?
Heinz: Well, if you look outside, you will see that the season of spring started much earlier than expected. So it's hot since mid of, or not hot, but it's warm since mid of February. And usually the bees are not active during this time. And due to the weather, on one hand it's good because the bees can be released of the hive. Because if they stay inside, sometimes there is a sickness called nosema. So it's some sort of, what's the English word for it? Diarrhea. So this helps if they can fly out and they can poop. And that helps. But on the other hand, they start quite early breeding. And this causes the problem of too less food. Because if there is food, if there is enough food, that's alright. But if there is not enough food, usually, then this is a problem. And then there is starvation and the bees will not survive. I can't really answer that question. It's quite hard.
Ben: Yeah.

Question 10

Ben: So do you do anything outside of the winter season to keep the bees alive other than the insulation?

Heinz: The insullation?
Ben: The insullation, yes.

Heinz: Oh. So, I'm listening, I'm listening to a friend who always said, bees can do everything themselves, except planting flowers. And this is what we follow. We think that nature has a strong power, a much more power than humans, and if we stay away from them, it's much better than to try to help them. This is a help which is of no help. So, leaving the bees alone, even if they die, would help them. So, when we support a weak colony, this is not good. If we support a weak colony, the colony would die in nature. So, that's natural selection. And beekeepers try to influence that. We believe that's not good, to influence that with beekeepers with lots of material, lots of so-called knowledge, so-called practices, to help them. But this is a help of no use, of no help. This is trying to help a weak colony to survive. And if this colony is refugees in the South, this is no good for nature, for the future. So, what we have learned from these scientists, and even this Dr. Seeley is, I've just mentioned Seeley in the US, is that let them die. Let them die, this will be a hard time for you, a very hard time, but after that, they will be even stronger than before. So, this is a totally different approach from beekeepers associations, but a totally different approach from all the others who think, we need to do this, we need to do that, and then we need to do this, with this kind of medicine, and with this material, and this, and that, and the other. This is, from my point of view, the wrong way to go.
Ben: Do you have that point with the Varroa mites too, where if the colony is infected, that they should also?
Heinz: Yes. So, Varro mites are everywhere, and this year I have lost lots of colonies due to Varroa mite, because we are very conservative against the Varroa mite. We try to do different practices, but all practices are weak and of no use. We have, we tried formic acid, oxalic acid, all sorts of things, but what really helps, in my opinion, is to make the colony stronger by himself. So, not feeding sugar water makes them weak. Not putting them on natural comb, because we use natural comb building, they can produce their own home. So, not using artificial wax foundation in the middle, this makes them weak. So, letting them, doing their own life to live, helps them to survive. So, therefore, we are beekeepers who let them swarm, we don't kill the swarm cells. We are using no wax foundation, so they can build their own comb, and it's very nice to see if they build their own comb, and how they build it. We are just using a little bit of, well, we use some frames as well, but the frames have a starter bar on top, and that's it. And then they can build the wax combs by themselves. And this makes the colony strong, and not weak.
Ben: Yeah.

Question 11

Ben: So, the increase in strength for the hive, would that be what you would consider a successful season as a hobbyist, or?
Heinz: Yes. Because what we found is that the most, that very strong colonies in summer, that they die in winter, if you don't treat them right against Varroa. Because the Varroa will increase at the end of the season, so the bee's development goes low.The queen is not laying eggs, that amount of eggs anymore, the boromite will increase and if you don't treat them right, then the colony collapses in the early autumn or early winter. We try to make different approaches, not to

use formic acid and not to use oxalic acid. But all these have, at the moment, no real result, we have high losses, yes, we have.

Question 12

Ben: Our next question is about the quality of honey production but it sounds like you don't entirely measure honey production as much, it's obvious.

Heinz: So when two conventional beekeepers meet, the first question is how much honey did you harvest? We don't do that, because we're beekeepers, as I said, we're ecological beekeepers, and if there's honey left, so we just take leftovers. If there's something left over, but you will ask, okay, what's the leftover? Well, we think we can measure the hive, we can weigh them, we can look at it, if we can open it, and we can look at the honey storage. If there is something left over for the beekeeper, we'll take it. We like honey, and we like to harvest honey. But if the quality is weak, we'll leave the whole honey in there. So we don't take honey out and feed sugar water, we leave the honey in there, which makes much more sense than anything else. It's a bad exchange, sugar water and honey. And when we feed this recipe of sugar water, half of it is honey, camomile, and a little bit of salt. And that's it. So honey production is not in focus. But if honey is harvested, we are harvesting between zero. In log hives, for example, at tree beekeeping, maybe 5 kilograms, 8 kilograms at the most, per hive, per season. And if we do it a little bit more professionally with our boxes, with our hives, then per hive it's about 10 to 15 kilograms. And conventional beekeepers laugh at us. They don't like it. Because they like harvesting between 50 and 70 kilograms per hive. And that's crazy. And that's not natural. It's just a trick to give more space to the bees so that they can fill the space with lots of honey. That's the trick beekeepers do. But that's of misusing an animal. It's not right. It's just misusing an animal like you do with cows, with pigs, with all the other animals. And we don't want to do that. And therefore we think that the bees have more chances to survive, are more healthy, than when we try to influence them a lot, all the time. It's a different approach. And this is an approach that Mellifera, as an organization, typically has, I guess? Yes, the whole organization is built on... Well, it started 1985, 1996, when the Varroa mite was coming up. And we tried to do something against the Varroa. So all these treatments are also developed by Melifera in Rosenfeld. And so we developed this oxalic acid vaporization, which is totally different from the formic acid. The formic acid is very intense. And oxalic acid is not that intense. And some say that the Varroa mite is killed, but, for example, the pseudoscorpion can survive. Because this is a little animal which helps the bees. And this pseudoscorpion is a little animal that helps the bees… is eating varroa mites and we're working also with this little animal so some beekeepers of us they have they're breeding this pseudosculpin which then is inside the hive and can help the whole colony yeah so it's a whole organism.

Ben: Yeah.

Question 13

So, my last question is what advice would you give to future beekeepers for this area? Heinz: Okay I didn't get the question about the future.
Ben: What advice would you give future beekeepers in the area?
James: Like if they were to join your organization.
Heinz: Yes. We are open for everybody so there is a beekeepers group which is a commercial group which is called Kreuzberg Beekeepers there in every suburb. There is, there are beekeepers in Steglitz are beekeepers in Kreuzberg and so on and so on and we're not fixed on regional we're just a regional group so and we're not limited to Germany. We are not limited to to Europe we're actually interacting with worldwide beekeepers to get experience from them what they do. For example, in Poland they they still have the Apis millifera millifera so they're working with the dark bee. Just because this dark bee was in former times was was living here and this was this was probably much better adapted to the environment here because than anything else. And so yeah,it's it's hard to say if because we are beekeepers who don't have that much honey.
Ben: Yeah.
Heinz: It's not that attractive. It's not attractive for other beekeepers to join us because they want to just harvest honey…
Ben: Yeah.
Heinz: ...and when in our groups when we have this education this this training for big for people who want to be a beekeeper become a beekeeper then we're trying to tell them that everything is connected.
Ben: Yeah.
Heinz: And you can't separate and do things here do things there and try to improve the the whole thing by just manipulating. And you need to live to look at them at the whole and that's what we're doing as an association which is not limited to Berlin. And we're we're open to everybody so everybody can join us and we were not limited to everybody can say their opinion can say and leave or stay we don't we don't collect money as a beekeepers association we don't have a structure.
Ben: Yeah.
Heinz: Where somebody needs to collect money and the other one needs to write everything down it's it's open it's an open format where everybody can join.

Question 14

Ben: James, Sai, do you guys have any other follow-up questions?
Sai: In the earlier part of the interview you were mentioned this a little bit. I guess I'm interested as how you would tell if the bees are like having difficulty? What how can you tell from their behavior during summertime or during we did research on if summertime it gets really hot they start to cluster outside of the hive is that one of those signs?

Heinz: Yes and no if they cluster outside the hive it's usually too hot and so they try to not try to protect their hive because if they stay inside it gets more hot…
Sai: Okay.
Heinz: …so they stay outside but usually it's an it's an interaction you can see with the brood…
Sai: Okay.
Heinz: …and when there is enough food the brood nest increases. If there is less food then the brood nest will shrink and produce the queen is not producing that much that much bees in that season so you can see a lot from the outside and that's what we're doing with tree beekeeping because you can't look inside. You can't take on frames because the cones are fixed inside.
Sai: Yeah, okay.
Heinz: You can't look where is the brood nest how big is the brood nest how much storage food they have, you can't look at it. So we need to look at the outside. And when you look at the outside, you can, if you just sit there and relax, you will notice that, okay, bees have pollen. They carry lots of pollen, lots of different pollen. There's lots of activity or less activity. There is, for example, strong competition in front of the entrance with wasps. So wasp is a big problem in Berlin. From my point of view, I have big problems with wasps because the wasps, they survive much better or they adapt much better to climate change than the honeybees do.
Ben: Okay.
Heinz: They're not affected from Varroa mites. I haven't seen any wasp with Varroa mites. And one by one is killing weak colonies. In nature, this is all right, but we don't want to lose our colonies, even if they are weak.
Ben: Yep.
Heinz: But sometimes we just need to let go.
Sai: Yeah.
Heinz: And you can adapt a little bit and make the entrance smaller so that they can protect their hive much better. They can try to fight against the wasps. But the wasps are getting more intense from year to year. And this might be also an effect of climate change…
Ben: Yep.
Heinz: …that they have a much better chance to survive or to adapt to climate change than the honeybees. I don't know this exactly, but I've seen the last few years more and more wasps coming in. And even these hornets, which are last year, which were noticed that Japanese hornet takes over as well, which has a long journey from Portugal, Spain, France, and now it's in Germany. Might also be an effect of climate change. And this is definitely a problem also for beekeepers.
Sai: Okay, I don’t think I have any other questions, thank you.
Heinz: You/re welcome.
Open Questions
James: Do you have any questions for our project?
Heinz: Yes. Are you beekeepers?
Sai: No, we…

James: I have beekeeping friends, but this project was more of a school position on what we do.
Heinz: Okay, cool.
James: Our sponsor, though, is a beekeeper down in Tubingen. And we're working with him and some of his colleagues.
Heinz: Good. Because only if you have a chance to look inside a hive, or to touch them, or to do a simple work, then you can feel the magic of a beehive. Because it's magic. And there are lots of things we don't understand yet. Even if there are Nobel Prizes, for example, Mr. Frisch, who founded the waggle dance, Karl von Frisch, and where bees then go in a certain direction to find the source of the nice nectar flow, and all these things. So it's a magic. And if you have bees, and I was lucky that my father had bees. And so I was very early influenced by him and his bees, and always fascinated me. So therefore I can only recommend to do a course for beekeeping. Our courses are full at the moment. And regularly we have lots of interest in our courses. And sometimes we have three courses in parallel. But one course is with 25 people. It's full, it's overloaded already.
Ben: Yep.
Heinz: It depends on how many beehives you have.
Ben: Yep.
James: What's the demographic of the courses as well? Is it younger people, or is it mainly older? It's totally different.
Heinz: So younger people as well as older people who have time, who have retired. But also young people, students, lots of who are interested in how nature works. Not only in beekeeping, but they want to know how nature works. Because we are the only ones who tell them a little bit more about not only beekeeping itself, but more of the whole thing, of the whole environment, that everything is connected together. And that you need to see this as a whole, and not like a car repair center, where you can exchange lots of things. There are lots of things you might see as not working, so...
Sai: If an individual is wanting to start this as a hobby, do they go to these organizations to get resources? Where do they purchase these hives to start the colonies?
Heinz: Yeah, we are too small to support them, for example, with colonies. So they need to watch out for swarms in the swarm season. And they buy this material on the internet. There are lots of beekeepers' shops. But sometimes it's hard to find the right boxes, the right hives for them. And when we tell them that we have certain preconditions for our hives, then they need to think, because most wooden boxes are thin-insulated. They are light, because everything which is good for the beekeeper is bad for the bees, and vice versa. So when we are telling them that this is important to look at, then they just need to ask their heart instead of their brain. And they are working together, heart and brain. So both need to make a decision, not only the brain, which thinks, okay, if you make a business case, eighty kilograms per hive per year, this is this amount of money. Okay, but you need to keep in mind that there is an animal that needs to be treated, who needs to be treated right. And not only this brainwashed thing that you need to buy a new

queen after two years, because the old queen, which is usually staying for five or six years in a colony, she can really survive this long…
Sai: Oh, really?

Heinz: …laying eggs all the time. But conventional beekeepers, and I'm sorry I need to mention every time this conventional beekeepers…
Sai: It's okay.
Heinz: …but sometimes they exchange the queen after two years, because the queen doesn't lay this amount of eggs anymore.
Sai: Ahh, okay.
Heinz: That's important for them, because more forage bees will produce more honey. And if the queen is laying less eggs than in the first years, then they exchange the queen. That's what we don't do. Our queens can live as long as they like to live. For example, I'm a little bit older than you, but this would mean if we do this with humans, I would not sit on this table. I would be erased and not needed anymore. That's what beekeepers do with their queens. Too old? More than two years old? Okay, get rid of it. New queen? okay more brood, more foragers, more honey. And that's not right. That's not how to treat an animal. Where are you from, by the way?
Ben: U.S.
Heinz: U.S.?
Sai: I was born in the States, but I lived my whole life in Kyrgyzstan, in Central Asia. Heinz: Ah, cool.
James: I'm also from the United States.
Heinz: United States? Wow, cool. We have contacts to the area of San Francisco. We're working with people who are more biodynamic beekeepers, more ecological beekeepers. And in two hours, there's a symposium called Honey Bee Watch of a friend of mine. And we have a discussion with Celie. And these beekeepers in the area of San Francisco who do bee lining. Bee lining is something where you find a bee, a honey bee on a flower. If you follow her, you see where is her home. And that's very interesting because you need to catch the bee, you need to feed the bee, you need to train the bee.
Ben: Yeah.
Heinz: And the bee comes back all the time. You mark the bee and then you follow the bee. If you catch her in a small box, you put a mark on it. And then you go to a different place where you see, okay, it might go in this direction. And you walk in this direction and then let her free. And she comes back.
Sai: Oh, wow.
Heinz: And this you need to do several times. When you are close to a tree or to something where their original home is. And then you find a colony which might be living in the wild and not with a beekeeper.
Sai: That's really interesting.
Heinz: It is.

Sai: Oh, wow. Are we closing for questions then?
James: Yep.
Sai: Thank you very much for letting us record the interview. And we will probably be ending it right now if that's okay with you?
Heinz: Yes, it is.

Appendix G. - Interview Transcript with Jonas Geßner

Interviewee: Jonas Geßner, Stadtbienen-Berlin
Interviewer: Vijay Mistry
Scribe: Benjamin Penti
Recorder: Isabella DeFronzo
Date of interview: 10 April, 2024
Location of interview: Atelier Gardens, Oberlandstraße 26-35, 12099 Berlin

Participation Agreement

We are the CALENDARS Team, a project coordinated between Worcester Polytechnic Institute and the CALENDARS Project. The goal of our project is to create a deliverable that will help inform beekeepers of potential effects from climate change and shifting seasonality on their hives. Our hope for this deliverable is to give beekeepers another resource to refer to when deciding how they should manage and care for their hive. This interview's focus will be surrounding your experience beekeeping and ways in which changing seasonality has affected you. As this project progresses, we will draw from these interviews for firsthand experiences and testimonies, with or without your name, depending on your preference. Do you consent to having your answers recorded for this purpose?

Interview Transcription

Vijay: I'm going to start recording now. But our participation agreement says that we are the CALENDARS team, a project coordinated between Worcester Polytechnic Institute, which is our school, and the CALENDARS Project. The goal of our project is to create a deliverable that will help inform beekeepers of potential effects from climate change and shifting seasonality on their hives. Our hope for this deliverable is to give beekeepers some other resource to refer to when deciding how they should manage and care for their hive. This interview's focus will be surrounding your experience beekeeping and ways in which the changing seasonality has affected you. As this project progresses, we will draw these interviews for first-hand experience and testimonies with or without your name, depending on your preference. So, you've consented to have these answers recorded for this purpose. If at any point you want a statement off the record, if you'd like it not to be used in a paper, feel free to let us know. We'll be more than happy to do that.

Jonas: Okay.

Question 1

Vijay: So, the first few questions you're going to need to know is your personal experience with beekeeping. So, the first one would be, how long have you been beekeeping for personally and how would you define your practice? Would it be more commercial, would it be more as a hobbyist, or somewhere in between?

Jonas: Okay, I did my first beekeeping course with Stadtbienen, actually, in 2016. And that's when I really first encountered with beekeeping in person, before I was reading a bit about it. But once I started, I got hooked and I was reading more and more, and I was never interested in setting up my own apiary in terms of having a lot of hives and producing honey and all that. I was always interested in the complexity of these colonies or how this insect organizes them, like how they organize themselves as a super organism. So, I never had more than two or three colonies myself. I would, sometimes we refer in German, we make a difference between, well, I would call myself more like a beekeeper, but in German, there's another word which is more like the honey producer, and my heart is closer to just providing them a place and also learn from them and also from the beginning, I started using them as an opportunity to teach children and also adults about environment, about environmental change and how everything is connected. Because I was very much inspired by doing the beekeeping by the movie, More Than Honey, which showed us that something needed to be done in order for the bees to survive. I would think, although now I'm in charge now here of 300 plus bee colonies, I'm still a hobby beekeeper because I'm not managing them myself, I'm just coordinating the projects from here. I'm talking to all the beekeepers, giving advice how to do things, but many of them have much more hands-on experience in beekeeping than I would have myself.

Question 2

Vijay: You talked a little bit earlier about these niches that are used here that you've used personally that are used in bee boxes across Germany. Could you go over the species again one more time?

Jonas: Yeah, basically what we as Stadtbienen would always say is the most important thing, it's local bees. So it should be honeybees, which are bred here. You shouldn't import them. We are not fans of, like you can even get what we call parcel bees, like you get a swarm sent by parcel from even sometimes from foreign countries. We are not into that at all. At the same time, we are not focused on one certain breed. The most used breed here is Apis mellifera carnica. So the carnica bees I think they're the most successful all over in the world now, although they originated in Slovenia and the south of Austria. And our local bee would have been Apis mellifera mellifera, the dark bee, which is common here up to Scandinavia and, yeah, I think in Switzerland, like the whole area. And which has been successfully or nearly successfully eliminated by all the breeds which have been taken in from Carnica bees because they produce more honey and they are less aggressive than our originally local bees. But we are not trying to preserve the old bees, we are very fond of these projects, but our main focus is on keeping a very diverse gene pool in bees. And so, especially in this urban environment, you would have a wide mix nowadays, which is probably dominated by Carnica, but, you know, people bring in Buckfast or the Italian bee or, as I mentioned, like there's still colonies of dark bees or they have brought them back in from Belgium, for example, where they breed them quite successfully. And

for us, it's more about that they have been adapted to the area here than that we look into a certain breed.

Question 3

Vijay: Stadtbienen as an organization, is very much focused on beekeeping within the cities, so I know you're not doing as much personal beekeeping now, but what is the reasoning behind beekeeping in a city versus doing it out in a more rural area?

Jonas: Yeah, I have to say, I wasn't aware of it, but beekeeping was an urban thing since centuries. After World War II, we had more beehives all over Germany than we have nowadays. And even in the cities, it was quite common, a bit like keeping pigeons as well and stuff like that. It was a way where you could do, because officially, as a beekeeper, you're a farmer, but in the city, you don't really have farmland, but still, you can farm the land by harvesting the nectar here. And when we started 10 years ago, it was a time where some research was done that cities are in some ways now the even better places for bees to live than somewhere in the countryside where there's a lot of agriculture and where you have a lot of monocultures. Let's take maize, corn, for example, which is like a green desert for insects. I mean, there's one or two who are very happy about corn because they live from that, but for insects or in terms of blossoms, there's nothing out there. So urban environments have a very diverse crop out there, or a lot of different plants which are interesting for bees or insects in general, but especially also for honeybees.

Question 4

Vijay: We talked a little bit earlier about seasons and how those work into beekeeping. One part of our project is understanding how beekeepers define their own seasons. So traditionally, you have fall, winter, spring, summer. We were wondering if you as a beekeeper would split these seasons into a different shape. We've had people talk about how there's like five main seasons throughout their practice where they do different actions. So we were wondering what you would kind of split up your year to look like, like what would you be doing in each phase?

Jonas: Yeah, well, I can't give you a very theoretical approach on that, but it's basically, you have to base your stuff around the finish phenology of the plants, like what is in bloom at what time or when does, at what time does we reach a certain temperature so the insects would fly and not be in their hives. So what we keep saying in our courses as a fun fact is that with the lime trees you reach kind of the peak of crop here in urban environments and at the same time it's the last mass crop we have. So afterwards there's only, nectar wise there's not as much food around and so we keep saying to people that bees in July they start to prepare for winter, which sounds strange because in the middle of summer, but basically for them the peak is over, I mean as you probably know the hives grow until mid-summer and that's when they reach their biggest size and then the brood would shrink again, the queen would lay less eggs. During swarm season she could lay 1,500 to 2,000 eggs a day, which is quite amazing because that just shows how big these colonies are at this stage.

Question 5

Ben: Just to follow up on the question, what kind of plants would you find specifically here in Berlin that are major markers for blooming?

Jonas: Yeah, when the hazelnuts bloom that's very important for bees because it gives you the first pollen in the year. It's not so much about nectar at the beginning because they still have their honey from the winter which they collected from last year, but in order to grow their brood they need fresh pollen. So hazelnut would be a very important indicator and in our beekeeping associations you usually have one person who is looking at phenology and would tell everyone hazelnut has started blooming this year and it's five days earlier than in the average or ten days earlier, whatever. This is one of the things you look at and then it's mainly temperature, I would say, and that's something like in the past you would, when I learned beekeeping only 16 years ago, not 16, 2016, I was still told it's basically six months where the bees will rest and it's not like that anymore because it's not getting as cold in autumn and in winter and it also starts to get hot much earlier again. But I think the next few ones would be crocus, I don't know the English word, it's like a purple flowers which are very early in bloom when it's still very cold, but on sunny days that's another one where they take a lot out of, in terms of pollen. And I think the first nectar would be with all the fruit trees like apple, cherry, pear, plum trees, that kind of stuff which gives really a lot of nectar and also maple is very early in the year.

Question 6

Vijay: So in relation to the weather patterns are changing, so there are higher temperatures throughout the year, winter itself does have that increased temperature throughout it, so you might have answered this a little bit already, but if in an imaginary scenario, you could control the weather, what would be the ideal climate during the year for beekeeping?

Jonas: I mean, we have to see that the honeybee is very adaptable to different territories and also to different kinds of weather because you have honeybees in Africa as well as in the Mediterranean where it never really gets as cold as it gets here and you have them up until Finland where there's only three months of spring and summer and that's basically it and it's like a much shorter season. But for here I would say ideally you have cold winters which are probably, well they used to start in November, it was getting that cold that it would be under minus zero degrees Celsius and that lasted until the end of February and only in March it would kind of, the temperatures would climb up above zero and that gave bees a very good break because while it's that cold they would go out of brood and just rest in that, I don't know how you call it, we call it a traube, I don't know, when they just come together very close to warm each other. But basically that helps them to rest and they get not worked up by all the things they have to do because in the past it was said there's different bees in winter than in summer because the winter bees would live up to six, seven months while the summer bees would only last for five, six weeks. And the initial idea was it's because they work so hard collecting that they completely work their ass off and die. But they found out that looking after brood is the most labor intensive thing they have to do. So being out of brood in winter gives them the opportunity to survive over that long period of time without having any bees coming after them because during high season it's a constant change with the one to two thousand I told you who are born each day, also one to two thousand die each day because they're at the end of their life cycle. And yeah, I think in terms of winter that would be ideal and then in terms of summer not as hot as we have it now and

especially not as dry. It can get hot, bees can adapt to high temperatures, that's not such a big problem but if it's too dry the crops will not produce nectar and then they can't find food and that's obviously a problem for them.

Question 7

Vijay: Related to that, earlier when we were at the bee boxes outside we were talking about how the past three years have had very specific conditions that made it not very good for beekeeping. So looking back to the past three or even the past five years, could you name those conditions once again that were negative for the practice of beekeeping?

Jonas: I will try but I'm not very good in keeping. I think last year was quite okay. It was hot and we had these temperature records but we also had enough rain in order to keep the nectar flowing. The year before it was too wet and too cold in spring and May is a very important month or April-May because as I told you the winter bees who lived that long they now have to be replaced by young, new bees and that's really a bottleneck because more bees are dying than are coming at that stage because the winter bees are worked up and die. So we had a very long period where it was too cold and therefore many of the hives didn't develop as good as they should have and the year before was I think one of the years with a lot of drought and at that year they couldn't find enough nectar in summer then. So yeah, you can just see if it gets out of balance it affects them in different ways so I think the temperatures we used to have here in middle Europe were kind of perfect for bees and they're not as good anymore, but they're not as bad as in some other environments as you have heard from the professor on that conference about Saudi Arabia where they just, I mean it's throwing bees into an environment where they can't survive basically. So it's not as bad as that yet but still already we can see how it really affects our bees and the harvest you can have at the end of the season.

Question 8

Vijay: Shifting gears a little bit, we talked earlier about how Stadtbienen as a whole is focused more on the survival and well-being of a bee over honey production but just to restate it for the recording, how would you measure success in a beekeeping season whether it be honey, survival or another metric entirely?

Jonas: For us it's, a good season is where the bees would like to swarm a lot because that means that they are thriving, that they really want to reproduce themselves because in order to have new colonies bees need to swarm. Like the reproduction on one to one wouldn't produce any new colonies, it's only that phenomenon when a few bees or half of the bees together with the old queen swarm. So that's something we see as quite successful although many traditional beekeepers would see that as a failure because it means they haven't managed their hives in a way where they force them to stay which mainly means cutting out all the queen cells once you see them and having a good survival rate in winter so that not too many bees die. And at the same time, we are not fans of blowing up colonies artificially by beekeeping techniques in terms of numbers of bees because once you make the colony very big also Varroa would really thrive in these hives because they have then plenty of brood to mate in because they need the brood in order to thrive themselves. So it's not so much about size and making everything bigger and what

we would see as the most healthy colonies, it's more if they can get along with the Varroa or if we can implement enough techniques to keep Varroa down. And I don't mean by treating with acids because there's other ways where you would artificially get them out of brood because then you can treat them with acids which are less aggressive than antacid for example which is mainly used in summer. So these are called biotechnical measures you take. I don't know the English term, the exact translation, but it's by caging the queen, for example, or you would exclude the queen on just certain frames so she can't put her eggs in all the others and then you can treat it and get Varroa under control. And if they have a great variety on pollen and different nectars, because research has shown that not only for us people, if we eat honey from a very diverse crop, also for the bees, that's a very healthy diet.

Question 9

Vijay: So Stadtbienen as an organization is very focused in education, teaching people how to beekeep effectively, especially with this focus on survival and helping bees just be bees. So with that, what resources or recommendations would you give to new beekeepers as they're getting into this practice, especially when it relates to weather-related issues and weather-related changes to beekeeping?

Jonas: I don't know if there's any special things we would recommend them. Obviously, I think, or I can put it that way, in our beekeeping courses, we take a very broad approach. That means at the beginning in our introduction, we would not only tell you, okay, we will show you how to manage the hive, how a queen is bred and blah, blah, blah. We also try to include that in the bigger picture that we would talk about what has it to do with our use of landscape. What can we do in order to protect insects in general? And it's not so much the beekeeping itself. As consumers, we have choices. If we eat organic food, for example, less pesticides will be used in production, and that's something which helps insects a lot. Also, the organic farming techniques are less intrusive and less aggressive. These are things we try to shed a light on and kind of show people how it's connected to our everyday life and what impact everyone can have if they do certain things or don't do them. That's why for us, it's from the beginning also linked to that whole topic of climate change. And still in our courses, we teach all the techniques to keep the bees. And we are also, although we would say in our way of beekeeping, we are not so much focusing on honey, we are not against honey or anything. We have a lot of participants who would tell us, but I want to produce honey, and that's fine. We also teach that. We just want them to have a better understanding that the bees are not here to produce honey for us. They are here to produce honey for themselves. And if we take it off them, it has this and this effect on them, and we have to deal with it or look after them, because it makes the interconnection is even stronger if we take out more, because that means we are responsible to look after them, that they will get happily and healthy over the winter.

Question 10

Vijay: So the last question we have for you is about what we're creating as a group. So our goal is to create a tool that can help beekeepers in their everyday life in their practice. So we're putting together what we're calling a dynamic calendar. And so what that is, is time, seasonal events, and changes to those seasonal events to practices that help mitigate the effects. So, for

example, if there was a very warm winter, it would show beekeepers practices they can implement to help their bees through this former winter period. So our question to you, as a beekeeper, but also as someone who interacts with some of the beekeepers on a regular basis, is in what form would this be the most helpful, whether it be a digital website, if it was a physical booklet, how would that be best able to help beekeepers?

Jonas: I think the way is to go digital. We can see, especially with our young urban customers, there is a shift going on. For example, in the past, you would write notes by hand on every hive. Like my mentor, where I learned the beekeeping from, he was over 80 and he had a sheet of paper in the hive, which he would just put underneath the lid and really write down, okay, I looked through them, I saw the queen, pollen is fine, blah, blah. And that's something people don't do anymore, they would keep digital logs. There's a lot done with smartphones now, so even if you could go for an app, that would be great. And there is stuff out there already, like you might have heard of Bee In Touch, which is, I think, the most used German one, like bee, like the animal. Or Beeb, with double E, dot NL is from the Netherlands. I think both are available in English as well, and they already have a lot of things that you can record also in terms of weather and stuff, which kind of gives you reports afterwards on how your bees have done over the years. And that's something where I see great opportunities. At the same time, in some of the things, like there's also a big interest and I would say, yeah, beekeepers tend to like developing things. So there is people who have put a lot of electric gear nowadays in hives where you can measure temperature, weight, humidity, and you get that sent to your smartphone 24-7, so you basically can see all the time what temperature do I have, is the hive growing, like if it's getting heavier or less. And there's interesting stuff going on, even nowadays with AI, where they identify pollen colors and they can, in some ways, if you crunch the data right, even relate it to certain plants, where they not just say, okay, it's a brownish or yellowish pollen they collected, so they can even suggest what kind of plant that could be. But at this stage, I see there's a lot of data collected, but it's not used or processed a lot yet. So this is really what I hope will happen next, that there's more focus on what can we do with all this information instead of just recording it.

Vijay: Alright, that's all the questions we have for you today. I don't know if either of you have anything else you'd like to add?

Additional Questions

Question 1

Ben: Yeah, I wanted to, we kind of talked about this outside already, but just to put on the record of, just kind of briefly going over the differences between the typical bee box that you have and the more old-fashioned beehive in the tree.

Jonas: Yeah, I mean, beekeeping, modern beekeeping is not that old, like keeping the bees in boxes is maybe something we do since 150 years. In the 50s, 60s, and 70s of last century, a lot of bees were still kept in scabs, so in these basket structures. And this is much closer to what they were kept in nature because they would build their own combs just the way they wanted inside and it's a stable structure. You can't move anything and this whole idea of we build a box and put in frames came, I think, 150 years ago. And it's something which benefits the beekeepers a lot,

but it's a question how much it benefits the bees. What we have done with the Bienenbox is, or what makes it different to most boxes you can find here in Germany, is that we have one room where all the frames are in. Usually it's separated in layers and then some beekeepers would use a queen extruder, which is like a fence, which doesn't let queen and drones through because they're too big to keep her in a certain place of the hive in order only to have brood there and reserve the whole lot of other layers for honey. We believe that the brood nest should be as small or big as the queen or the colony chooses to build it. That's why we have this one big trunk hive where we put in the frames. And still we wanted to have the frames because as an educational tool, it's much easier to learn about beekeeping if you can take them out and look at the combs than if you just have this stable structure. But I think for the bees, it could be better to live in these old structures, either it's the trees or baskets, which I showed you, that reed tower, which is a bit of a combination of a log hive and these old basket things, because they breathe much better. So thereby it's not getting as humid within the hives than what we have in the boxes. So we have created this hive and it gives us great educational potential, but we don't see it as the end of development in terms of what's best for the bees.

Question 2

Ben: So in some of our research, we're finding that polyurethane, which is more of a plastic kind of hive, is having more promising results in maintaining a constant temperature and humidity level. I was wondering, have you guys experimented at all with more...

Jonas: Yeah, well, in ecological beekeeping, we don't want any artificial material. So one of the policies, if you want to get certified organic, is that you're only using natural materials, which could be wood or straw, reed, or even clay. But it's true that they keep the temperature better, but in terms of humidity, they're even worse because they're completely insulating…

Ben: Okay.

Jonas: …and then the hives have the highest humidity in them. And somebody said it's a bit like having bees in a tropical climate, although they don't really like to live in that kind of environment. They like it more dry inside.

Ben: Okay.

Jonas: But maybe, I don't know, maybe I misunderstood. I know there's a few very...I don't know if you have seen Hiive. It's basically that trunk model but it's made out of cork and it has a plastic cover. And that's a very interesting new approach because they have taken into account that it should be good insulated but at the same time not as humid inside. But again it's a hive which is good for the bees but it's hard doing beekeeping with it when you have to manage in cities because when I told you earlier on that swarming is something we welcome. At the same time we don't want the bees to swarm uncontrolled which means we basically check for queen cells once a week during swarm season and if we see them we don't break them. We would kind of manually divide the colony by taking the old queen and maybe half of the bees which are inside and then we build a new swarm and with this one we can… yeah… start a new colony somewhere else. Instead of letting it fly out and then you have to catch it because that can be, if

you might have heard, we had the first swarms here this year already which is far too early. It was always said for Germany not before the 20th of April and now somebody told me here in Berlin her first swarm was at the end of March and last Saturday when it was so warm and like summer I got about 5 to 10 emails from people who saw swarms somewhere around Berlin and were looking for somebody to catch them and that's a difficult one because here they don't find any places where they could nest. So therefore we're happy with the swarming but at the same time it has to be in a controlled way. If you're in an environment where you can let them swarm and collect the swarm again that's fine otherwise we, I always call it the scissor, I don't know the English word, if you don't have a natural birth but you have a…

Vijay: A cesarean section?

Jonas: a cesarean section and that's kind of the way what we do with our beekeeping, we just take and divide the colony just before it would swarm.

Question 3

Ben: Sorry for asking so many follow-up questions. We're starting to do a little bit more research into beekeeping technology so I'm just, the hive materials are one of them. You also mentioned talking about like people using different types of like sensors and things like that. I don't know if you've had any experience using these types of like research but have they been an effective way to manage a hive and handling like increasing temperatures or decreasing temperature in the hive?

Jonas: They can be if you really know how to read them. I mean the idea is in order to keep your brood alive they have to maintain a temperature of 35 degrees, something between 36 and 34. So if they go into brood again after winter you can see it by the increased temperature before the temperature would be only 10 to maybe 15 degrees in the hive and then it goes up and then you know if they keep that constantly and you don't have to go there and pull up the lid and you already know that kind of stuff. So all these technology can help to, if we use it well, it can help that we have to do less destruction because every time you open that lid they say it takes about two days until they get everything up and running again the way they want it because you're interrupting by doing that. And also scales I think are quite successful. Successful, because you can see if there is a certain amount of crop coming in, or if that's, like if the scale drops, you know, they're not finding food, they're eating. So basically, that means you might have to even feed them or look after the hives if there is enough inside. So in these terms, that helps. But I think we are still at a stage where people add all these gadgets, and at the same time, they are still opening their hives all the time. So we are not there yet. That's what I meant when I said earlier, by using all the data we collect in order to make really the right decisions and implement that.

Ben: Okay.

Question 4

Ben: I guess I have two more questions. So like, if we develop something digital, do you think, so currently for us to develop something digital with our limited time frame, it would be very

much more of a skeleton of a program. Would you think that would be a better application, like a skeleton of a website, or a very thought through infographic would be? Like an infographic sending like a newsletter or a booklet of some kind?

Jonas: Probably the infographic I would go for, because especially if you send it at certain times, it's something which is reminding people much more than if you just put up a website, because obviously if nobody is, if you don't get any notifications, you might not look it up.

Question 5

Ben: And then just kind of looking over our interview, I just kind of wanted to clarify our question about the seasonality. I was wondering, just trying to rephrase the question is like, if you were to walk us through your beekeeping, like a beekeeping year, what would be the different periods and what would mark each period in your mind throughout the entire year?

Jonas: I think we could like easily go by the seven steps which we use for our practical sessions during, because our beekeeping courses go over a whole season until the next year. And if you walk through that, that gives you a good idea of what has to be done at what times. But even there, there might be a difference if it's our beekeeper in Hamburg, or if it's our beekeeper down in Bavaria, because seasonality is a bit different there.

Ben: I guess we could then define it just purely here in Berlin then. And then also, what are your seven steps that you were talking about?

Jonas: The first would be like, our course is basically based on, you put on, from the start when you set up a new colony, that's the first step. So, setting up a hive, and then you either you catch a swarm, or you get an artificial swarm from somebody, and you would put that in your hive. That's first step and that's happening usually in May. When I say usually, this year, it could also happen this month already. And it's something which you can delay until the middle of June. And then I would say it's nearly too late, because they need enough time to build all their resources for winter. And once you have set that up, the next step, yeah, that's not really probably a seasonal step. It's more about to get used to beekeeping practices, how to use your tools and your equipment. That's our second step in which we have in June. Then you have in summer, it's basically two topics. It's Varroa treatment and honey harvest. But honey harvest is something we teach only theoretical at that moment because obviously, first of all, we are not so much into the honey harvest thing, but also in the first year when you set up a new colony, you wouldn't harvest because you have usually fed your bees in the first few weeks with additional sugar syrup, which we also do because it helps them to constantly build their nest so that's summer in July. And then you have in September, which we call Einwintern. You make them ready for winter, basically. That's where you really have to check again, do they have enough food and where you even, you can either use a scale or you just go through all the combs and add what you guess what's in there. And you have to make sure that you have about 15 kilograms of honey in there in order so they have enough for the whole winter. Then you don't do a lot anymore until December. Some of my beekeepers say, don't do it before the 6th of December, Nikolaus Day, which is an important holiday here. And I think it's mainly this, they say, because you can remember it well. But basically, the winter Varroa treatment can only be done when the bees are out of brood. And

the things you have to keep in mind is from the first frost, like from the first moment you have temperatures below zero, it takes another three weeks before there's no brood anymore. Because even if she stops laying, there's still three weeks brood, which is in the making and new bees will come. And then you're out of brood. And that's very important, because that winter treatment only works because it's not as aggressive from the acid. It only works if there's no brood, because it doesn't go into the brood the way. And then you jump to spring, which is in March, we have our next step, which is basically checking, do they have enough food or do I have to feed them some, it's a paste of sugar you can give them at that stage, because the liquid syrup, they wouldn't really take if it's too cold. And you also have to check, did they survive? How big are they? You would take out old combs, which have been used for two, three seasons, and you would extract them. And you also set the colony in a smaller, by taking out empty combs, you would minimize the space where they live. And by doing that, you give them the opportunity to keep that warm much better, because it's obvious, if the room is big, they have to heat more. So you keep them compact. And by doing that, that makes them happy to go into brood again and to start again. And then you have to constantly add more frames from usually April, but we teach that in March already, because we only have these certain points where we teach. And the next step is swarming then in May. So that's...a full cycle where they would be a grown colony. In the first year, even conventional beekeepers wouldn't harvest honey. So only in the second year you would have a full-grown colony. And then the cycle starts again by swarming and you can start with a new colony and so on. That's something you find on our website as well, like the whole year cycle. We don't have an English version, but Google can translate it for you on the website if you want to look that up again.

Ben: Okay, that’s everything on my part.

Vijay: I think we are all good on our end. Thank you so much for interviewing with us today…

Jonas: Yeah.

Vijay: …and for taking the time out of your day.

Jonas: You’re welcome.

Vijay: We will definitely be in contact again about sending out that survey to your beekeepers…

Jonas: Yeah, yeah, for sure.

Vijay: Probably within the next 24 hours we’ll have that sent over to you as well.

Jonas: Yep, cool.

Appendix H. - Interview Transcript with Professor Tim Landgraf

Interviewee: Tim Landgraf, Hiveopolis
Interviewer: Benjamin Penti
Scribe: James Teague
Recorder: Saida Bahtierova
Date of interview: 18 April, 2024
Location of interview: Basics Coffee, Königin-Luise-Straße 39, 14195 Berlin

Participation Agreement
We are the CALENDARS Team, a project coordinated between Worcester Polytechnic Institute and the CALENDARS Project. The goal of our project is to create a deliverable that will help inform beekeepers of potential effects from climate change and shifting seasonality on their hives. Our hope for this deliverable is to give beekeepers another resource to refer to when deciding how they should manage and care for their hive. This interview's focus will be surrounding your experience beekeeping and ways in which changing seasonality has affected you. As this project progresses, we will draw from these interviews for firsthand experiences and testimonies, with or without your name, depending on your preference. Do you consent to having your answers recorded for this purpose?

Interview Transcription

Saida: And I think I'll just put it nearby.

Dr. Landgraf: Yeah, yeah, sure.

Saida: It's a bit noisy.

Dr. Landgraf: Yeah. Okay.

Ben: Okay. We're the Calendars Team, a project coordinated between Worcester Polytechnic Institute and the Calendars Project. The goal of our project is to create a deliverable that will help inform beekeepers of potential effects from climate change and shifting seasonality on their hives. Our hope for this deliverable is to give beekeepers another resource to refer to when deciding how they should manage and care for their hive. The interview's focus will be surrounding your experience beekeeping and ways in which changing seasonality has affected you. As this project progresses, we'll draw from these interviews for first-hand experiences and testimonies with or without your name, depending on your preference. Are you okay with us using your name?

Dr. Landgraf: Yes.

Ben: Do you consent to having your answers recorded for this purpose?

Dr. Landgraf: Yes.

Question 1

Ben: Okay. So our first question is more just kind of general about you. I've read through a lot of your research. I noticed you did a TED Talk. So just kind of going into it, are you a beekeeper? If so, how would you consider yourself? What kind of beekeeping practice? Are you a commercial, hobbyist, purely academic?

Dr. Landgraf: Yeah, no. No, my background is in computer science, so I'm a roboticist/machine learning researcher. I do look at collective behavior, so decision-making and coordinated movements and actually all kinds of animal groups, so including humans, but mostly focusing on fish and honeybees. Honeybees, because they're like a fantastic model. And so I'm not a beekeeper. I do have a beekeeper in my team. I do know a couple things about beekeeping, but I'm not practicing beekeeping. I'm not, you know, experienced enough, I would say. Yeah.

Ben: Okay.

Question 2

Ben: Yeah, as you mentioned, you do research into machine learning and animal behavior. More specifically, I saw some of your research into the robotic bee system with, like, analyzing the queen bee.

Dr. Landgraf: No, no queen bee. So the honeybee robot is supposed to perform honeybee dances.

Ben: Mhmm.

Dr. Landgraf: And there are a few different types of dances, but we were focusing on the waggle dance, which is communicating the location of new found resources like nectar or pollen or even water and resin, whatever becomes valuable throughout the season, right? So a forager comes back, performs this waggle dance, and like a handful of nest mates of future foragers are following, not just like looking.

Ben Yeah.

Dr. Landgraf: Actually looking isn't possible because it's dark, but not just like, well, actually running after her. So it's like a pair kind of dance, a one, two, five or ten. And after running after

her a couple of times, they kind of decode the content of the dance and understand where to go, which is crazy in its own.
Ben: Yeah.

Dr. Landgraf: And the honeybee robot is supposed to imitate that dance. So we want to see other bees running after her, after the robot, as if, you know, they would follow and decode like a natural dance. And then we would like to see them fly out. And I've built this robot to understand the components of the dance. So what kind of, like, right, if I say a sentence, there's, like, stuff in there that's really important and essential for you to understand the meaning.

Ben: Yep.

Dr. Landgraf: And then there's the 'ahs' and ums and those things that don't actually need to be in there. But they're kind of in there because that's how I do things. And so what are the things that are important in the honeybee dance? You can approach this question by using the robot because then you can tell the robot to, you know, switch on or off different components like wing movements, or you can make it smell this way or that way. You can make it become hot or not. You can change different motions, you know, which you can't when you have natural bees and living bees. You can't tell them not to move. I mean, you can cut the wings, but yeah, we don't want to do that.

Ben: Yeah.

Dr. Landgraf: And also, you can't control all these aspects. So it's much more elegant to use the robot. So that was the idea, which was much easier to think than actually to do. And then, that was my PhD thesis, so more than 10 years ago. And then I got a new grant a couple years back, and that grant was more of an applied kind of thing, so that's the Hiveopolis project, which is much more complex than just the honeybee robot, but that was one component in it. Here, the idea was, okay, even without understanding what the dance is, if the robot works, we can use it to send bees there or there. So if, for example, we knew there's a new, I don't know, flower patch in bloom that provides very high energy or high-protein pollen, we could send them there and not wait until they found themselves. So… but the honeybee robot is really delicate and really hard to actually make work kind of thing, so that's really basic science. It's far from being applied anywhere other than the lab.

Ben: Okay.

Question 3
Ben: How was the honeybee robot able to decipher what the bee language was?

Dr. Landgraf: That has been published decades back already, so in the 1940s, a guy who then eventually would get a Nobel Prize for also this discovery published a paper saying, look, they're not just dancing because they found something, they're dancing something or they're moving such that they're communicating information that is beyond that mere existence of food, it's also communicating location. And then this guy also said how to decode this. And then there was a long controversy about whether the bees actually decode it. I mean, we as humans can decode it, right? So there's a distance component, so the longer they do this wagging kind of motion, the farther away the food source is. And the direction was a little tricky to decode for us humans because it's depending on the sun. So as the sun travels, the dance would rotate. And so it was really hard to understand, okay, that's actually the reference direction. But so for us humans, it's clear what all these things, at least on an abstract level, mean...

Ben: Okay.

Dr. Landgraf: …it was like many decades after the first description, it was really unclear if that is really used by the bees. So that would make it a communication system and not just like, well, something's correlating with some external properties. And then in the 90s, beginning of the 2000s, there was a guy or a team of people who used radar to actually track bees that have been following a dance. They also like were displacing bees from when they, you know, decoded the dance and they would run out and they would catch them before they would fly off and then would take a bike and bring them there just to see how this fight path looks. And it turns out, yes, they actually fly a vector. Irrespective of where they start, yeah? So they're not just like seeking something that smells like this. They're actually translating this into a vector flight. So that was known. And so the only thing that I did was track the dances on videos, make a model from like a statistical analysis, what kind of movements seem to be important because they don't vary much. Make a model, implement that on the robot, and then tweak the robot as long as it had to be tweaked to actually be accepted, which means not attacked. And then at some point they would follow. I mean, not all the time, right? So there's still some things we don't understand but that was the first time that was captured on a video. Bees would consistently, not just one or two waggle runs, so a really long time. When they decided to start following and decoding, they would even do that for 20, 30 or so waggle runs as normally they would do on natural dances. But yeah, so I think there are a lot of things to look at rather than just simply what it will look like many many questions still open, some of which motivated me to track pretty much everyone in the in the hive so we mark everyone with a barcode like markers to understand you know how previous experience shapes the future. Your future decision like the foragers future decision to follow the answers or which that's to follow for example.

Ben: Okay, huh. Would with like directing the bees, would there be like I would say because you were mentioning like right now it's only really capable in a lab, but for like you know the future

would you be seeing any like application or even just anything from your studies being applied to the average beekeeper?
Dr. Landgraf: I think there's a huge gap still between what we do and what beekeepers can do. It's not that there's knowledge missing I think beekeepers are really, I mean not all of them right, there's always a distribution of how much time they also invest and stuff and how old they are. I don't know how old your beekeepers and on average are here it's pretty old, it's like sixty something.

Ben: Yeah we've been finding that with a lot of our interviews it's yeah much more older side.

Dr. Landgraf: Yeah, I mean it depends also on where you look I think in Berlin it's much better than you know on the countryside but yeah, so I think it's it's limited to time so if there's technology that you want to use and it doesn't work you know pressing one button or just putting it in there and so there's no clear benefit of it. You know if that use case isn't validated well and it's not adapted well to the needs of the user it won't be adapted and it's far from that. So…

Ben: Okay.

Dr. Landgraf… and the bee robot I think it's it's never gonna make it into into a commercial hive or a beekeepers hive in time soon because it so for the application of sending bees somewhere you don't need a robot. We're experimenting with tunnels so it's also something that there has been known before if you have a tunnel, narrow tunnel, with like black and white random patterns printed to the walls…

Saida: Mhm.

Dr. Landgraf:...and you there's like a mesh right so that they can't go, go up and out.

Ben: Yeah.

Dr. Landgraf: But to train them to fly through the tunnel they don't have like overlapping fields of view for both eyes right, so they they can't see the depth. What they perceive is a high optic flow as if they are flying really fast.

Ben: Yeah

Dr. Landgraf: But they don't they just find a tunnel but they don't know and they overestimate the distance that they fly and they report that in a dance so you train them in a six ten or so meter tunnel to drink from a food source that would you know result in a round dance which doesn't

have any distance and directional components in there kind of does. But yeah, that doesn't matter. But it's not a waggle dance but if you have the bee forage from the feeder in the tunnel.

Ben: Yeah.

Dr. Landgraf: Those six or ten meters of tunnel flight leads to an overestimation of the six meters into something that you know feels like a hundred or two hundred years and so they would dance a waggle dance now if you rotate that…

Ben: Yeah.

Dr. Landgraf: …that tunnel you can rotate those dances and basically send other bees to those virtual locations now having a six or ten or even longer tunnel and rotate that is a pretty pretty laborious task so I'm testing a like a tunnel simulator so bees fly in there they have a little metal tag they click themselves onto like a like a little carbon rod with a metal with a magnet on its end so they are like tethered there and then we switch the walls on and the walls are moving.

Saida: Mhm.

Dr. Landgraf: And then you can turn this whole thing, it's not like longer than this like you can just put it on the table and turn the table. Yeah, so far it doesn't work perfectly but we do see dances and that's that's crazy it's a crazy first step and we're gonna publish that soon so hopefully nobody is hearing that and is stealing my idea. But yeah, so I think this is the kind of thing that would work, but I don't know if triggering dances to certain locations makes sense if the alternative is just put bees there, you know, you can just take the box, bring it there, and so technology has to compete with these simple solutions, and most simple solutions are good.

Ben: Well, I remember from our interview with Jonas from Stadtbienen, he said that even moving his, because we were asking, he's like, I'm moving my hives, but luckily all my hives died, so I guess even moving the hives a few meters will sometimes disrupt the bees.

Dr. Landgraf: Yeah.

Ben: So I guess that could be like an application of the tunnel and say, like, if the bees are having a difficult time readjusting to the movement of their hive, you can just put the tunnel there kind of thing.

Dr. Landgraf: It does stress them. I wouldn't say it would kill them. We have moved hives a lot of times, and if they're like, they have enough bees in there, they're strong enough, and if the food's right, right? So if you put them in the desert and there's nothing, obviously they would die, but

yeah. And especially in the U.S., right, with these almond, these huge almond, what's it called, like fields, they're like moving so many bees, like tons of bees from all over the U.S. to these fields to pollinate those trees, and that works. So you can move them over, I don't know, over half a continent if they don't mind. I mean, sure, they will mind if you would ask them. They would say, yeah, some of those colonies die.

Question 4

Ben: So we've seen that beekeepers especially love collecting data, especially younger beekeepers. Would you see any effective way using any research, machine learning, to actually apply all this data that's existing out there?

Dr. Landgraf: I think using sensors and, you know, data processing pipelines that work in all kinds of hives and using cheap sensors, I think that's something that will be coming, because that's easy, that doesn't cost much. You know, all the, so all the, you know, tunnel and robots, feeding information back into the hive is much harder, and just reading information out of that box with all the animals in there, that's fairly easy, and it has been done a couple of times already, also in width of many, many hundreds of hives even, so there's a project called Umweltsperre of my previous PhD supervisor, Randolph Mensah, they put sensors in, not acoustic sensors, not microphones, but something similar, so they would measure electric fields. Which, you know, in the end is produced by the same kind of movements that also would produce noise or like acoustic signals. But I think these, so you always have this huge gap between research and the product, and that gap is really hard to find money for, because also the beekeeping industry, like beekeepers, you know, private beekeepers, you know, who put their hives on the roof or in the garden, but even the industry of large apiaries and people who, like in the U.S., would move bees from, I don't know, the East Coast to the West Coast, for example, I think there's not that much money in there, and there's, so the value of using technology, I don't know, I'm really skeptical, I think the value is much higher for, like the hobbyist beekeeper, because, you know, you can have a look in there, you can enjoy your bees even through the lens of data, right, and especially these younger technologies or I don't know, tech people, right? So they were born with their phones in their hands. So I totally see that. Not so much in the big industry. Because they have like small margins. I think there's, so what's the value, right? So saving colony lives? I think they have a big, big part of the machinery that just cares about getting new colonies. Rearing queens, inseminating queens, building up new colonies. Because that's cheaper than, I don't know, using technology. But maybe that's a cultural kind of shift that we have to push.

Ben: Yeah. That's what we're kind of seeing is a little bit of that cultural shift, at least, is with part of our project is trying to make sure the hives survive, and a lot of the people that we've interviewed so far, Hienz from Melllifera, and then Jonas, who I mentioned earlier, from Stadtbienen, they're both trying to find ways to make sure that, especially with the hobbyists, that

they survive. And that's kind of led us down this tech track and development of an app of sorts that can start being used by the beekeepers to help track not only seasonal data, but their hive data to survive. So hopefully, yeah. So currently we're just kind of looking at temperature inside the hive and humidity. But you also mentioned the electric fields. Electric fields.

Dr. Landgraf: Which is vibrations, basically, right? So whatever moves, so for example, wings, they are really dry, and they carry a static charge because they are rubbing against each other, right? So they have two pairs of wings, and they're rubbing each other and that creates a static charge. And if you move the static charge, and you have a static reference electrode, you would have a potential that goes up and down, which is basically the same as sound pressure, if you measure that sound pressure. And vibrations are really important. But then, vibrations are produced by single individuals, so they are really localized. They don't travel that far. So you would have to have a grid, if you really wanted to have the full distribution of where these things come from. You might not need that full distribution. Maybe one sample is enough.

Benl Yep.

Dr. Landgraf: But yeah, I would always combine global information, like temperature or humidity, with local information.

Ben: And yeah, I think all this information could be used to track not only the survivability, but how active the hive is.

Dr. Landgraf: And yeah, that's doable.

Question 5

Ben: So I think our last one is, would there be any technology that you haven't mentioned so far that beekeepers should implement in their hives to improve the survivability or production of the hive in response to climate change? Like, is there any technology you know from your own research somewhere else that you've heard of that beekeepers should be using more often? Or even, I guess, like data models to process all this kind of like data?

Dr. Landgraf: Mm.

Saida: There's a bee behind your laptop.

Ben: Oh.

Dr. Landgraf: Aw. She has pollen.

Saida: It hit his laptop and fell over.

Dr. Landgraf: She's really cold.

Saida: Yeah. It got really cold for a second.

Dr. Landgraf: Yeah. Oh, yeah, she's really cold.

James: It's behind your laptop.

Ben: Probably is.

Dr. Landgraf: Ah, yeah, maybe your laptop is warm enough.

Ben: Yeah. No, this thing really gets the heat. Good picture.

Dr. Landgraf: How cold is it?

Ben: Here's a picture for our beekeeping tech portion, guys.

Dr. Landgraf: Yeah, it's only eight. It's pretty lower limit of what they wanna do.

Ben: Yeah, no, it's freezing.

Dr. Landgraf: In the sun, she's fine, but this is pretty shady here.

Question 6

Saida: Yeah. I do have a specific, just a small question. Is there a reason why you choose bees for the project? Because insects like ants also do have similar system, so they didn't use bees.

Dr. Landgraf: I think bees are really under, I mean, they're like famous, right? But they're still underappreciated because they're so much more complex than most people think, you know? I don't know what you see in a bee, but I see a huge brain and very complex behaviors. We've scratched the surface, you know? The dance is only the tip of the iceberg.

Saida: Yeah.

Dr. Landgraf: There's so much more going on, very subtle things. Watching videos or watching the actual thing, you can see so much and that's when I think AI and machine learning and data driven things are really helping humans because you can't understand everything just looking at it, right? So you can focus on one animal, you can record a video and rewind the video and look at, I don't know, ten animals, but you can't look, you can't understand what's happening to all the animals. Even in a small colony of 2,000 bees or so, it's impossible to understand. You need processing power and statistics and AI to make sense of what's going on.

Ben: Yeah.

Dr. Landgraf: That's why I chose bees, partly because they're allowing stuff that you wouldn't be able to do with humans because you can't track all the humans. You can but I'm not Facebook or Google or something. So you can put them in a box and then you can have two cameras and although they're expensive, that's something I can't afford and there still not easy. I think there's still so much cool stuff to discover and that's why I chose them.

Saida: That sounded very lovely.

Ben: Yeah.

Question 7

Ben: James, you want to say something?

James: Do you view it as more like the individual bee or is it just the colonies that you're interested in?

Dr. Landgraf: I think the beauty of the bee is that they have both, that they can, for example, navigate. That's what they do on their own. They don't need the colony to be able to find back home, for example, over like 10 kilometers, for example, like most of Berlin. So if she was there and if she was able to store that kind of point in her internal map, then she will be able to get home. Something that I can't say about myself. If you put me to navigate in a new city, like find a restaurant and then find back home, impossible sometimes. So that's really remarkable. And then, of course, the whole collective stuff is really impressive and really unknown. And so there's many things to learn. And I'm interested in complex systems, complex meaning you have individual units interacting. And, you know, due to the vast number of units and the different types of interactions, they're like things that emerge on the next level, like brain cells that speak to each other. And then we have something like self-awareness or something like that, which nobody knows where that comes from. And where we have like neurons that are linked together in the bee brain and then you have bee brains linked together in a colony. And so you have many

levels that kind of process information like that, that like that analogy with the biological computer. How do honeybee hives process and compute their outputs, process information from the outside? How do they integrate? How do they decide? How do they reach consensus? All these questions that are really... you know, you can generalize. So understanding bees doesn't mean that this knowledge is limited to bees. You can find principles of computation, for example, you can apply these to other species, to humans. I believe that there's like a swarm or swarm, let's say, grammar or swarm language, not just dance language. It's like the way nature has organized collective systems to exchange information, to process, and bees are a perfect system to study that. So your question was the technology.

Ben: The technology, yeah.

Dr. Landgraf: To be honest, I'm not so sure about that. I think there's a technology that I can't do, which is genetics. I think we've… so the bees we have and the problems that they have are the result of us having them, right?

Ben: Yeah.

Dr. Landgraf: So we made them to become nice and, you know, they're willingly giving us the honey but that also makes them not really fighting against the Varroa that much.

Ben: Yeah.

Dr. Landgraf: And maybe there are other things we can do for them. I mean, I'm not saying we have to go back because I think we can't. It's about understanding what we're doing and acknowledging that that was something that we did and then we move forward and then we find solutions and technology like genetics, for example, could help us doing that. We don't actually only have that. We have so many more things but like tech, so the AI stuff and so on.

Ben: Yeah.

Dr. Landgraf: I think that that's really important to understand what's going on, to visualize even our influence on bees, to make transparent how they are, how well they are or how well they aren't, you know.

Dr. Landgraf: Maybe give some assistance to help us to make them better.

Ben: Yeah.

Dr. Landgraf: And to be honest, so the impact of climate change hasn't been, I mean, or only recently gone to the focus of research, right? So there's a couple of things that came out but I don't think we have to properly describe what's going on with them. So obviously things get like in the year, earlier when it gets warm, so they start foraging. Hey, Philip! Philip!

Philip: Oh, hi!

Dr. Landgraf: We have a meeting in 12 minutes.

Philip: Yeah, I was going to go see you.

Dr. Landgraf: Yeah, sure.

Philip: How about I save myself a walk? Can I just hang out here?

Dr. Landgraf: Yeah, you can hang out. Can Philip hang out?

Ben: Yeah, of course, of course.

Dr. Landgraf: So meet Ben and I forgot your names.

James: I'm James.

Saida: I’m Saida.

Philip: Nice to meet you.

Dr. Landgraf: Philip is from the UK, from Lancaster, visiting.

Philip: Let's do weird bee stuff.

Philip: Bee stuff?

Dr. Landgraf: Yeah, they're doing bee stuff too.

Philip: Excellent. What kind of bee stuff?

Ben: So we're researching how climate change is affecting the practice of beekeeping, specifically here in Berlin.

Philip: Really?

Ben: Yeah.

Philip: What's happening here in Berlin?

Ben: So what we've really seen is that Berlin, especially because it's a big city, that you're seeing a very unique rise in the drasticness of different weather events, especially we saw earlier even this month of just seeing the temperature got super warm. We're seeing swarming happening, happening much earlier. This is disrupting a lot of cycles. We've seen a lot of varroa mites surviving throughout the winter. That's a big one. And then we're also just seeing hives failing much higher than usual.

Philip: Nice. Have you got Asian hornet here? We've got sightings in the UK.

Dr. Landgraf: Me too. Me too.

Philip: But no wintering yet.

Dr. Landgraf: I think last year was the first year where we saw some.

Ben: Yeah, we've heard a little bit about wasps attacking hives more often, but we haven't seen too much of that across beekeeping.

Dr. Landgraf: Those hornets are fierce. They're fierce.

Saida: Like two inches… they become the new enemy, as you can say.

Philip: Some are replacing varroa. Or directly varroa.

Ben: Looking into technology also that can help beekeepers adjust to the practice of all this climate change that's been happening. So that's what led us to this interview here.

Philip: Very nice.

Dr. Landgraf: These students are from the US and they get to go to Berlin for two months. Because that's what they do. They study.

Philip: Very nice. Which university?

James: Worcester Polytechnic Institute.

Philip: Which one?

James: Worcester Polytechnic Institute. It's in Massachusetts.

Philip: Ah, very nice.

Dr. Landgraf: I recently read a PhD program for Fulbright. Fulbright is a bilateral program, US with X and X here in Germany. The office is in Berlin and I helped them identify the best candidates. One of those guys wanted to go to Worcester Polytechnic University. That's why I learned about your school.

Ben: Oh, wow. We're doing great. I really enjoyed going to school there. I'm a robotics engineer also there so yeah I don't think I ever said James is biomechanical…

Dr. Landgraf: Yeah, yeah.

Ben: Sai is video games, interactive media and game development.

Dr. Landgraf: So cool, so it's so diverse I weird that you that you kind of meet

Ben: Yeah.

Dr. Landgraf: That's like through this NGO or this CALENDARS.

Ben: Yeah.

James: This project isn't really based on major, it's just everyone applies to a program and you get put into projects.

Saida: Worcester Polytech is know for just their project, like the curriculum part of it is just projects to just help you in the future if you are going to work in a business or company then you will be able to be very effective working in a group or meeting.

Dr. Landgraf: Yeah, that makes sense.

Saida: Yeah, that's what is so interesting about WPI. That's why I applied to come here.

Dr. Landgraf: So, yeah, where were we in the last question yeah I actually I don't know about specific technologies that I would… partly because I think the there is no product yet like good product. It takes a couple of years probably yeah to make one but there are companies so there's a startup in Stuttgart or something like southwest Germany yeah they're both like epic AI a pick AI or something and they they are building camera based entrance boxes or so, so you can track them flying in and out count like it's a counter.

Ben: Yeah.

Dr. Landgraf: There's a company in Bulgaria they work with they're also building components that you can put in the hive

Ben: Yeah

Dr. Landgraf: But like adoption is it's not that high.

Ben: Yeah, that's what we've been really finding, is like there's a lot of sensors out there but no way of actually utilizing this data in a proper format so that's what we're trying to research for like a future project on by school is finding a way to use all this data kind of out there.

Dr. Landgraf: Yeah.

Ben: It's one of our goals now.

Dr. Landgraf: But I think it's also something nobody wants to do as a beekeeper you don't want to be in charge of like where to put the data how to make sure it's like backup nicely and well and you know is there corrupt data in there or did the sensor just blow and then doesn't give any data just zeros. It's you know with that kind of like amount of data you can't do it manually there they have to be like scripts like running through your data just to check what's what may have happened or or just to make sure that everything's recorded well and you I think this isn't there yet. So yes we have the sensor yes we have some services on top of them.

Ben: But nothing really.

Dr. Landgraf: Yeah.

Ben: Okay.

Dr. Landgraf: I think this needs also proper interviews with with your target group right so what is it that they would pay for?

Ben: That's what we've talked with them a lot about is like we've talked to even some of the older beekeepers are saying like we're like, hey would you prefer kind of like an infographic newsletter kind of format or more of an app kind of format with app website.

Dr. Landgraf: Dashboard or something?

Ben: And universally they always say like they want something that's more of an app but it's surprisingly yes. But most of the time we've really just been talking to like heads of organizations and they really say the reasoning for that is so they can reach out to younger beekeepers easier.

Dr. Landgraf: Yeah.

Ben: To help grow their like influence because you're not gonna change these old guys ways at all. But you could start getting like the younger beekeepers to get into it with the tech and everything. It's just us, even like you're talking to these beekeepers they don't know about how to like analyze the data and everything so that's where we're trying to got a little stumped.

Dr. Landgraf: So what kind of, what kind of product would people pay for people would pay for?

Ben: People would pay for…

Dr. Landgraf: ... like alarm this colony is preparing a swarm that would be something, right? Because we are like fuck, it's getting warmer that's like yesterday. You did find the colony.

Philip: The Queen was still there. Yeah, but she took her daughters had thrown out the four or five Queen cells.

Dr. Landgraf: Oh, wow. So that was close, and that was just based on a hunch?

Philip: Yeah, cause of the sudden heatwave. Do you guys know what the demographics are of German beekeepers?

Ben: Not entirely, we don't have demographics.

Dr. Landgraf: Right now the average is 60 something years old.

Philip: Same on the U.K.

Dr. Landgraf: What about the U.S.?

James: I think it's still up there but it is a young typically there are younger beekeepers.

Ben: Yeah.

James: Most of the ones that I know are… there are a couple older ones, and then they have their sons that do it, as well as one of my friends from university, his family, that they're beekeeping in Washington.

Dr. Landgraf: Yeah.

James: So, it's not entirely old people, but it is still up there in ours.

Dr. Landgraf: Yeah.

Ben: It's retirees.

Dr. Landgraf: Yeah, because they have the time, right?

Philip: And the money.

Dr. Landgraf: And the money. Well, yeah. True.

Philip: It's very expensive in the UK to keep bees.

Ben: Yeah, huh?

Philip: As is everything, I think.

Dr. Landgraf: Hmm. Well, we have this, like, hipster beekeeper thing.

Ben: Yeah, that's… I read one book over in the New York... that took place in New York, and they were just like... there's a huge population, demographic-wise, of just hipster beekeepers. And, like, that's a big, growing, like, demographic.

Dr. Landgraf: I call them hipster beekeepers. Can we use that term for that?

Ben: Yeah.

Dr. Landgraf: Yeah? Cool. Because they do, because it's like, you know, it brings them, it roots them, you know, it brings them back, it decelerates them, you know. Back to nature, right? So, all the techie…

Ben: We have called them hipsters.

Philip: We had that in 2014, 2016.

Ben: Yeah.

Philip: And then the population of young beekeepers just plummeted.

Dr. Landgraf: Like, for the pandemic?

Philip: No, it was... everyone joined up. It was like 18 to 30-year-olds. It was to do beekeeping. One year of beekeeping, and then first winter, big colony losses, and they stopped.

Dr. Landgraf: Yeah.

Ben: Yeah.

Philip: There's a whole thesis written on this.

Dr. Landgraf: Yeah.

Ben: Okay.

Dr. Landgraf: Okay?

Ben: Yeah. Oh, yeah, Philip. We were recording this. Are you okay with us?

Philip: Oh, absolutely.

Ben: If we end up using your name in this, are we okay?

Philip: Of course, yeah.

Ben: Okay. Thank you.

Dr. Landgraf: The name is Philip Dun…

Philip: Tim can give you the details, it's written down.

Saida: Thank you.

Dr. Landgraf: Thank you, guys.

James: What is your project?

Philip: I have so many silly things that I do. The main reason I'm here is because I have a nest box for bumblebees.

Ben: Mm-hmm.

Philip: That I made with 3D printing.

Saida: Oh, wow.

Philip: And I use it for, like, conservation. I'm putting boxes in trees for...

BenL What material did you 3D print it out of?

Philip: It's a wood PLA composite.

Ben: Huh. How effective is that at, like, maintaining the temperature?

Philip: The temperature is absolutely fine. Bumblebees don't need public temperature. The recent printing method I've used has solved the other problem, which was humidity. They got too sweaty in there.

Ben: Yeah.

Philip: But now with the wood PLA composite, it's now more breathable.

Ben: Okay.

Saida: Oh, okay.

Ben: Yeah, we're finding discrepancies between some research that we're doing with polyurethane hives versus wooden hives.

Philip: Oh, yeah.

Ben: Yeah, depending on which beekeeper you ask, you either hear they're really great or they're really bad.

Dr. Landgraf: Yeah, it's a cultural thing. There's no clear data, I think.

Philip: Where I keep bees, our winter is typically six to seven months long.

Ben: Yeah.

Philip: So some beekeepers insist on the poly hives because otherwise they use all their stores up and it's a really long hard winter with the bees. And other beekeepers say that it's terrible to just use wood. If it gets cold, put a blanket over it.

Saida: Okay.

Ben: Yeah. ‘

Dr. Landgraf: We use wooden hives too. Yeah, I mean, I was pretty ignorant about it. I was like, yeah, whatever works. And then we had a researcher and she decided that we needed those wooden things. And to be honest, we have an apiary just next to us and they lose as many bees as we do.

James: Yeah.

Philip: I find poly hives, propolis is worse for a poly hive.

Ben: Yeah. Yeah.

Dr. Landgraf: True. True.

Ben: Yeah.

Dr. Landgraf: True.

Saida: Is there a personal choice when it comes to doing it on the ground hives or putting them up in the trees? Because we did read about that putting them in trees, also the bees can also help keep them, like protect them from rain and such. Is there a personal...

Philip: Honeybees.

Saida: Yeah, like honeybees, their hives.

Philip: We keep them on the ground for safety and access. But I keep all my bees in wood.

Saida: Yeah, Okay.

Dr. Landgraf: Yeah, they get heavy, right? So I don't know if you put them in the tree.

James: One of the beekeepers that we were speaking to about that, they aren't really in it for the honey. And they were just trying to...

Ben: Yeah, they wouldn't put it...

James: The genes of the bees naturally.

Ben: Yeah.

James: They were just doing that to see if that would help them at all.

Ben: Yeah, so they dig a hole right inside the inside of the tree trunk.

Dr. Landgraf: Yeah.

Ben: That's where they put the hive it's older fashion, I guess and it's more effective, but it's harder to use.

Dr. Landgraf: You can't get any honey out of there.

Ben: No.

Dr. Landgraf: We we we take a little bit of honey, but we I think believe every like most of that we leave in there.

Philip: Yeah, yeah. You have no use for it beyond the occasional…

Dr. Landgraf: A little bit of butter, a little bit of honey.

Ben: Yeah…

James: Alright, thank you very much.

Saida: Thank you very much.

Dr. Landgraf: Thank you.

Saida: Thank you for joining us.

Dr. Landgraf: Thank you all the best for your free project and enjoy Europe, promise me you go around and see places…