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Abstract (English)

Since the 2000s, the notion *citizen science* has flourished. Yet, the term itself remains hard to define, partially due to its two origins. The first describes citizen science as a democratizing form of civic engagement with Science, while the second denotes a novel form of data collection. The plethora of definitions and practices subsumed under the term has led to calls for more standardization and subsequently to proposed frameworks and typologies. Despite its multiple understandings, many scholars argue citizen science can address complex issues facing Science and society. One such issue is colony loss, the trend of decline in health of honey bee colonies, whose cause(s) remain unknown. Citizen science collaborations between beekeepers and scientists offer a novel way of generating knowledge on this phenomenon. The EU-funded project INSIGNIA brings together beekeepers and scientists across Europe to create a non-invasive honey bee colony monitoring method. Using qualitative interviews with four Austrian citizen science beekeepers, this thesis analyzes how they construct their role within the INSIGNIA project because, while much work has been done on categorizing citizen science practices, there is little research on the perspectives of citizen scientists and their interactions with scientists. Each beekeeper made sense of their role in the project based upon their own histories, their understandings of their own knowledge, and their perception of the project. Still, they saw their roles as outside of Science. Whether each beekeeper was content in their roles depended on their expectations of engagement, which in some cases was incongruous with the planned project structure. Linking these findings to wider discourses, this thesis concludes with discussions on my role as an STS researcher in INSINIA, potential categorizations of the citizen science practiced by INSIGNIA, and potential dependencies of beekeepers on projects like INSIGNIA created from an absence of governmental support.

Abstract (Deutsch)

Der Begriff *Citizen Science* gewinnt seit den 2000ern zunehmend an Popularität. Dennoch entzieht er sich, auch aufgrund seiner zwei Ursprünge, einer endgültigen Definition. Zum einen wird Citizen Science als eine, die Forschung demokratisierende Form der Zusammenarbeit von Bürger*innen und Wissenschafter*innen gesehen. Zum anderen beschreibt der Begriff eine neuartige Form der Datenerhebung. Die Vielfalt an Definitionen und Praktiken unter diesem Begriff haben zu Rufen nach mehr Standardisierung, und in der Folge zu unterschiedlichen Rahmenkonzepten und Typologien geführt. Trotz dieser unterschiedlichen Lesarten argumentieren viele Forscher*innen, dass Citizen Science in der Lage ist, komplexe gesellschaftliche und wissenschaftliche Probleme zu adressieren. Eines dieser Probleme ist die zunehmende Verschlechterung der Gesundheit von Bienenvölkern – das sogenannte Bienensterben – deren Ursache(n) bis heute ungeklärt ist/sind. Citizen Science Kollaborationen zwischen Imker*innen und und Wissenschafter*innen können hier einen neuen Weg der Wissensproduktion eröffnen. Das EU-geförderte Projekt INSIGNIA bringt Imker*innen und Wissenschafter*innen aus ganz Europe zusammen, um eine nicht-invasive Monitoring-Methode für Bienenvölker zu entwickeln. Auf Basis von vier qualitativen Interviews mit teilnehmenden österreichischen Imkern, untersucht die vorliegende Arbeit, wie diese ihre Rolle innerhalb des Projekts konstruieren. Während es umfangreiche Arbeiten zu Citizen Science Praktiken gibt, existiert nur wenig Forschung zu den Perspektiven der Citizen Scientists und ihren Interaktionen mit Wissenschafter*innen selbst. Die Imker verstanden ihre Rolle in dem Projekt hinsichtlich ihres persönlichen Hintergrunds und ihrer Vergangenheit, dem Verständnis ihres Erfahrungswissens und ihrer Wahrnehmung des Projekts. Dennoch verorteten sie ihrer Rolle außerhalb ‚der Wissenschaft'. Die Zufriedenheit mit ihrer Rolle hing von den Erwartungen hinsichtlich des Ausmaßes ihrer Teilnahme ab, denn diese waren in manchen Fällen nur schwer mit der geplanten Struktur des Programms vereinbar. In der Verbindung dieser Ergebnisse mit den breiteren Diskursen schließt diese Arbeit mit Diskussionen meiner eigenen Rolle als STS-Forscherin in INSIGNIA, möglichen Kategorisierungen der Citizen Science in INSIGNIA, sowie den Abhängigkeiten von Imkern von ähnlichen Projekten, die das Resultat mangelnder Unterstützung durch die Regierung sind.

1 Introduction

Citizen science is an emerging mode of doing science with ramifications for both the realms of scientific research and science policy, with assertions of potential radical democratization of Science and its authority on knowledge production as well as the promise of, "fundamentally different relationships between scientists and the public [as well as] researchers and the questions they ask" (Kennedy & Cavalier, 2016, p. 117). Arising from early critical engagement of non-scientists with science and scientific research (see Brown & Mikkelsen, 1990; Wynne, 1996; and Epstein, 1996), the term citizen science was coined in the mid 1990s by Alan Irwin (1995) and Richard Bonney (1996), creating two origins and understandings for the same term. The field arose from both a need for more democratic forms of civic engagement with Science and a desire for novel methods of data collection and interpretation in order to collectively address the complex issues that both Science and society are facing (see Irwin, 1995; Ottinger, 2010; and Gabrys, Pritchard & Barratt, 2016). During the first two decades of the 21st century, citizen science flourished and with this flourishing came a plethora of practices and definitions all subsumed under the title of citizen science, partially due to the term's uptake by the media and science policy institutions (Strasser, Baudry, Mahr, Sanchez, & Tancoigne, 2019).

The sheer amount and practices that are subsumed under the term citizen science has led to pushes for more standardization and categorization of the term (Haklay, 2013, and Strasser et al., 2019), as well as calls for more inclusive, universal citizen science frameworks (Vayena & Tasioulas, 2015). Despite the growing numbers of attempts to improve upon current practices and definitions, some still argue citizen science has not lived up to its full potential (Ottinger, 2010). Martin (2006) contends engagement of citizens with scientific research through citizen science has the potential to increase the responsiveness of scientific research to broad social concerns, because the research is enriched by their knowledge(s), interests and participation, instead of being oriented solely towards the specific interests of researchers. While other scholars contend the potential of citizen science lies in its ability to collect both novel and large amounts of data, even in resource-limited environments (Gouragine et al., 2019) as well as in the social sciences (Heiss & Matthes, 2017). Despite the large amount of studies proposing

different ways or 'typologies'[1] for defining and categorizing citizen science projects (Strasser et al., 2019) as well as studies on citizen scientists' reasons for participating, little research has been done into the perspectives of the citizen scientists and their interactions with the participating scientists. A deeper understanding of the perspectives and experiences of citizen science participants in a project may shed more light onto their personal motivations and how they perceive their role(s) within the larger project. Moreover, since the exact definitions and roles of a citizen scientist remains unclear, with multiple understandings existing (see sections 2.2 and 2.3), studies into their own personal perspectives may prove fruitful.

Yet, it is this promise of the ability to address both broad scientific and social concerns collaboratively that makes citizen science well suited for generating knowledge on the complex effects of pesticides on honey bee health and, in particular, on the emerging phenomenon of colony loss (also more broadly termed as pollinator decline) and its surrounding controversy. The phenomenon first caught the attention of the media in 2006 when a specific form of colony loss, called Colony Collapse Disorder (CCD), caused the radical incident wherein entire bee colonies simply disappeared from their hives never to return. Colony loss is nothing new. Throughout history there has been sporadic incidences, wherein large number of bee deaths would occur, but the continuously increasing numbers of these cases led to concerns among beekeepers and scientists alike. With claims of the cause ranging from cell phone towers and pesticides to a combination of multiple, simultaneous sub-lethal factors (e.g. lack of forage diversity, honey bee diseases), the exact cause or causes remain undetermined. One major factor is potentially believed to be the use of neonicotinoid insecticides (often shortened to *neonics*). Citing the precautionary principle, the European Union (EU) in 2018 decided to ban the use of all neonicotinoid insecticides outdoors in response to years of studies on their potential harm to honey bees (Butler, 2018). Nevertheless, there is still no consensus on the cause or causes of colony loss, leaving scientists, beekeepers and policy makers searching for answers.

Suryanarayanan and Kleinman (2017) assert the reason for the inconclusiveness of scientific studies on colony loss is related to specific norms and histories of what counts as valid and valuable research. Control-oriented methodological choices focus on single

[1] For the purpose of this thesis, I use single quotation marks to signal to the reader that word choice is not my own, i.e. used by author(s) in their texts or by the beekeepers in their interviews.

factors in a controllable environment, which cannot account for real-world scenarios and complications, e.g. multiple sub-lethal addictive effects. It is this real world messiness that could be the culprit, the authors argue. Still, one thing is certain, more data and more research is needed to understand the often-complicated links between the environment, insecticides and the health of honey bee colonies. Maderson and Wynne-Jones (2016) cite, "the potential for beekeepers' knowledges to be incorporated into participatory policy processes addressing current challenges to pollinator health" (p. 88). The authors see beekeepers as "being on the front line of being on the front-line of understanding pollinator health because their day-to-day practice necessitates continual, regular engagement with bees" (p. 92). Furthermore, according to the authors, the records kept by beekeepers on the health of their colonies and environmental conditions lends itself for utilization in citizen science projects, wherein scientists work with beekeepers to help to better understand contributing factors to colony loss. Citizen science projects where beekeepers work alongside scientists to look into possible contributing factors of colony loss have been growing in numbers (see sections 2.4.3 and 2.4.4). While these partnerships have great potential to help find answers, Kleinman and Suryanarayanan (2019)—drawing from their study on collaborations between scientists, farmers and beekeepers—assert "the relationship between scientists and nonscientists in the context of collaboration is typically complicated by asymmetries in social status and real differences in the kind of knowledges each party has" (p. 2). The authors show that *trust* and *authority* are crucial factors when trying to establish a productive partnership and collaboration between scientists and beekeepers.

For this thesis, I will look at one such collaboration, the citizen science project entitled Environmental monitoring of pesticide use through honeybees that uses the acronym INSIGNIA, which stands for *Citizen Science Investigation for Pesticides in Apicultural Products*. The INSIGNIA project engages citizen science beekeepers to help develop non-invasive sampling methods for monitoring honey bee colony exposure to insecticides and pesticides as well as measuring the biodiversity of the foraging plants, i.e. the plants available to the bees. According to Brodschneider and Crailsheim (2010), honey bee nutritional health is integral for the proper development and survival of their colonies, with pollen-diverse diets preferable to single-pollen diets as mixed-pollen diets generally provide a larger variety of nutrients (also see Danihlík et al.,2018, and Omar et al., 2017)—making biodiversity of foraging plants another key factor in understanding colony loss and honey bee health more broadly. It is the goal of the INSIGNIA project as well to develop a citizen science protocol that enables citizen scientists to aid in the monitoring of plant biodiversity and pesticide contamination across Europe.

As part of my work with in the INSIGNIA project, I was able to conduct four interviews with Austrian citizen science beekeepers. These interviews are the basis for the empirical material of this thesis. Through the interviews I attempt to gain a deeper understanding of the perspectives and experiences of the citizen science beekeepers by asking the main question: *How do citizen science beekeepers construct their role within the broader project, INSIGNIA?* As stated above, more research is need into the perspectives and experiences of citizen scientists and their interactions with the project's scientists—potentially offering a deeper understanding and a new perspective on the roles of the citizen participants in citizen science projects.

For the purpose of this thesis, I draw upon a large body of Science and Technology Studies (STS) literature in chapter 2, identifying the key strains of literature in *public participation in science* (2.1), *citizen science* (2.2), *citizen science policy and funding* (2.3), and *bee research in the social sciences*. In chapter 3 of this thesis, I give a detailed description of the case study of INSIGNIA, which is meant to inform the reader about both my role in the project and the sub-set of my work for that role, which makes up the empirical material for this thesis. Chapter 4 introduces my main question and six sub-questions, while chapter 5 provides the reader with an in-depth description of my methodological choices, as well as the methods used for my data analysis. Chapter 6 constitutes the main analysis of this thesis. The chapter starts off with section 6.1, a detailed, rich description of each of the four Austrian citizen science beekeepers interviewed for this thesis. These descriptions enrich the main analysis in section 6.2, which provides a comprehensive analysis along the lines of my six sub-questions and concludes with a discussion of my main question, as well as suggesting my own preliminary typology of citizen science, identifying four possible types of citizen scientists that I encountered. The final chapter, chapter 7 *Discussion and Conclusion* introduces three lines of discussion—*my role in the project*; *my understanding of the type of citizen science being done in the INSIGNIA project*; and *how governance in Austria influences project structure*—as well as one concluding reflection on Science, which takes on a more personal tone.

2 State of the Art

2.1 Public Participation in Science

The phenomenon of citizens as actors in knowledge production processes has long been studied by STS scholars (See Brown & Mikkelsen, 1990; Wynne, 1996; Epstein, 1996; and Rabeharisoa & Callon, 2004); albeit neither under the specific label of citizen science nor with a specific policy-funding driver. Public engagement and collective experimentation studies, i.e. the critical engagement of non-scientists with science and scientific research, have displayed how the local knowledge of citizens can aid in improving risk assessment models and in uncovering implicit values held to be good science, which in turn may lead to a re-ordering and suggesting of different moral orders in scientific research (Ottinger, 2010). Many of these studies focus on the events occurring during a controversy, especially environmental ones.

One seminal STS study was conducted by Wynne (1996), wherein he looked into the controversy between scientists and sheep farmers in the hills of Cumbria (in England) after the 1986 Chernobyl nuclear disaster. After the nuclear incident, storms in the area led to radioactive contamination of the land through the rain water. Due to the contamination of Cumbria's grazing lands and based upon scientific evidence, regulators chose to place a three-week-long ban on the selling of sheep and sheep products. However, even after the three-week-long time period of the ban had elapsed the area remained contaminated, straining the relationship between farmers and scientists. These tensions were further heightened due to the poorly managed, often secretive, nearby nuclear power plant of which the farmers were suspicious—for reasons of previous potential contamination incidents. Wynne shows how the scientists did not value the practical expertise of the farmers, leading to their further alienation. Wynne contends the knowledge of the local farmers could have aided the scientists with their experiments on the sheep and radioactivity, but instead their exclusion led to further measurement mistakes and messy experiments, which in turn made the farmers doubt the scientists and their authority even more. Wynne suggests in this instance the scientists should have treated the sheep farmers as 'lay experts' of their own profession and local environment. Even though the mistrust and clashing social identities greatly hindered cooperation in this instance, Wynne still stresses that the positions of expert and 'lay-person' should not be seen as pre-determined but rather as flexible arenas for potential interaction, negotiations and mutual exchange. Moreover, Wynne argues one step further by

contending that the ways in which the 'lay-people' make sense of a certain situation, in this case the scientific research of the contamination of their fields, is based upon their social setting in which they are embedded. Thus, sense-making processes of different actors or actor groups are context dependent (i.e. how someone makes sense is based upon their own social setting and histories).

Controversies in medicine have also provided rich sites for STS scholars to study the interactions of scientists and publics during times of civic engagement and collective experimentation. An early such case was described by Brown and Mikkelsen (1990), a case in which residents of Woburn, Massachusetts during the 1970s noticed the formation of a cluster of leukemia cases and pressed the government for further investigation. The study conducted by government officials failed to find a link between any causal factors and the cluster of leukemia cases. However, residents believed the water to be a causal factor and the government had not run tests for potential water hazards or contaminants. In order to prove that the water was in fact a causal factor, residents of Woburn collaborated with biostatisticians at Harvard, helping them to create and disseminate a survey. Due to the efforts of the residents, a conclusion was reached that contaminated water *did* contribute to the increase in cancer rates in Woburn. Brown and Mikkelsen's study shows how the local residents were more attentive and knowledgeable of local factors than the scientists who initially studied the phenomenon. Brown (1992) goes further into detail about how different ways of knowing between citizens and experts clashed in regards to the Woburn leukemia cluster, which, when combined, produced a new "socially constructed approach to popular epidemiology" (p. 279) as the citizens of Woburn were forced to look elsewhere for answers, other than the initial scientific findings of the governmental bodies. As Brown aptly summarizes:

> The striking awareness of the new scientific knowledge coupled with governmental and professional resistance to that knowledge, leads people to form social movement organizations to pursue their claim-making. In turn the further development of social movement organizations leads to the further challenges to the scientific canons … with each continuously reinforcing each other (1992, pp. 278-279).

The tendencies articulated by Brown can be seen in more recent STS work on social movements in biomedicine, wherein patient advocate groups, unhappy with the scientific status quo engaged in civic discourse and collective engagement to force Science to listen to their needs and to create awareness. One salient STS case study on this topic was conducted by Epstein (1995, 1996), wherein he examined the *Acquired Immune Deficiency*

Syndrome (AIDS) activist movement of the 1980s. During this time, AIDS activists struggled against governmental regulators and drug researchers in order to have the AIDS drug trials redesigned. The traditional double-blind trials were raising ethical questions, as proof of the efficacy of the drug relied on the control groups succumbing to AIDS (at the time a highly deadly disease). Initially ignored by scientists and the government regulators alike, the AIDS activists took on the scientists and regulation bodies by both immersing themselves in the scientific literature and by subversive means—e.g. crushing all pills and giving them out equitably to all participants in a trial, effectively ruining the double-blind control of the trial. In the end the trials were re-designed such that, while not following the traditional gold standard of a double-blind trial, they did provide usable data and, therefore, valuable knowledge, while also adhering to the needs of the people most affected. Epstein contends the AIDS movement inspired further biomedical activism, creating a

> certain suspicion of biomedical claims making; an emphasis on empowerment and a repudiation of 'victim' status; a push toward greater equality in the doctor-patient relationship; and the demand for a greater role for patient groups in determining research priorities, assessing research findings, or making regulatory or policy decisions on the basis of those finding (emphasis in original, 1995, p. 428).

Thus, these newly inspired biomedical activist groups, following the precedent of the AIDS movement, confronted the traditional expert-lay hierarchical relationship to demand the right of participation in the production process for those affected by its outcomes.

Callon and Rabeharisoa (2003) describe a different modality of lay participation both *in* and *with* scientific research. Using the example of the *Association Française contre les Myopathies* (AFM) [French Association of Muscular Dystrophy Patients], the authors show how concerned muscular dystrophy (MD) patients and MD specialists worked both with and complementary to one another. In doing so the authors take a symmetrical point of view to the relation of lay and expert knowledge(s). In their case study MD patients formed the AFM organization in order to create more visibility for their orphan disease. AFM brings together concerned groups (e.g. patients, parents of children with MD, etc.) together with MD specialists who are researching both MD treatments and genetic causes in a more traditional laboratory setting. However, Callon and Rabeharisoa show that the concerned groups of patients also perform their own form of research (e.g. cataloging their disease's development and comparing it to others), which the authors dub *research in the wild*. They go one step further, suggesting that, "it might be fruitful to consider

concerned groups as (potentially) genuine researchers, capable of working cooperatively with professional scientists" (p. 195). Through their study on the AFM, the authors show how both sides are mutually enriched through cooperation, while also, "demonstrat[ing] that these two forms of knowledge are not intrinsically different" (p. 196). What makes this collaboration different from the previous controversies and their resulting advocacy groups, as described above, is that MD has always carried the status of an orphan disease. This status means that there is a relatively small amount of people affected by the disease, which reduces the financial incentive for the pharmaceutical industry to look for a cure—often leaving these diseases underfunded and, consequently, under researched. Thus, patients were forced to independently manage their disease and to mobilize communities in which to share their knowledge of it, with some aspects of their practice becoming very similar to scientific ones. The authors go as far as to say, "there is no fundamental difference of status between knowledge produced by patients and that produced by researchers or clinicians. On both sides we find experiments, instruments, and procedures of visualization, formalization, evaluation, accumulation, and writing" (pp. 197-198). The similarities between the practices of the researchers in the wild and the laboratory specialists allow them to form a hybrid collective that is both mutually enriching and symmetric in terms of knowledge flow.

Callon and Rabeharisoa's (2003) study and the other aforementioned works show how motivated citizens were able to comprehend complex issues, both social and technoscientific, such that they are capable of highlighting gaps in scientific research, while contributing their own knowledge as well—a key insight and a founding notion of citizen science. These early STS studies into the phenomenon of citizens doing science alongside scientists show that collaborations between citizens and scientists were occurring long before the term *citizen science* came to be used to describe this trend. These early studies argue for a more symmetrical relationship between public and formal (i.e. scientific) expertise, while showing how these collaborations can be mutually enriching. Indeed, each study helps to highlight how each collaborative sense-making process is both context specific and embedded in local social settings. Callon and Rabeharisoa (2004) further show how people outside of science may be practicing science by other means—something the authors contend should be considered 'genuine research' that is mutually beneficial for citizens and scientists alike. The symmetrical, mutually enriching collaborations between citizens and scientists (described above) lay down the foundational principles for citizen science. In the next sections 2.2 and 2.3, I will build upon these studies as I look deeper into citizen science and its current definitions and practices.

2.2 Citizen Science and STS

"The age of citizen science is upon us … This transformation means more than simply a new kind of volunteer labor" (Kennedy & Cavalier, 2016, p.117)

Citizen science emerged as one approach to engage the public in science, in other words as a mode of public participation. The term itself is accredited to Alan Irwin (1995) and Richard Bonney (1996). However, their original uses of the term vary quite considerably, creating important differences in both their understandings and implementations of the term *citizen science*, as well as contemporary differences in citizen science practices (Cooper & Lewenstein, 2016). It is also important to highlight that Irwin's notion of citizen science also differs from the current prominent usages of term (Strasser et al., 2019), although claims of citizen science acting as a democratizing force still persist. For example, Kennedy and Cavalier (2016) contend, "[t]he age of citizen science heralds the potential of a fundamentally different relationship between scientists and the public, and between researchers and the questions they ask" (p. 117). To put it simply Irwin's vision of citizen science can be seen as 'democratized citizen science' (i.e. more democratic, participatory science), while Bonney's view is more of a 'contributory citizen science' (i.e. non-scientists contributing scientific data) (Cooper & Lewenstein, 2016).

Irwin (1995) first used the notion of *citizen science* to highlight the need for scientists and 'lay citizens' (i.e. members of the public) to work collectively in order to address complex problems, in this case through the lens of challenges in sustainable development and how community engagement can make its research more robust. He stresses the need to consider the prospects for a more active 'scientific citizenship' in order to bring Science and publics closer to one another. Irwin argues further that for this partnership to be effective, Science should reflect upon the public's own knowledge and reconsider its expectations of the public (e.g. the expectation of the public to embrace scientific knowledge). Thus, highlighting the need to create space for citizens' expertise. For Irwin the term citizen science is two-fold:

> convey[ing] both senses of the relationship between science and citizens… 'Citizen Science' evokes a science which assists the needs and concerns of citizens … At the same time, 'Citizen Science' implies a form of science developed and enacted by citizens themselves … [and] the 'contextual knowledges' which are generated outside formal institutions (emphasis in original, 1995, ix).

Irwin called for a more democratic Science both *for* and *by* citizens, i.e. a science whose policy is more responsive to the concerns of citizens and includes space for the production of local knowledge, complimenting contemporary STS feminist debates of the time, which introduced the notions of *indigenous knowledge* (Watson-Verran & Turnbull, 1995) and *situated knowledge* (Haraway, 1988). Despite Irwin's and others' appeal for the democratization of Science through the inclusion of different types of knowledge(s), Strasser et al. contend:

> Although Irwin's work is often cited in reference to current practices labelled as 'citizen science', it is more of a reflection on the participatory ideals … than on the practices currently subsumed under the label of 'citizen science' which *focus on the production of scientific knowledge outside of scientific institutions, but mostly following the norms and values of institutional scienc*e (emphasis in original, 2019, p. 4).

Yet, some modern scholars still strive for the ideals first laid out by Irwin (1995). For example, Martin (2006) argues that engagement through citizen science has the potential to increase the responsiveness of scientific research to broad social concerns, instead of the specific interests of researchers or industry, concurring with the statements of Irwin. Kennedy and Cavalier (2016) assert that, "[i]n its simplest form citizen science challenges the norms of who ought to be welcomed into the world of science … Taken a step further, however, citizen science advocates are arguing implicitly and explicitly for a radical change to the structures of political power" (p. 117).

Bonney's original conceptualization of citizen science stands in stark contrast with Irwin's. In the early 1990s Bonney was interested in public participation in ornithology (the study of birds, i.e. bird watching and classification). Through his work with the *National Science Foundation* (NSF) in the US, he proposed the term to refer to, "scientific projects in which 'amateurs' provide observational data (such as bird spotting) for scientists and acquire new scientific skills in return, a 'two-way street'" (emphasis in original, Bonney, 1996, as cited in Strasser et al., 2019, p. 54). Thus, to Bonney and the NSF citizen science was both a *tool* for the promotion of the public's understanding of science and a *means* for the public to participate more with institutional scientific research. Current day uses and implementations of citizen science tend to follow more closely Bonney's interpretation of the notion, even though current practices subsumed under the term of citizen science remain heterogeneous in nature. Cooper and Lewenstein (2016) propose a 'third story of citizen science', one in which both 'styles of citizen science' are connected. In this vision of citizen science, the authors envision a practice that is both

democratizing *and* contributory, suggesting that they are not and perhaps never were completely separate ways of doing citizen science. They suggest, "[o]ne way of exploring the relationship between the meanings of 'citizen science' [i.e. Irwin's and Bonney's] … is that the 'democratic' represents a larger context in which the 'contributory' style of citizen science resides" (emphasis in original, 2016, p. 60).

Despite its growing popularity and use, especially in the popular media and science policy discourses, citizen science still remains very heterogeneous in nature, lacking a precise and widely held definition. Yet, its ever-increasing prominence in these discourses (however heterogeneous), "points to a potential transformation in the modes of public participation in science … challenging a number of founding elements of the modern regime of knowledge production based on the separation between expertise of professional scientists working in dedicated research institutions and the lay public" (Strasser et al., 2019, p. 53). Still, many scholars attempt to define the term. Vayena and Tasioulas (2015) loosely and generally define citizen science as, "any form of active non-professional participation in science that goes beyond human subject research conducted by professional researchers" (p. 479), while Ottinger (2010) succinctly defines the term as "knowledge production by, and for, nonscientists" (p. 245). The Oxford dictionary defines citizen science as, "the collection and analysis of data relating to the natural world by members of the general public, typically as part of a collaborative project with professional scientists" (Oxford Lexico Dictionary, 2019). These are only some of the many different definitions of citizen science currently being used. The present plurality of definitions speaks to the relative youngness and increasing popularity of the concept as well as its heterogeneous contemporary applications.

During the past decade the use of the term citizen science (as well as citizen science projects themselves) has flourished. Vayena and Tasioulas (2015) identify two main factors for this increase in participation of non-professional scientists in scientific research: "the increasing availability to ordinary people of online tools and mobile devices that can record, store, process and transmit data … [and] the growing acceptance of the idea that ordinary citizens should be empowered to have a say, and play an active role in political, scientific and cultural processes that affect them" (p. 480). The two factors, according to the authors, combine to create a level playing field between the 'ordinary citizens' and the scientists so that a more symmetrical, mutually-beneficial relationship can be synthesized. Additionally, Haklay (2013) contends the current trend of rising educational levels in most countries should be considered as perhaps the most significant contribution to the past decades' increased interest in and growth of citizen

science, even in the face of growth contributed by other factors such as technological and other societal factors (as described by Vayena and Tasioulas, 2015).

Current efforts in citizen science remain heterogeneous in nature, ranging from the classic crowd-sourcing projects, like large data collection events that seek to tackle manifold real-world problems, to collectives engaging in knowledge generation and problem solving, wherein citizens are actively encouraged to partake in the designing, structuring, and running of the research. Due to this flourishing diversification of citizen science practices and projects, Strasser et al. (2019) argue it remains "still unclear whether the very diverse practices subsumed under that heading [citizen science] form a coherent whole, let alone a cohesive social movement" (p. 53). However, this apparent lack of clarity about the diverse practices along with their ever-increasing diversity, has not gone unnoticed. Many scholars of STS and practitioners (e.g. citizen science project organizers, funding bodies, etc.) have proposed a wide range of different *typologies* (or ways of classifying different 'types' of citizen science (Strasser et al., 2019)) in order to attempt to make sense of the numerous practices encompassed under the heading citizen science. Vayena and Tasioulas (2015)'s typology classifies citizen science into four main types of citizen science participation:

> *(a) crowd-sourced* participation in a project established and governed by professional scientists, e.g. individuals contribute relevant data, observations, etc.; (b) participation in financing, agenda setting or governance in projects established by professional scientists, e.g. *crowd funding* [sic]; (c) *collaborative participation* in which citizen and professional scientists play a broadly comparable role in the initiation, pursuit and governance of a research project; and (d) in the most radical version of participation, citizens themselves take the lead in initiating, designing and conducting a project—a type of activity that has come to be known as *participant-led research* (PLR)" (emphasis in original, p. 482).

These general categories in Vayena and Tasioulas's typology are based off of the level of involvement of the citizen and the type of collaborative work occurring between the citizen and the traditional scientific researcher. The authors also include the relatively radical category *participant-led research* (PLR), which makes this typology unique. Haklay (2013) created a similar, yet more hierarchical typology, entitled *Levels of Participation in Citizen Science* (See Figure 1 below), which is based off of Arnstein's (1969) *ladder of citizen participation*.

Haklay's levels are organized based upon the amount of participation required, with level one being the most minimal and level four being the most extensive or 'extreme', although PLR remains absent. Haklay's updated version of Arnstein's ladder is meant, according to the author, to be value-free and focused on the different potential participation modes of citizen science, while keeping the different levels as devoid of value and moral judgements as possible—meaning no level of participation is inherently better than another. While the author argues it would be beneficial to strive towards as high of a level of participation as possible, he stresses what matters most is a proper fit for both the citizen participants and the scientists of each citizen science endeavor, on a case by case basis—thus, making the 'right level' of participation context dependent.

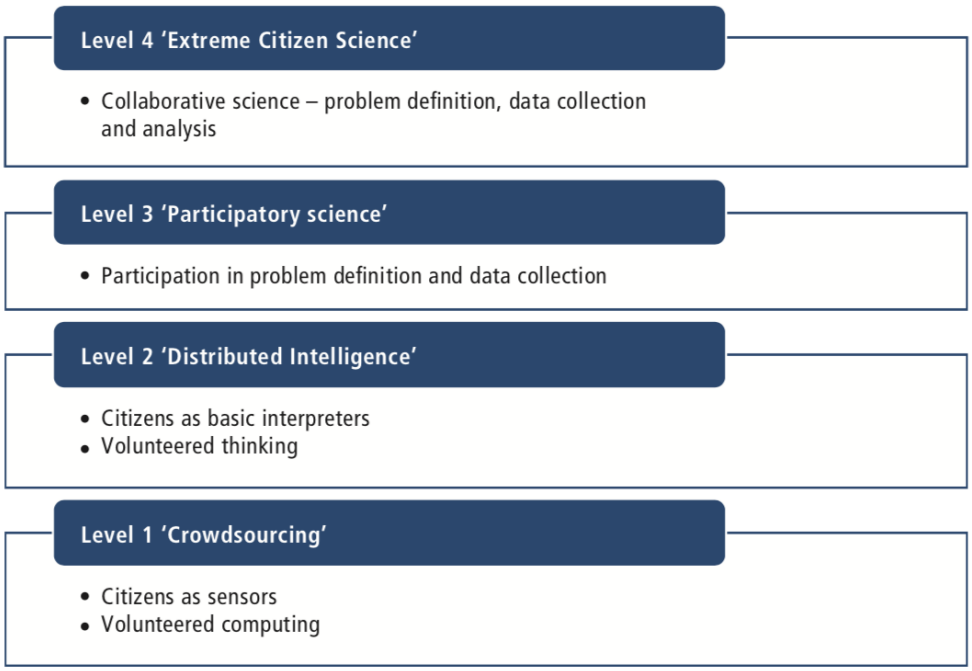

Figure 1: Levels of Participation from Haklay, 2013, pg. 116

Strasser et al. (2019) also propose their own typology of citizen science practices, which focuses on "distinguishing between five *epistemic* practices" (emphasis in the original, p. 55). The authors chose these distinctions for their unique topology because it, unlike other typologies (such as ones described by Bonney et al, 2009; Haklay, 2013; and Cooper & Lewenstein, 2016), has "a clear political agenda: to encourage projects fulfilling citizen empowerment, rather than exploitation, while ensuring that they contribute to science, as defined by scientists" (Strasser et al., 2019, p. 55). The five epistemic practices identified by the authors are *sensing*, *computing*, *analysing* [sic], *self-reporting*, and *making*. The authors hope this typology will help move away from trying to correctly and

discretely categorize citizen science towards attempting to capture "the greater diversity of participatory practices" (p. 55-56). The authors highlight, "[t]his typology does not imply any hierarchy between the different kinds, they are simply qualitatively different, and often hybrid, modes of knowledge production …. Their purpose is to help us analyze (not classify) participatory projects in terms of their different knowledge practices" (p. 56).

Further complicating the already diverse notion of citizen science and the typologies attempting to make sense of its different forms, are the unique and alternative forms of data that originate from its heterogeneous practices. Gabrys, Pritchard and Barratt (2016) argue that data from these novel monitoring techniques of citizen science are "often 'just good enough' to establish patterns of evidence that can mobilise [sic] community responses in terms of communicating with regulators, requesting follow-up monitoring, making the case for improved regulation and industry accountability, and keeping track of exposures both on an individual and collective level" (emphasis in original, p. 11). Furthermore, the authors suggest that the fact these monitoring methods typically do not strictly follow regulatory standards allows them to be more inclusive while also generating forms of evidence that resonate with the experiences of the citizens taking part in the data collection and monitoring. Thus, creating a variety of new possibilities for what the authors term citizen sensing and citizen data; such as in their own case, wherein Gabrys, Pritchard, and Barratt utilize the vignette of air pollution monitoring by citizens. Through their case, the authors explore how citizen science can become a "strategy for reworking and refiguring who or what is authorized to generate data and make their stories count" (p. 12).

Moreover, while the majority of citizen science initiatives focus on the involvement of the public in knowledge production in natural science fields, they are noticeably absent in the fields of the social sciences. Recently social science researchers have been pushing both for increased citizen science research in the social sciences and for more reflection on citizen science's role in the social sciences. Heiss and Matthes (2017) assert that while largely left to the natural sciences, citizen science—in the sense of members of the public participating in activities and tasks normally performed by scientists—has much to offer the social sciences and humanities. The authors argue since social science research attempts to make sense of societal structures and social issues, it would already be closely aligned with citizen science research, with the would-be participants being both a direct source of data and beneficiaries of new research. Furthermore, methodologies in social science research by design deal largely with human subjects and, therefore, should

be more compatible for uptake by citizen scientists. While civic engagement has a lot to offer social science research, Heiss and Matthes contend some challenges remain, such as: social science researchers' internal debate over objectivity and truth; the subjectivity of human observations; data quality along with reproducibility; target group mobilization; and ethical questions. Nevertheless, the authors conclude that although there are noted challenges, "there are good reasons to encourage the implementation of citizen science in SSR [social science research]. Most important, the cooperation with citizens allows to [sic] access large scale and 'hidden' data which … provide a huge innovative potential for the knowledge production in SSR" (emphasis in original, p. 26).

STS scholars (see Irwin, 1995; Fischer, 2000; Vayena & Tasioulas, 2015; Ottinger, 2016; and Kennedy & Cavalier, 2016) have suggested that citizen science has the potential to transform Science by creating innovative ways for more inclusive, participatory forms of knowledge production and policy making. In addition, Kullenberg (2015) argues that citizen science has the potential to be a "privileged tool of resistance" (p. 50) allowing for the production of scientific facts by lay-people, which are then able to, "travel without encountering the usual forms of opposition, thus creating a displacement of what can be contested" (p. 61). Thus, citizen science is seen as having the ability to create a path for the incorporation of local knowledges into scientific knowledge production, without the forms of resistance seen in early studies (e.g. Wynne, 1992, and Epstein, 1996). Nevertheless, Kullenberg warns that "citizen science can be a very successful resistance practice, as long as it is able to produce novel facts that still adhere to scientific methods and standards and remains connected to the established institutions of science" (2015, p. 50).

Despite its potential, many authors also have criticized the current trends and practices of citizen science. Ottinger (2010) contends citizen science has not yet lived up to its theoretical potential in practice. She argues little research has been conducted into the underlying factors that determine to what degree a citizen science initiative, "can be influential or effective, especially in shifting research agendas, changing standards of proof, or affecting policy processes" (p. 246). Through her study of a long-term citizen air monitoring project by residents living adjacent a Shell chemical plant, Ottinger shows how standardization practices for measuring and evaluating the air quality help to determine whether or not the citizens' data would be taken into consideration by governmental regulators or chemical industry officials. These standardization practices help to provide "regulators with a ready-made way to dismiss activists' data as irrelevant to air quality assessment" (p. 246), suggesting that standards aid in shaping the

effectiveness of many forms of citizen science. Ottinger sees standards as both an obstacle and a potential resource for citizen science in order to bridge boundaries and gain access to expert-dominated areas.

Vayena and Tasioulas (2015), although viewing citizen science as having great potential to contribute to scientific research in meaningful ways, highlight the lack of "an underlying set of values and principles" (p. 480) in citizen science, which is able to address the ethical questions that it raises. In their opinion the ever-increasing interest in citizen science, coupled with its current lack of a framework creates both ethical and regulatory concerns needing to be addressed. The authors point to concerns such as:

> the potential exploitation of citizen participants in scientific projects, whether set up by fellow citizens or established institutions; the adequacy of oversight mechanisms to ensure the scientific validity and ethical acceptability of research projects in which citizens are involved; the role of informed consent, especially in communities of peers; ownership of personal data and intellectual property issues in cases where discoveries are made; physical, psychological, privacy and other risks, especially where self-experimentation takes place; and the nature of society's responsibility to recognize and foster scientifically valid and ethically sound citizen science (p. 480).

Furthermore, the authors warn that without a framework to consider all of the aforementioned concerns, the full potential of citizen science as socially-accepted valuable means of knowledge production will not be attained. They suggest drawing upon the *Human Right to Science* (HRS) first discussed in the post-war era. HRS is an ethical principle that not only gives every human the right to share in the benefits of scientific advancements but also "it confers on everyone actively to participate in the scientific enterprise" (emphasis in original, p. 481). The authors conclude that right now is a key moment in which we can negotiate

> how best to facilitate the phenomenon of citizen science within an ethical framework that takes seriously the right of all to participate in, and benefit from, scientific progress. All stakeholders in the scientific enterprise, including citizen scientists themselves, need to be given the opportunity to engage in the dialogue about the duties that arise under the RSC [Human Right to Science and Culture] and how best to give effect to them (p. 484).

Amongst calls for more unified frameworks for citizen science lie questions of whether or not citizen science can be a democratizing force in Science, as Irwin (1995) had envisioned. To be democratizing, citizen science needs to shift the concentration of power (in the form of the epistemic authority of Science) to a larger number of people, i.e. citizens. However, this ideal of openness and distribution of power goes against, "the traditional view of science as an arcane activity and of scientists as closed, elitist circle cut off from community" (Strasser et al., 2019, p. 62). Hence, it is not surprising that questions of equality of participation still remain salient. Haklay (2018) shows that participation in citizen science has a higher number of participants with a tertiary education than what would be expected if percentages of participation mirrored general population statistics and "it is clear that as the task complexity increases, the participation of people with higher levels of education increases" (p. 56). While Haklay explains there are positive aspects of higher percentage of tertiary education participants (e.g. better trained participants), he also points out, "even those [projects] that are based on micro-tasks and allow for a lighter level of engagement, are not reaching the wider population, and especially not enough of those without tertiary education. They are therefore not engaging across all sectors of society" (p. 56). Participation inequality, wherein projects disproportionately engage highly educated participants and fail to attract others, goes against the ideals of a democratizing citizen science. Haklay however, sees a complex picture of participation emerge through the interplay of education attainment and participation inequality. Haklay uses two different skill level requirements for citizen science projects, comparing knowledge level (skill) vs. engagement level, in order to identify four different types of citizen science participation (see Figure 2 below). In a high level of knowledge/high engagement project, Haklay sees the opportunity for scientists to 'harness' the knowledge of their participants in order to have them perform work/tasks similar to a research assistant. For example, the authors see the pay-off here as the participants developing their own expertise. Secondly, high level of knowledge/low engagement project, according to Haklay, has the 'key benefit' of

> the impact of well-educated participants on the outcomes of the project … since participants can understand what the project owner is trying to achieve and the importance of rigour [sic] in carrying out the task. It can also allow the use of disciplinary jargon in the explanations and instructions to participants (p. 60).

Still the last two types of participation, low level of knowledge/high engagement and low level of knowledge/low engagement, Haklay believes are well suited for less-trained participation, but still have high levels of well-educated participants, despite "demonstrat[ing] the high potential for inclusivity in citizen science" (p. 60). Haklay concludes by stressing that there remain important social benefits for all four types of participation in citizen science projects and argues, "[s]implistic assumptions that only full inclusion at a deep level is appropriate for citizen science projects should be avoided. Instead, they should consider how people at all levels of education and engagement gain from, and contribute to, citizen science activities" (p. 61). Lastly, it is important to know that Haklay (2013, 2018) calls for a more contextualized understanding and valuing of citizen science projects, where the training level and level of engagement are balanced with the needs of the participants and the requirement of the research project—with every type of participation being considered valuable. However, Haklay highlights that it is also important for such a project to make possible the opportunity for participants to

	High engagement	**Low engagement**
High level of knowledge	• Highly valuable effort: research assistants • Significant time investment • Opportunities for deeper engagement (analyses, writing papers)	• Skills might contribute to data quality • Possible use of disciplinary jargon • Opportunities for lighter or deeper engagement to match time/effort constraints
Low level of knowledge	• Opportunities for education, awareness raising, other skills • Support and facilitation are necessary	• Opportunities for active engagement with science with limited effort • Potential for family/ cross-generational engagement • Outreach to marginalised groups • Potential for large temporal and spatial coverage and contribution to science

Figure 2 Levels of Participation, from Haklay, 2018, pg. 59

move between different levels of engagement depending on their current requirements.

This section has shown the multiple beginnings of citizen science (i.e. Irwin, 1995, and Bonney, 1996) starting in the mid-nineties and flourishing in usage throughout the beginning of the 21st century, leading up to today's heterogeneous umbrella term of citizen science. Questions of what exactly is citizen science and who is actually doing

citizen science along with questions of democratization of and representation in Science are still being wrestled with by scholars and practitioners alike. Sill, not much research has been done on the perspectives of the individual participants in citizen science, detailing their interactions with the participating scientists, like this thesis is attempting to do. Most work on citizen science focuses defining the term, as shown above, or on the motivations for participation of the citizen scientists, like Domrose and Johnson (2016). In the next section, I will discuss the attempts of science policy and funding agencies to apply frameworks to the divergent practices subsumed under the term citizen science as well as their efforts to answer the same questions as the scholars in this section.

2.3 Citizen Science Policy and Science Funding

The term citizen science has been taken up in the policy and science funding world, with an increasing number of citizen science projects receiving funding in recent years. In response to the ever-increasing popularity and interest in citizen science, multiple institutions supporting and promoting citizen science initiatives have formed across Europe. Citizen science's entrance into the policy and science-funding worlds has created a push for broad definitions that encompass the diverse practices and evaluative frameworks to allow these institutions to properly access citizen science projects. However, currently there are no established indicators for the purposes of an evaluative framework for policy-makers and funding schemes, i.e. external evaluation, or for project initiatives, either for a planning instrument or for self-evaluation (see Kieslinger et. al, 2018). It is important to note that most of these institutions conceptualize citizen science as *a method of knowledge production*.

The European Citizen Science Association (ECSA) (2015) defines citizen science as, "a flexible concept which can be adapted and applied within diverse situations and disciplines" (ECSA, 2015, p. 1). The ECSA created a *List of Ten Principles for Citizen Science,* wherein it aimed to design a set of principles from which citizen science frameworks could be built or improved upon. The ten principles are as follows (ECSA, 2015, p. 1):

1. Citizen science projects actively involve citizens in scientific endeavor that generates new knowledge or understanding.
2. Citizen science projects have a genuine science outcome.
3. Both the professional scientists and citizen scientists benefit from taking part.

4. Citizen scientists may, if they wish, participate in multiple stages of the scientific process.
5. Citizen scientists receive feedback from the project.
6. Citizen science is considered a research approach like any other, with limitations and biases that should be considered and controlled for.
7. Citizen science data and meta-data are made publicly available and where possible, results are published in an open access format.
8. Citizen scientists are acknowledged in project results and publications.
9. Citizen science programmes [sic] are evaluated for their scientific output, data quality, participant experience and wider societal or policy impact.
10. The leader of citizen science projects takes into consideration legal and ethical issues surrounding copyright, intellectual property, data sharing agreements, confidentiality, attribution, and the environmental impact of any activities.

These ten principles attempt to highlight foundations for good practice in citizen science for a large variety of projects and to protect participants from possible exploitation, a common critique of citizen science projects (Strasser et al., 2019). The principles were meant to account for all potential uses of citizen science and, thus, they attempt to encompass a wide range of potential considerations from the project actively involving citizens in the production of new knowledge or understandings to open-access formats and ethical considerations. It is important to mention ECSA's ten principles have strongly influenced the designs of citizen science frameworks and typologies (see Strasser et al., 2019; Haklay, 2018; and Kieslinger et al., 2018). With these ten principles, Kieslinger et al. (2018) developed and aligned their own proposed citizen science framework, noting the need for established criteria for the assessment of citizen science initiatives, both externally and internally. The authors highlight three core dimensions of their proposed framework (*scientific*, *participant*, and *socio-ecological and economic*) and two levels (*process and feasibility* and *outcome and impact*) as well as 55 questions to help guide framework implementation. The authors aim to professionalize the citizen science community while guiding funding and increasing impact. An important take away one can see from these initiatives to create a useable framework is how citizen science comes to be treated as a research approach, almost a method or way of 'doing-science'.

Another influential player in European citizen science policy is the Socientize Expert group of the European Commission's Digital Science Unit. Socientize has delivered two reports entitled the Green Paper on citizen science for Europe (2014) and the White Paper

on citizen science for Europe (2015). Although the white paper built upon its predecessor, the green paper focused more on "foster[ing] the interaction between the citizen science stakeholders and the EU policy officers, reinforcing the culture of consultation and dialogue in the EU" (European Commission, 2014, p. 8), while the white paper, "aim[ed] at improving the understanding and uptake of the impacts associated with Citizen Science" (Serrano Sanz, Holocher-Ertl, Kieslinger, Sanz Garcia, & Silva, 2015, p. 14). In both papers the expert panel defines citizen science as, "refer[ing] to the general public engagement in scientific research activities when citizens actively contribute to science either with their intellectual effort or surrounding knowledge or with their tools and resources" (European Commission, 2014, p. 6).

Other European institutions have also created their own guidelines and criteria for citizen science in an attempt to standardize citizen science research projects in order to evaluate and compare them. One of the first organizations to do this was *Österreich forscht*[2]. Founded in 2014 with the mission to connect citizen science actors in Austria and to advance citizen science as a method, Österreich forscht strived to create transparent criteria for projects wanting to be listed on their platform stating, "[t]he objective of these criteria is to maintain and further improve the quality of the projects presented on the platform" (Österreich forscht, 2018, p. 1). They created their criteria to be able to standardize and open-up their evaluation processes so that potential projects could better align with Österreich forscht's conceptualization of citizen science. Their quality criteria list consists of two parts, the first part is a negative list, meaning what does *not* count as citizen science. For example, according to Österreich forscht a citizen science project is neither one

> that exclusively involve[s] people with project-specific professional and scientific backgrounds … [nor run] by professional scientists or scientific institutions, in which people are merely interviewed regarding their opinion / attitude, way of life, etc. [nor] by professional scientists or scientific institutions, which merely collect data on participants (Österreich forscht, 2018, p. 3).

The active choice was made for a negative list in order to be as inclusive as possible due to the fact that citizen science is such a flexible concept, adaptable and applicable to

[2] Translation (from German): *Austria researches*

diverse settings and fields. Therefore, by listing what is *not* citizen science, space is left open in order to account for the wide varieties of potential citizen science projects. The second part of their list is a set of minimum standards that all projects must adhere to, which is further divided into standards for scientific research, collaboration, open science, communication, ethics and data management. Their thorough and detailed criteria were some of the first of their kind and, thus, have influenced other new citizen science organizations, which aim to create similar guidelines.

Another important player in the field of European citizen science is Bürger schaffen Wissen[3] (GEWISS), a German platform for citizen science. In 2016, GEWISS published their own green paper, which lays out a plan for the development of citizen science in Germany for 2020. The paper defines citizen science as, "the process of generating knowledge through various participatory formats" (GEWISS Program, 2016, p. 6) that "encompasses the active participation by citizens in the various phases of the research process in the natural and social sciences and in the humanities" (p. 13). GEWISS views citizen science on the one hand as integral to both scientific and societal discussions and on the other as a beneficial approach to science that can be used to the advantage of science, policy and society. Many other citizen science platforms have been forming in recent years in Europe with platforms forming in Belgium/Netherlands (shared national platform, *iedereen wetenschapper*), Switzerland (*Schweiz forscht*), and Sweden (*Arenas for co-operation through citizen science* (ARCS)). Citizen science in all its forms and areas is a growing trend in Europe. As the term continues to develop and to create funding interest, the need for standardization, especially in evaluation practices will increase, making efforts to develop and establish standards ever-more important.

2.4 Bee Research in Social Sciences

2.4.1 Colony Loss in Social Science Research

In STS and other social sciences there has been a modest amount of research conducted on bees, beekeepers and bee colonies. A major contribution to this body of literature are the studies conducted by Suryanarayanan and Kleinman. The pair has written

[3] Translation (from German): citizens creating knowledge (direct translation). Please also note this is a play on the German words *Bürger* and *Wissenschaft* or citizen(s) and science

substantially on the topic of colony collapse disorder (CCD)[4] through the lens of ignorance studies. In their article, Kleinman and Suryanarayanan (2013) analyze the ongoing debates about the role of insecticides in CCD in the US as a case study in order to look into the social production of ignorance. The authors see the social production of ignorance as the result of an actor's choices during the knowledge production process (e.g. where to look during a study and how the study is conducted). These choices made during a scientific study or report also correlate to things left unexamined and, thus, every knowledge production process also produces ignorance or non-knowledge (see Harding, 2000, and Gross, 2010), i.e. "the privileging of certain taken-for-granted approaches to knowledge production leads to a systematic production of ignorance" (Kleinman and Suryanarayanan, 2013, p. 494). The authors conclude that certain dominant epistemic forms promote the production of ignorance. In another article Suryanarayanan and Kleinman (2013) explore, through semi-structured interviews with key players in the controversy, the nature and politics of expertise regarding CCD. They show that while beekeepers are entitled to a voice in the debate, they are largely ignored by regulatory, policy and industry actors (e.g. "Entitlement does not guarantee influence" (p. 233)). The authors argue simply understanding why certain actors should be granted a voice in the debate is not enough. Instead, they contend that there needs to be a better understanding of why knowledge claims of certain actors have legitimacy and influence, while others do not.

The authors work on CCD was chronicled and analyzed in their 2017 book, wherein Suryanarayanan and Kleinman provide a detailed and descriptive look into the CCD controversy and the production of ignorance within it. The authors approach the debate from various angles by providing different vignettes (i.e. stories) of actors in the controversy, such as various types of beekeepers holding differing opinions on the cause(s) of CCD as well as vignettes of scientists, industry and regulatory bodies. Through these vignettes the authors provide an in-depth look into the historical contexts of different actors, which in turn have an influence on contemporary knowledge production. For example, the United States Environmental Protection Agency's (EPA) standards for measuring sublethal effects arose from a specific historical context and have a specific set of norms (e.g. favoring false positives over false negatives) wherein it becomes quite

[4] It has been brought to my attention by researchers in the INSIGNIA project that the term 'colony loss' is more fitting than CCD. However, in this state of the art, I use the terminology of the authors, as presented in their work, for consistency in describing their contributions to this corpus of literature.

hard to prove that pesticides pose real and measurable risks. These norms are further aided by the use of good laboratory practices, which the EPA imposes on agricultural companies for the testing of their potential insecticides, which again favor certain methods, such as focusing on a single factor, that do not create space for studies on multi-factor, sublethal effects.

The production of ignorance is another thread present throughout each one of their vignettes, linking the various actors and ways of knowledge production. For example, the EPA's stance on the role that indirect and sublethal effects of insecticides play in causing CCD is directly based upon their standards and norms, which like any other mode of knowledge production also produces ignorance. The authors argue, "ignorance stems from the absence of acceptable tests for measuring these indirect effects … [thus] ignorance follows from excluding data from beekeepers and scientists on indirect effects, asserting that they are unacceptable or insufficiently definitive" (p. 98). Ignorance in the debate is also produced through the research practices of scientific studies working on CCD and their *control-oriented* methodological choices. These control-oriented methodological choices lead to a narrow type of knowledge production and Suryanarayanan and Kleinman contend, "[k]nowledge and its twin—ignorance—are shaped by the norms and values that underpin experimental design, and these norms and values in turn reflect particular histories" (p. 51). Control-oriented methodologies center on making things measurable and easily controllable, which usually means focusing on single quantifiable effects. This focus means experiments do not reflect nature or real-life scenarios for bees and, therefore, ignores them. Finally, their study concludes two things. The first being that, "there is nothing inherent or intrinsic that makes one set of knowledge acquisition practices or one set of norms about evidence better than another" (p. 112), as each norm or knowledge acquisition practices has its own particular history. As a consequence, over time the inherent values attached to each practice and norm come to be taken for granted as they become institutionalized. Secondly the authors conclude, "controversies about what counts as appropriate and adequate knowledge (or, indeed, what the truth is) reflect differences across stakeholder groups about appropriate norms and practices around knowledge acquisition" (p. 112). These conclusions speak as well to the debates surrounding citizen science as the authors' first conclusion would imply that knowledge acquisition practices of scientists should not be considered as intrinsically better than those of the citizen scientists, allowing for a more symmetrical understanding of knowledge contribution from both sets of actors in a citizen science project. Moreover, the authors' second conclusion calls for more reflection on how differences in norms of various stakeholder groups can create

tensions around what is considered as adequate knowledge—something to take into account when looking into citizen science projects.

Watson and Stallins (2016), acknowledging the different (non)knowledges produced by differing knowledge cultures (as described by Suryanarayanan and Kleinman, 2017), attempt to reframe the debates surrounding CCD from a cultural geographical perspective. In these debates they see three dominant knowledge claim narratives on the causes and ramifications of colony loss: *the conservation narrative*, *the reductionist regulatory narrative*, and *the socioecological complexity narrative*. According to the Watson and Stallins, the *conservation narrative* focuses on how the decline of honey bees in recent years is situated amongst wider the issue of global pollinator decline, while they view *reductionist regulatory narrative* as one in which, "[i]solating and responding to the most proximate causal agent is prioritized over any larger historical analysis" (p. 226). Lastly, in the *socioecological complexity narrative* actors hold the opinion that there is no one universal causal factor for CCD, instead the narrative emphasizes the "contingent and unstable social and ecological causality of CCD" (p. 227). The authors view these narratives as, "encapsulat[ing] the tensions between epistemological containment arising from the social production of knowledge and the inevitable ontological fluidity and interconnectedness of material ecologies" (p. 230). They argue for a more pluralistic and material approach, which incorporates the multiple narratives and creates space for ontological fluidity in order to "deepen [the] explanatory power while limiting the influence of human biases that anchor us into fixed categories of causality derived from how these knowledges were socially produced" (p. 231). In other words, the authors contend that the incorporation of material ecologies into policy approaches, which aim to solve honey bee colony decline, opens up 'narrative packages' (i.e. the three aforementioned narratives) to the complexities of the situation allowing them to "move beyond the useful, but ultimately limited description of how knowledge about CCD is socially produced" (p. 230) and towards solutions that can account for these complexities and potential future ecological surprises—i.e. focusing more on solutions for CCD rather than its exact root cause.

Offering up another way to think about CCD more holistically and borrowing from critical animal studies as well as environmental sociology, Nimmo (2015) suggests the term 'apis-industrial complex' as a biopolitical reading of the animal-industrial complex that also incorporates the highly social nature of honey bees and their colonies. Nimmo sees CCD as, "constitut[ing] an animal technocultural assemblage of formidable complexity, surrounded by considerable controversy" (2015, p. 4). The author argues that viewing CCD as an assemblage of the animal, the ecological and the technocultural, while situating it

within biopolitical reading of intensive animal farming systems, avoids the narrow focusing-in on any one particular aspect of the complex system (i.e. pesticides, pollinator decline, etc.) in order to "recognize their embeddedness within the self-escalating material contradictions between a technoculture bent upon seeking the increased productivity of living systems in accordance with the unreflexive [sic], unconscious, but irrepressible resistance to this that inheres in every particle of those biomaterial systems" (p. 15). Furthermore, according to Nimmo, honey bees are to be seen only as an essential node in a much bigger complex, highly vulnerable, but nevertheless as "technologies themselves, and indispensable components of monocultural systems of agricultural production that increasingly dominate the world food systems" (p. 15). Thus, thinking of CCD in terms of an apis-industrial complex allows one to concentrate on the bigger picture instead of focusing on different components individually in order to better grasp the controversy as a whole.

Lorenz and Stark (2015) use the backdrop of debates around colony loss to look into the increase of urban beekeeping in Berlin. The authors find this trend surprising, as rural beekeeping and honey bee health is on the decline, and urban beekeeping itself cannot solve the problem of pollinator decline in the countryside. Thus, the authors assert that there is no obvious link between the ecological problem of pollinator decline and the rise of urban beekeeping as a possible solution. Using Latour's (2004a) notion of political ecology, i.e. "that humans cannot control 'nature' but need to accept the practical interdependencies and need to come to arrangements with 'natural things' within [democratic] assemblies" (emphasis in original, p. 122), they evaluate the current usefulness of the urban beekeeping trend and if it can help with pollination ecology crisis occurring in rural areas. The authors conclude that, due to its popularity, urban beekeeping can help in two ways. First, it can inadvertently help by creating a trendsetting effect, which will eventually spill over onto the countryside and, secondly, by creating a stronger political voice to enact much needed political regulation. Lastly, the authors show through their analysis, that the social sciences can play a role in creating remedies of socio-ecological problems by, "empirically reconstruct[ing] these processes and their interconnections and provid[ing] evaluations … [and] point[ing] to discrepancies among actors and to shortcomings in the procedures" (p. 125).

2.4.2 Bees and Beekeeping in Social Science Research

Discussions about bees and beekeeping in the social sciences is not limited to conversations about colony loss and CCD. Many authors use bees and beekeepers as case

studies to discuss various other phenomena. Lezaun (2011) shows how bees and the beekeepers are often intertwined in the debates surrounding genetically modified organisms (GMOs) in Europe. At the turn of the 21st century, the EU was searching for a way to make GMO crops peacefully coexist with traditional varieties in such a way that cross pollination, e.g. genetic flow, would not occur. However, due to their large flight radius and potential to cross-pollinate, pollinators along with their flight habits became of interest to policy makers. Lezaun argues this threat made pollinators into, "potential vectors of 'genetic pollution'" (emphasis in original, p. 738). Using the figure of 'the parasite' by Serres (2007), Lezaun shows how the EU's attempts to create a 'coexistence policy' led to, "a radical intensification of the ecological monitoring of the landscape, in order to achieve an ever more perfect isolation of biological and legal kinds" (2011, p. 741). This escalation of research monitoring also multiplied the number of concerned actors (bees and beekeepers), because the domestication of transgenic crops would now require the restriction of their movements or "their obligatory sedentism" (p. 748). In the end the beekeepers, or "the intruder[s]drawn to the argument by the efforts to turn gene flow into an object to governmental administration" (p. 753), became unwanted stakeholders in a debate in which they had to fight to partake. It is their active exclusion by the coexistence bureaucracy and their emergence in defiance of it that makes beekeepers exemplify the role of the parasite (as described by Serres, 2007), "that of inventor or 'catalyst' of a new sort of social order" (emphasis in original, p. 754). The parasite does so by forcing the system to deal with its presence, just like the beekeepers forced the European governments to take their stakes into account, eventually forcing a new kind of political order to be consolidated in the European coexistence project. The topic of beekeepers and their entanglement in the European GMO regulations debates is approached from a different angle by Binimelis and Wickson (2019). The authors utilize a system-based perspective to look at the socioeconomic impacts that GMOs have on beekeepers, which they see as, "highly critical and currently particularly vulnerable actor within agriculture landscapes … whose livelihoods are directly entangled with and affected by farmer choices and practices" (p. 548). They see both bees and beekeepers as heavily dependent upon the practices of the farmers in their areas, which they argue would not be taken into consideration in an assessment of GMOs. Therefore, they contend agricultural biotechnologies need to be assessed using a system-based approach to account for the 'sociopolitical package' in order to protect the highly vulnerable actors like beekeepers.

However, sociological research on bees and beekeepers indeed goes beyond their struggles for visibility in the GMO debates of the early 21st century. For example, some

sociological research is being conducted on knowledge practices and knowledge cultures amongst beekeepers. Employing a cultural geographical perspective, Adams (2018), identifies hobby beekeeping in the UK as an interesting site to look at the enskilment process of expertise. Beekeeping in the UK (and all over the world) is a very old, complex practice that requires life-long learning to develop a tacit understanding of the inner workings of a hive. For example, according to Adams, experienced beekeepers can assess the health of their hive by 'reading' a panel of the hive (i.e. looking at the moving mass of bees that look simply chaotic mess to the untrained eye). Adams discusses how up until recently beekeepers would learn their craft by joining beekeeping clubs, which offered a more informal mentoring process. However, beekeeping in the UK currently is undergoing significant changes in how training is done, mostly due to the government's ever-increasing involvement with beekeepers after the rise of colony loss in 2007 and the increased interest in beekeeping as a hobby. Adams attributes formalization of the learning process for beekeepers by the government in the UK (through the creation of beekeeping certifications and licenses) as contributing to the neglect of more informal traditional enskilment (i.e. training). This new formal governance, according to Adams, clashes with beekeepers' experiences and needs. In contrast to Adams ethnographic approach, Uchiyama, Matsuoka, and Kohsaka (2017) utilize a quantitative approach to look into the different ways in which beekeeping as a form of ecological and local knowledge is transmitted throughout Japan. The authors highlight the current efforts in Japan to manage the service of pollinators in Japan's ecosystems, as the increasing importance of pollinator services, like those performed by both wild and honey bees, has not gone unnoticed by Japan's regulatory bodies. The authors found that much of the knowledge of Japan's beekeepers is passed down generationally. Furthermore, this knowledge contains the ecological conditions required for sustainable beekeeping in Japan. Since the knowledge remains tacit and mainly limited to the family unit, it creates, "a challenge to open the knowledge transmission channels beyond families, potentially transforming the knowledge from tacit knowledge among limited members to an explicit manualized knowledge system" (p. 266), as Japan's government seeks to utilize and share this knowledge.

Moving beyond the beekeepers and their knowledge(s), Moore and Kosut (2013) present a unique way to think about the bees themselves by sensitizing their research to intra-species mindfulness. As part of a larger ethnographic research project on New York beekeepers, the authors discuss the difficulties of conducting an ethnographic study with multiple actors, both human and non-human (i.e. the bees and other insects), in which they interpret and position the bees using their ethnographic data and translations. The

authors use their work to grapple with the question: “How can we both notice ‘associations’ and ‘controversies’ in producing the groups of bees, beekeepers, general public, military institutions, pharmaceutical industries, farmers’ markets, or gardeners and at the same time maintain a stance that there is indeed oppression of one species over another going on” (emphasis in original, p. 534). They use their notion of intra-species mindfulness to highlight how constellations of human and non-human actors are co-constituted. To describe their enmeshment, one needs to de-privilege language, focusing on other ways of observing and interacting. Thus, Moore and Kosut argue for equal inclusion of actors like bees into sociological observation, with the intent to draw attention to imbalances in the relations between humans and bees. According to the authors, bees, like other non-human animals, understand the world in ways we as humans can never fully access and it is with intra-species mindfulness that we retain “an active remembering of ourselves [the researcher] as part of a multispecies world” (p. 535), while conducting our research and analysis.

2.4.3 Beekeeper’s Knowledge and Participation in (Citizen) Science

Kleinman and Suryanarayanan (2019) assert “the relationship between scientists and nonscientists [here beekeepers and farmers] in the contexts of collaboration is typically complicated by asymmetries in social status and real differences in the kind of knowledges each party has” (p. 2), (also see Suryanarayanan and Kleinman, 2013). From 2014 to 2016 the authors created a study to bring together important stakeholders in debates around colony loss in the US, including scientists, beekeepers, farmers and regulators, in order to see if and how they can work together to design an experiment to address the complexity of circumstances around colony loss. Through their study the authors gained valuable insight into the dynamics and roles of each actor group. However, for the purpose of this thesis, I will focus on their findings on the relationship between scientists and beekeepers. Kleinman and Suryanarayanan discovered that both “*trust* and *authority* were crucial matters in constraining or enabling dialogue … and that *time* was crucial in altering the impact of these factors” (emphasis in original, 2019, p. 2). Further constraints in the dialogue were noticed by the authors in the form of “apparent recognition of expertise of participating scientists by the beekeepers” (p. 3). The authors also highlight that “beekeepers’ concerns about the capacity of scientists to deliver practical solutions were tied to the temporal immediacy of beekeepers’ worries” (p. 13), because the worries of beekeepers were different, more immediate than those of scientists, whose concerns focus more upon, “horizons defined by the values of replication and reproducibility” (p. 13), i.e. results that fit into standards considered

acceptable by their peers. During the experiment it became apparent that the interactional dynamic of the group created a "differential authority reflected in the unequal epistemic statuses" (p. 13), meaning the beekeepers often deferred to the scientists for things like designing field experiments. However, it is important to know that, "nonscientists showed domain knowledge that scientists did not have, in shedding light on the particular factors that typically would be characterized as 'noise' or 'outliers' in statistical relationships by scientists" (emphasis in original, p. 14). Sometimes as well, concerns of the beekeepers about the impact the invasive sampling methods had on the hives clashed against the scientists' desires to have a full and hardy data set. Kleinman and Suryanarayanan (2019) concluded that *trust* is central for productive collaboration and partnerships. Still, "[a]t the same time, work on nonscientists-scientists interaction points to how social assumptions about different knowledges and capacities ([thought] of as authority and social asymmetries) by participants can be a barrier to cross-group understanding and respect. This in turn can impede collaboration" (Kleinman & Suryanarayanan, 2019, p. 21).

Complementary to Kleinman and Suryanarayanan (2019), Maderson and Wynne-Jones (2016) reflect on the potential for incorporating the knowledge of beekeepers in participatory policies working to address challenges in pollinator health and the challenges beekeepers face in doing so. Pollinator decline is a serious trend both in the UK, where the authors performed their study, and all over the world. The decline of pollinators (both wild ones and the honey bee) threaten food security as many staple food crops rely on pollinators. Like colony loss, the overall decline of pollinators has been linked to the agricultural use of broad insecticides and the increase of monocropping, creating what some beekeepers call 'green desserts', which look lush and green to the human eye but lack forging biodiversity for pollinators. Kleinman and Suryanarayanan (2019) also mention monocropping as a point of contention in their collaboration, between beekeepers' concerns and farmers' needs. For their study Maderson and Wynne-Jones (2016) looked into UK initiatives to tackle the problem of pollinator decline (the National Pollinator Strategy and Pollinator Action Plan) and their incorporation of beekeepers' voices, knowledges, and expertise. Both of these initiatives, according to the authors, acknowledge the unique position of beekeepers and seek their expertise to "supplement, and develop, scientific data" (p. 89). However, the authors also suggest their incorporation has its difficulties as, "conflicts are evident regarding *what* and *whose* knowledge is most valid" (emphasis in original, p. 89) and making matters worse, "[b]eekeepers often find that their perspectives are not granted the same weight as others and fall outside the parameters of conclusive scientific practice" (p. 89).

Through their study the authors consider the differences that were apparent between the knowledge of beekeepers and that of "the typically acknowledged expertise of scientific studies" (p. 92). First and foremost, the authors see beekeepers, due do their daily interactions with their bees, as on the front lines of understanding pollinator health. Beekeepers, thus, tend to be attuned to the health of their bees, environmental conditions, and the resulting honey quality. They contend this attunement often puts beekeepers ahead of the curve in terms of noticing trends in pollinator health. According to Maderson and Wynne-Jones, these factors combine to lend beekeepers to roles in citizen science, since their beekeeping requires a certain attunement and environmental record-keeping (i.e. "synergies with conventional scientific observations" (p. 92)). A second difference the authors highlight is the beekeepers' tendency to have multiple or 'other' ways of knowing that do not necessarily align with more traditional scientific ways of knowing, although there is some overlap. The beekeepers that the authors studied tended to focus on real-world complexities—something with which Science struggles. Due to this proclivity, the beekeepers' "resulting knowledges are consequently more fluid and contingent, and the acknowledgement of their differing basis of knowledge construction makes many approach formal scientific findings on pollinator health with a cautious reserve" (p. 92). Still, the authors found that beekeepers do tend to use a mixture of peer-reviewed science and their own practical experience.

However, it is important to highlight the tensions that came to the foreground during Maderson and Wynne-Jones's study, especially when it came to controversies arising from the noticeable time-lag between beekeepers expressing concerns about something and when follow-up scientific research, addressing their concerns, occurred. The authors contend that during these controversies, "beekeepers found their knowledge was dismissed as 'anecdotal' until formally recognised [sic] and/or replicated in scientific studies" (p. 94), noting that the privileging of scientific knowledge and data has been a common theme in other controversies around honey bees (see Suryanarayanan & Kleinman, 2013, and Kleinman & Suryanarayanan, 2019). Furthermore, beekeepers affiliated with 'official groupings' were privileged, while beekeepers with more environmental motivations were often much more marginalized. The authors lament, "[w]hile their knowledge of bee and wider ecosystem health may be of relevance, it is difficult to access due to their lack of affiliation with government-acknowledged statutory associations" (p. 94).

Like Kleinman and Suryanarayanan (2019), Maderson and Wynne-Jones conclude problems of trust stemming from "control and directional flow of knowledge" (p. 96) as having critical impact on future collaborations. Currently the authors see the beekeepers

as, “providing their ‘citizen science’ to support monitoring projects and decision making that is ultimately beyond their control” (emphasis in original, 2016, p. 96). Maderson and Wynne-Jones emphasize that, “the aim of participatory policy and citizen science is not simply to deliver better information to policy … rather the aim is to enable greater circulation and co-production of knowledges” (p. 96). The authors urge for participatory projects that have “greater inclusion and a more general participatory approach” (p. 96) despite ‘substantive barriers’.

2.4.4 Citizen Science Projects Involving Bee Research

Although limited, but growing, some citizen science projects on bees and beekeepers have been conducted and are increasing as Science looks for novel ways to understand the ongoing trend of the general decline of honey bee colonies. One such example is *C.S.I* Pollen. Its name stands for *Citizen Science Investigation*. The project itself is an international task force of the *COLOSS*[5] *Honey Bee Research Association*, which aims to better understand the available pollen diversity in Europe through the use of over 700 citizen science beekeepers across 15 European countries. The citizen science beekeepers collected pollen samples from their colonies during the foraging seasons of 2014 and 2015 with the goal to better understand the plant biodiversity (van der Steen & Brodschneider, 2015). Another example of a bee monitoring citizen science project is the *Open Source Beehive Project* based in Barcelona, which is a citizen science project that is attempting to track bee hive decline. To do this, the project has created sensor enhanced bee hives which employ Data science in order to study honey bee colonies. Citizen scientists can acquire kits, entitled ‘BuzzBoxes’, from the project that include a hive and sensor, while all the data produced is open-access (Institute for Advanced Architect Catalonia, 2019). Other examples include *HiveScience*, a citizen science initiative run by the EPA in the US, which is a project that uses a cell phone application to engage with US beekeepers in order to monitor their hives (EPA, 2019). In addition to the application monitoring, beekeepers are encouraged to contact the EPA in order to receive a sampling kit. Yet, most of the motivation, supplies and engagement is expected to come from the side of the beekeepers. Lastly, the project *Broodmapper* was an initiative to teach citizen scientists, through an interactive website, to label different stages of bee brood

[5] COLOSS = Prevention of Honey Bee COlony LOSSes

development, which would help track trends in how miticide and fungicide interactions affect honey bees (Extension, 2013).

Furthermore, Domrose and Johnson (2016) look into the motivations of citizen science volunteers who took part in the *Great Pollinator Project*. The project itself took place in New York City, as a collaboration between the Center for Biodiversity and Conservation at the American Museum of Natural History and the New York City Department of Parks and Recreation's Greenbelt Native Plant Center. The goal of the project was to "improve park management practices to conserve pollinator habitat, to raise awareness of native bees, and to identify which areas of NYC had good pollinators" (p. 41). For this project volunteers were asked to observe specific flowering plants and to record the types of bees that came in a 30-minute window. The authors conducted focus groups as well as surveys both pre and post observation season with the citizen science volunteers to access their motivations and to understand better how to retain participation levels. They found most citizen science volunteers were motivated by either a desire to learn more about bees or a desire to contribute to environmental research. Understanding the scientific process was not a common motivation for participation. Domrose and Johnson show how the researchers in the Great Pollinator Project were able to increase participation in the second year by 25 percent, when they, during the recruitment process, took into account the motivations of the volunteers. They argue assessments taking place throughout the duration of the project can help to gain a deeper understanding of participants motivations which can then create the ability to target more efficiently particular conservation outcomes while simultaneously recruiting and retaining more volunteers.

3 Introduction to the INSIGNIA project

This section strives to provide the reader with a deeper understanding of how this thesis is situated with the large project of INSIGNIA. By positioning this section before my research questions, I hope to provide the reader with a clearer picture of the project, allowing for a more concrete understanding of my main question and sub-questions. I will present INSIGNIA through a detailed description of the project and my own involvement with it, including my motivations for taking part in the project.

The empirical material for this thesis, as previously mentioned, is derived from my own involvement in the INSIGNIA pilot project. The EU-funded project is run by a consortium of 28 scientists from 16 institutions across 12 EU countries, whose goal is to develop a novel protocol for non-invasive sampling of honey bee colonies by citizen science apiculturists in order to measure and monitor pesticide use of the surrounding areas.[6] Previous monitoring methods often involved invasive forms of sub-sampling, i.e. extraction of information from a living organism for analysis. These non-invasive forms of sub-sampling require neither killing honey bees nor taking large amounts of their food storage (e.g. bee bread) in order to measure the plethora of chemicals they come into contact with; such as flowering plant pollen, pesticides, plant pathogens and even radioactive material. The INSIGNIA project, along with gathering data on plant biodiversity and pesticide contamination across Europe, focuses on developing a much-needed non-invasive sub-sampling protocol for citizen science apiculturists that minimizes harm done to both the individual honey bees and the colony. At the same time such a protocol needs to be effective and easily accessible for the citizen science apiculturists. INSIGNIA relies on citizen science apiculturists to collect data in the form of bi-weekly samples. Additionally, new protocols will be created not only for sub-sampling methods but also for transporting and storing the samples, as the chemicals present in the honey and bee bread deteriorate rapidly and, therefore, require careful handling. In the first year, four EU member states partook in the monitoring season from March until October 2019. The sites in the first year were located in Austria, Denmark, Greece and the United Kingdom, while in the second-year additional sites in Belgium, France, Ireland, Italy and Latvia will be added. The sampling sites and their citizen scientists will be chosen to highlight different land uses, which will allow for a contrasting range of

[6] For a deeper description of the INSIGNIA pilot project and a list of all the participating institutions and members, please see: https://www.insignia-bee.eu/

expected pesticide exposure. During this first year (2019), the well-established monitoring techniques of pollen traps and bee bread sampling were compared to two innovative techniques, *APIStrips* (see Figure 3) and *Beehold* tubes (see Figure 3), using a three-hive set-up (see Figure 4) in order to find the most suitable and economically feasible non-invasive sub-sampling method. Based on the results of this comparison, more extensive monitoring method testing will be conducted in nine EU countries in 2020. The results of the two years of monitoring data will then be combined with geospatial land use data from the *Coordination of Information on the Environment* (CORINE) database, so that geospatial models of plant diversity and pesticide exposure of honeybees can be developed to link graphically pesticide contamination and plant biodiversity to certain land areas. INSIGNIA researchers hope the results of these models will be able to contribute to implementations of European environmental legislation. The pilot project is scheduled to be completed in 2021.[7]

Figure 3: Insertion of APIStrip into bee hive, University of Graz, April 2019 (personal photo)

[7] Much of the information about the INSIGNIA Project comes from the slides of a presentation entitled: INSIGNIA: Pilot study on environmental monitoring of pesticide use through honeybees (Protocol development for the apiculturist-citizen scientist pesticide use monitoring with honeybee colonies 2019 - 2021) presented by J. van der Steen, from Alveus AB Consultancy, for the Apimondia symposium: new approaches to honey bee health held in Rome, Italy (February, 2019).

Figure 4: INSIGNIA's Three Bee Hive Sampling Set-Up. Visible are Beehold tubes (left hive) and Pollen traps (middle and right hive), University of Graz, April 2019 (personal photo)

Figure 5: Close up of Beehold tubes, University of Graz, April 2019 (personal photo)

The project views the citizen scientists as having great potential to assist in both apicultural and environmental science and, consequently, the project strives for the development of an easy-to-follow protocol that allows for the long-term incorporation of citizen science beekeepers into pesticide monitoring processes across Europe. The project concentrates on the design of a 'toolbox' for citizen science beekeepers in the form of clear instructions, introductory workshops and instructional videos. The project

also hopes to gain a better understanding of how to best communicate and disseminate information between the scientists working in the INSIGNIA consortium and the citizen scientists taking part in the project. To ensure the best interactions are occurring between the scientists and the citizen scientists, a sociological component was included in the first year of the project. I was asked to set-up a small sociological research project to study and address these sociological concerns that may occur during the first year of the INSIGNIA project, with the intention to better deal with and incorporate the concerns in the second year. My work in the project consisted of performing two stages of interviews with the citizen science beekeepers in Austria, Denmark, Greece and the United Kingdom. The first stage of interviews was conducted during the beginning of the growing season, between April and May of 2019. Each beekeeper was to be interviewed, pending availability. The second round of interviews occurred during August and September 2019, around the end of the first year's monitoring season. Each citizen science beekeeper was also asked to take a survey (asking to list the features of the INSIGNIA research process in order of their perceived importance and impact) during both interviews to see if their opinions change over the sampling season. Their answers were compared to the answers of the INSIGNIA scientists, who also took the survey at the beginning and end of the sampling season.

This thesis utilizes only a small subset of the data collected during my involvement in the INSIGNIA project. For the purpose of this thesis I chose to use my interviews with the four Austrian citizen science beekeepers as empirical material. My choice to focus solely on these four beekeepers was both a methodological, practical and temporal one. I was able to meet the four Austrian citizen science beekeepers in person (i.e. one-on-one), normally at their homes, which created a more relaxed atmosphere than over the telephone or skype—generally creating richer data. Furthermore, by focusing solely on the Austrian citizen science beekeepers, I was able to reduce cultural diversity and the need to consider how the different cultures may affect beekeeping practices and interpersonal interactions amongst the beekeepers and scientists. Thus, I was able to focus more on the practices of the beekeepers albeit in a specific cultural context, eliminating the need for cross-cultural comparisons. Lastly, due to complications in the project (e.g. language barriers, logistical issues etc.), I was unable to interview all beekeepers from other countries in a timely manner. All of these factors were taken into account leading me to make the decision to use the first-round interviews with the four Austrian citizen science beekeepers as the empirical data for this master's thesis.

4 Research Questions

Drawing upon the body of literature detailed in Chapter 2 and Chapter 3, I use my main question to look deeper into the roles that the four citizen science beekeepers take on within the INSIGNIA project. As mentioned before, my main research question is as follows:

How do citizen science beekeepers construct their role within the broader project, INSIGNIA?

This question focuses on the citizen scientists and their role construction and not on the roles imagined or intended for them by the participating scientists in the project. My main aim in choosing this main question was to get a deeper understanding of a citizen science project from the perspective of the citizen scientists themselves. In order to achieve my broader aim, I employ six sub-questions.

4.1 Sub-questions

1 How do different types of knowledges meet within the project?

With this sub-question, I will look at where and when different knowledges meet within the project. It is important to mention that both the scientists and the beekeepers are parts of very different epistemic communities, with their own idiosyncratic ways of generating knowledge and sense-making. This question sensitizes me to the different ways in which these various types of knowledges encounter each other, or whether in fact they do meet.

2 How do the beekeepers understand their own knowledge and what it can contribute to the project?

This sub-question is intended to aid in exploring the beekeepers' self-conceptualization as knowledgeable subjects. For instance, I will consider in the next chapter whether they the beekeepers see themselves in the project as equal peers to the scientists or on different planes than them. I will also reflect on whether the beekeepers see their own practices as involved in the knowledge production process.

3 How do the beekeepers relate to the scientific knowledge and how are they incorporating it into their practices?

This sub-question can be seen as a complement to sub-question two, looking at the proverbial other side of the coin. With this sub-question I look into how the citizen science beekeepers relate to scientific knowledge, both in their everyday practices and in the project specifically. In order to do this, I will examine how they have incorporated scientific knowledge and the acquisition of it into their practices.

4 How do the beekeepers relate to the controversies surrounding colony loss?

With the fourth sub-question, I will examine how the beekeepers perceive the controversy around colony loss. As shown in Suryanarayanan and Kleinman (2017), colony loss is a very polarizing debate in which even beekeepers are not unified. With this question, I look to better understand the beekeepers' reasons for engaging with the project and their interests in the research as well as some of their reasons for engaging with scientific studies.

5 How do beekeepers position themselves towards the scientists?

This sub-question explores how the beekeepers meet their scientific counterparts in the project. With this sub-question, I will be looking at possible tensions but also fruitful encounters between the two worlds present in this project. I will examine whether or not the beekeepers see themselves as equals to the scientists or if perhaps they see themselves as completely separate from the scientists.

6 How is epistemic authority negotiated within the project?

With the last sub-question, I am interested in better understanding who (scientist or beekeeper) gets to make and attribute knowledge within the project. I also will look at how these decisions are negotiated.

5 Material and Methodological Approach

Building upon the literature background and theoretical framework presented in the previous chapters, this section strives to provide the reader with a deeper understanding of the methods and tools I utilized in order to produce and analyze my empirical material for this thesis along the lines of my main question and sub-questions. In this chapter, I will discuss my methodological approach for collecting and analyzing my data as well as the ethical considerations that I took into account during the process.

5.1 Methodological Approach

In order to address my main research interest, *how the citizen science beekeepers position themselves in the INSIGNIA project and towards Science more broadly*, I chose to perform qualitative interviews, using a semi-structured approach, with an open-ended questionnaire (explained in more detail below). As mentioned earlier, I visited the beekeepers in their homes, which was a more comfortable environment for the beekeepers, frequently leading to interviews well over the one-hour time estimate. Oftentimes, the beekeepers gave me a tour of where they kept their bee hives and of the surrounding areas after the interviews. To incorporate insights gained during these more informal discussions, I also kept a research dairy and took some photos. In this diary I recorded my expectations of the interviews before and my thoughts after leaving the beekeepers' homes. I made an attempt to write in detail everything that I could remember about our time spent outside of the recorded interview as well as interesting thoughts—writing detailed memos about certain aspects. It is through these notes that I was able to incorporate the ethnographic undertones that are present in my analysis as I was able to write down and, therefore, remember enriching details of the setting and how the beekeepers interacted with their surroundings. In the following section I will explain my rationale for choosing qualitative interviews as the main source of empirical data and their subsequent analysis.

5.1.1 Qualitative Interviewing

I chose qualitative interviews as my data collection method, because I felt they were the best fit for answering my main question of how the beekeepers construct their role in the INSIGNIA project, as well as my sub-questions. While ethnography would have also been fruitful in answering my question, the method would have required a disproportionate

amount of effort and time for both the beekeepers and myself. Moreover, other forms of qualitative data production, like document analysis, would not have offered me insights into the beekeepers' personal perspectives; how they constructed their role with the project; and in what ways they see themselves participating in science. Therefore, the decision was made to concentrate on qualitative interviews. I approached the design and execution of the interviews from a more constructivist stance. In contrast to positivism, which conceptualizes the interview process as a way of accessing facts about the world, or emotionalism, which conceptualizes the interview process as a way of accessing an interviewee's 'authentic experiences', constructivism conceptualizes the interview as *mutually constructed* meaning-making process, which is created through the interactions of the interviewer and interviewee (Silverman, 2015). Silverman (2006) contends, "[a]ccording to constructivism, interviewers and interviewees are always actively engaged in constructing meaning. Rather than treat this [meaning-making] as standing in the way of accurate depictions of 'facts' or 'experiences', the researcher's topic becomes how meaning is mutually constructed" (emphasis in original, p. 118). Thus, constructivism

> disputes the possibility of uncovering 'facts', 'realities' or 'truths' behind the talk, and treats as inappropriate any attempt to vet what people say for its 'accuracy', 'reliability' or 'validity' – thereby sidestepping altogether the positivist problems … This approach is valuable in so far as it draws attention to the fact that experience is never 'raw' but is embedded in a social web of interpretation and re-interpretation (emphasis in original, Kitzinger, 2007, p. 116).

Furthermore, constructivists are focused on *active* meaning-making during the interview wherein both the interviewee and the interviewer take on an active role. In response to the criticism that constructivism's focus remains too narrow, Holstein and Gubrium (1997) propose 'the active interview', wherein questions of *why* and *how* form a dynamic interconnectedness. In short, borrowing from constructivism and the authors' notion of the active interview, when planning, performing, and analyzing the interviews, I not only focused on *what* was being said but also *how* it was being said as well as my own role in our mutual meaning-making. This focus on the *how* aided me in aligning my questionnaire with my main research question, as I was looking into how the interviewees construct their roles.

Next, I needed to decide upon a concrete qualitative interviewing method, keeping in mind the constructivist ideals. Silverman (2015) identifies three main types of qualitative interviews: *the structured interview*, *the semi-structured interview* and *the open-ended interview*. According to Silverman, the structured interview requires neutrality and no improvisation with the interviewer usually being trained in delivering a strict questionnaire in order to ensure consistency. The open-ended interview is the most flexible of the three styles, allowing for what Silverman calls a "fluid interaction" (p. 386) between the interviewer and the interviewee. To create this fluid interaction the interviewer must partake in active listening giving the interviewee the freedom and space to talk at length and openly—for this type of interview, there is no need for a questionnaire. The semi-structured interview combines both structure and freedom of conversation. According to Jensen and Laurie (2016) the semi-structured interview "allows your participants to answer freely based on personal reflections, knowledge and experience … embrac[ing] the collaborative nature of the interview: through the interview process, the interviewer and participant work together to develop a shared understanding of the topic" (p. 173). The authors also argue that this type of interview allows for the exploration of a topic in depth while simultaneously maintaining the flexibility to allow the conservations to unfold more naturally, adapting with ease to the normal twists and turns that are present in a dialogue. Building upon the constructivist conception of the interview as a site of mutual meaning-making, the semi-structured interview is well equipped to foster collaborative sense-making. Therefore, for my actual interview method, I decided to have a semi-structured interview style, which employed open-ended questioning—as described by Jensen and Laurie (2016).

5.2 Material

5.2.1 The Interviews

For this thesis, I conducted and analyzed four semi-structured interviews as stated above. I approached the interviews as a novice of beekeeping, treating each beekeeper as the expert of their own practice. I made this choice intentionally so the beekeepers would feel encouraged to go in depth about their craft and not feel like they were over explaining anything. Even when I knew how something was done or about a certain topic, I would let them explain it again, because this gave me insight into how they do their practices or how they know something. A questionnaire, which utilized open-ended lines of questioning, was prepared for multiple reasons. The first being that it helped to ensure

continuity amongst the four interviews, while allowing space for the dialog to wander to topics the participants found pertinent and interesting. Secondly, as a young researcher I was still rather inexperienced in conducting interviews (especially in German). Thus, having the questionnaire provided me with a crutch, giving me reassurance that the interviews would stay on-track. Lastly, since these interviews were done in conjunction with my sociological work in the INSIGNIA project, the questionnaire also assured that I asked questions that were important for my work with INSIGNIA.

The questionnaire (for the full English and German questionnaires please see Appendix xxx) was divided into three main sections that were meant to be modular in nature, meaning they could be re-ordered—adapting to the flow of the conversation. Additionally, the questionnaire included an introductory section as well as a section for closing questions. The layout of the questionnaire was purposefully designed to facilitate a continuous conversation. The questionnaire included bold headers for each section in order to make them easily recognizable to aid in easily identifying each section during the interview. Moreover, the questionnaire had boxes situated left of the questions to allow for efficiently marking which questions already had been asked. The opening section contained questions about the beekeepers' personal histories with beekeeping and the surrounding land areas with which their bees may come in contact. These questions were intended to both give the beekeepers time to settle into the interview as well as providing me with a general background information about them. After the introductory questions, I allowed the interviews to progress more or less freely by choosing the section that related the closest to what the participants were currently discussing, giving the interview a more conversational tone. Therefore, no two interviews in this series followed the same order. The three main sections were the *beekeeper's relation to their bees*; *the beekeeper's personal knowledge(s) and practice(s)*; and *the beekeeper's experiences with the INSIGNIA project*. In the section looking into the beekeepers' relation to their bees, questions were asked about their bees as well as about their own experiences and opinions about colony loss. With the section, I hoped to gain a deeper understanding about their relationship with their bees; how they conceptualize their beekeeping; and how they related to colony loss. For the section looking into the beekeeper's knowledge(s) and practice(s), the questions focused on gaining a deeper understanding of how they themselves conceptualize their own knowledge; how they relate to scientific knowledge; and with which kinds of knowledge practices do they engage. For example, questions were asked about who they turn to when they have a problem; what kinds of sources they use to stay informed about beekeeping; if they engage in any form of record keeping; and if they feel scientists can

benefit from the knowledge of beekeepers. In the section concentrating on the beekeepers' experiences with INSIGNIA, questions dealt with their experiences participating in citizen science projects and their expectations for the project, as the four interviews occurred at the very beginning of the sampling season. In the closing section the beekeepers were asked if there was anything else, they would like to discuss and whether they had any further thoughts on how the sampling devices could be improved.

During the interview, I made the decision to take on a more active role, oftentimes reassuring the interviewee and signaling active interest in what they were telling me. That is to say, I was not a detached interviewer. Jensen and Laurie remind us: "Even though you need to be professional during interviews, you should still be warm and emotionally responsive. You're discussing issues that often have deep personal significance for your appropriate emotions and empathy broadly in line with how you would respond in a normal conversation" (2016, p. 182). Despite aiming for a more conversational tone for the interviews, I made sure the large majority of talking was done by the participants. I also never purposefully interrupted them, allowing them to talk at length about what they themselves found important. At times, I even allowed for silence to make certain the interviewee was finished with their thought while simultaneously encouraging them to talk more. Overall, I feel the interviews went well, creating empirically rich data.

The interviews took place in four different locations across Austria—the specific locations have been intentionally left out to protect the identities of the beekeepers as much as possible, as their communities are rather small. Three of the four interviews were conducted at the personal homes and properties of the participants, while one was conducted in a public location. Generally speaking, this meant the interviewees were in a comfortable space and I was put in the position of their guest. At all of the home visits, I felt very welcomed as I was treated as a guest. Every time I was offered coffee and some sort of accompanying sweet. Furthermore, I never left empty handed. My hosts graciously offered me a wide variety of delicious bee products. It was this hospitality that created a relaxed atmosphere present throughout the interviews. The relaxed atmosphere worked well with my active interviewing approach and by the end of each interview, I felt that we had established a friendly rapport in which the beekeepers spoke rather friendly with me. While some may criticize my choice to be more personable with the beekeeper participants. I feel, due to the situation and location of the interviews, a more detached approach would have created an uncomfortable situation and potentially less depth of conversation. For a more detailed description of the interviews please see section 6.1.

5.2.2 The Participants

The selection of the participants for this project happened through the group leaders of each country (in the first year Austria, Denmark, Greece and the United Kingdom). I was not part of the selection process. However, I believe the group leaders of each country attempted to find participants that represented a wide variety of surrounding land use, when possible. I do know, through my interviews, that the beekeepers in Austria were either asked personally to take part in the project by the Austrian lead coordinator for the INSIGNIA project or heard about the INSIGNIA project at a conference and inquired. As much as the beekeeper participants hold different opinions and live different lives, they share quite a few similarities. All the Austrian participants are male. Their ages range from late forties to mid-seventies. Beekeeping is not the sole source of income for any of the beekeepers, unless in retirement they all have another job besides beekeeping. To varying degrees, they are all active in their local beekeeping associations, with three out of the four teaching beekeeping. Additionally, all the Austrian beekeepers have participated previously in other scientific research projects similar to INSIGNIA. Please see Table 1 below for an overview of the four citizen science beekeepers.

Name	**Approx. Age**	**Years of Experience**	**Number of Colonies**	**Teaching Experience**	**Previous Projects**
Anton	Mid 70s	21	10 to 12	Yes	Yes, many
Matthias	Late 40s	12	60 to 70	Yes	Yes, a few
Werner	Early 50s	15	about 50	No	Yes
Helmut	Early 60s	31	about 30	Yes	Yes, one

Table 1: Overview of the four citizen science beekeepers

5.2.3 Data Analysis

As mentioned previously the basis of my empirical material comes from the four interviews with Austrian citizen science beekeepers in the INSIGNIA project. The actual length of the interviews varied between 58 and 107 minutes. As all interviews were conducted in German, each of the four interviews were transcribed by an Austrian native

speaker, to both save time and reduce the chance of error, as I am not a native speaker. The transcripts were transcribed for accuracy, incorporating transcriptional elements from Atkinson and Heritages (1984), such as pauses, word repetitions, utterances, transcriptionist doubt and accentuations—more detailed transcription annotations such as characters of speech delivery and intervals were left out. Since I was mainly looking into how the citizen science beekeepers construct their roles, I felt an accurate, yet less-detailed transcription method would suffice, as it is time efficient and a more detailed transcript would not yield deeper insights. Moreover, for multiple reasons, including the efficiency of the transcription process, the decision was made to have the written German of the transcripts be in standard Austrian German or *das österreichische Deutsch* and not in the various Austrian dialects used during the interviews.[8] The length of each interview and the length of their corresponding transcripts can be seen in Table 2:

Interviewee	**Duration (mins)**	**# of Transcript Pages**
Anton[9]	100 mins	31
Matthias	58 mins	20
Werner	107 mins	35
Helmut	100 mins	31
Total	356 mins	117

Table 2: Lengths of the individual interviews

It is these transcripts and my field notes that make up the core of my empirical material, which I then analyzed by loosely using coding methods of *Grounded Theory*, as described

[8] Austrian Standard German varies from Standard High German or *Hochdeutsch* in vocabulary, grammar and pronunciation. Most Austrians speak in dialect when in a casual setting. By claiming that my interview partners were using dialect I by no means imply that they are unable to speak Austrian Standard German. Instead, their use of dialect speaks more to the relaxed and friendly nature of our conversations.

[9] Since Anton was my first interview, a few questions I asked the other beekeepers were missing from his interview. Thus, I asked Anton them in a later interview. So, a few quotations for Anton are actually from a later interview.

by Charmaz (2006). It is important for me to highlight the word *loosely.* By *loosely,* I do not mean to imply that my coding as a form of qualitative analysis was not methodical or stringent in nature. Instead, it is meant to bring attention to the underlying ideals of Grounded Theory that simply cannot be met in a master's thesis. Grounded Theory in its purest form is a way of developing a theory from a large data set without any preconceived notions or questions before interacting with the data, meaning the theory is grounded in the data itself—something very time consuming and unachievable for a master student. According to Charmaz (2006), Grounded Theory emerged in the 1960 from a collaboration between the sociologists Barney G. Glaser and Anselm L. Strauss, wherein they studied dying in hospitals. Their 1967 book *The Discovery of Grounded Theory* "advocated *developing* theories from research grounded in data rather than *deducing* testable hypothesis from existing theories" (emphasis in original, Charmaz, 2006, p. 4). Despite the overwhelming preference of their time for quantitative research and data collection, Glaser and Strauss showed how qualitative research could develop theories systematically. They argued for creating analytic codes and categories; simultaneous analysis and collection of data; continuous development of a theory grounded in the data; the use of memo-writing from elaboration; and doing a literature review after analysis (Charmaz, 2006). Although different strands of Grounded Theory exist today, with some remaining focused on discovery, while others having moved in the direction of verification, the basic tenets of Grounded Theory remain the same. Charmaz contends:

> "Grounded Theory guidelines describe the steps of the research process and provide a path through it. Researchers can adopt and adapt them to conduct diverse studies. *How* researchers use these guidelines is not neutral; nor are the assumptions they bring to their research and enact during the process" (emphasis in original, 2006, p. 9)

It is with this notion of flexibility and reflectiveness that I approached my use of Ground Theory for my data analysis. Although I already had a previously developed interest and main question when starting to code my transcripts, I tried to remain as open as possible to what I may encounter or pull out of the data at hand. I also coded the transcripts as I received them from the transcriber, meaning I had a bit of a cyclic process, wherein I was able to build upon the previous coding when beginning with a new transcript. I followed the coding steps and memo writing laid out by Charmaz (2006). According to Charmaz, "coding means categorizing segments of data with a short name that simultaneously summarizes and accounts for each piece of data" (p. 43). I began with a round of *initial coding* in which I tried to remain as open as possible to potential insights in the

transcripts. More practically speaking, my initial coding was preformed using a quick line-by-line technique, wherein I also tried to remain as true to the data as possible—using the codes to describe and preserve the actions in each line, while keeping them simple and precise. For my second phase of coding, I employed *focused coding* techniques, which built upon my initial codes by organizing them into relevant categories. During the focused coding process my codes became more concise and precise, through the combination of different initial codes or the creation of new codes. Charmaz states: "Focused coding requires decisions about which initial codes make the most analytical sense to categorize your data inclusively and completely" (p. 57). I feel it is important to highlight that my coding process was not a linear one, but cyclic in nature. I oftentimes would alternate between rounds of initial and focused coding, particularly when I found a certain passage interesting or in need of revisiting. In order to record my thoughts in depth, I partook in memo-writing during the entire process. By memos I mean longer written thoughts in relation to my data. Some memos were definitions of certain themes or categories, while others were the beginnings of my analysis. The coding of the transcripts was performed using the program *Atlas.ti*, with some of the memos being hand-written.

5.3 Ethical considerations

An important element in conducting research is to reflect upon the ethical considerations required for qualitative interviews. Before conducting the recorded interviews with each participant, they were informed of their rights through an informed consent. Each participant agreed to being audio recorded and knew they could withdraw their consent at any point during the interview. They were also informed that they would be pseudonymized in order to hide their identity as much as possible. However, due to the relative smallness of the Austrian beekeeping communities I do not know if true anonymization could ever be reached. It is for this reason that I took extra steps to prevent identification of the beekeeper participants. I made sure not to include where they live or even what Austrian state they come from. Even though I met many of their family members, I tried to keep any mention of them to a minimum and intentionally vague.

When recording the interviews and taking photos of the different locations, it is of utmost importance to follow proper protocol for data protection. All of the recordings of my interviews and field photos were taken on a recording device without any form of internet connection and where transferred to my desktop directly. The recordings were given to

the transcriber on a USB stick with strict instructions not to share the files over unsecure file sharing services (e.g. Google, Dropbox, etc.). The transcripts were pseudonymized to remove any possible direct link back to the participant to the best of my abilities. Furthermore, care was taken to ensure any document containing identifying information about the participants was stored offline or shared securely.

Lastly, it is important for me personally to mention the notion of care that I brought with me to every interview and into my work more broadly. Müller and Kenney (2014) argue for a more care-oriented approach to interviewing as a method in STS. The authors believe by paying attention to the ways in which STS research interferes with the phenomena it studies, researchers could engender more "caring relationships in the context of the study" (p. 541). They borrow their use of care from de la Bellacasa (2011), who "aims to encourage an ethos of care in the study of science and technology" (p. 85). Drawing upon feminist thinking, de la Bellacasa argues for the inclusion of care in STS engagements, which are often in the form of critical interventions with technoscience. Building upon Latour's notion *matters of concern* (see Latour, 2004b), de la Bellacasa, "explore[s] how constructivist accounts of science and technology can help turn matters of fact and sociotechnological assemblages into 'matters of care'" (emphasis in original, p. 86). For the author care and concern mean slightly different things, but most importantly care can be transformed into the verb *to care*, which highlights the "notion of material doing" (p. 87). Thus, the notion of *matters of care* as presented by de la Bellacasa is a suggestion on how researchers can reflect upon how their research affects the things they study and how they, the researcher, can participate in their 'possible becomings'. De la Bellacasa concludes: "Caring is more about a transformative ethos than an ethical application. We need to ask 'how to care' in each situation" (emphasis in original, p. 100).

Drawing from the work of these authors on care-oriented approaches to STS research, I attempted to approach my research and interviews with care in mind—paying attention to the ways in which my research could affect the interviewees as well as how my own participation contributes to the construction of their experiences in the project. In practice this meant a few things. First and foremost, I took the well-being of the beekeepers into consideration when making my questionnaire and conducting the subsequent interviews so that, to the best of my ability, the beekeepers felt comfortable and heard. Moreover, I took throughout the interviews an active interest in what they were discussing. I also tried to impart on the beekeepers that their participation and observations were integral to the project. Furthermore, I tried my best to leave the beekeepers with the impression that I found their thoughts and opinions valid. This is not

to say that they were not valid. Instead, it is meant to highlight the emphasis I placed on trying to ensure the beekeepers had positive and rewarding experiences during the interviews.

6 Analysis

In this section I will present my analysis of the four interviews that I have conducted with the Austrian citizen science beekeepers within the framework of the INSIGNIA Project. The analysis will be divided into two sections. Section 6.1 will be more of a prelude to section 6.2, which constitutes the main portion of my analysis. Section 6.1 is meant to introduce the reader to the four beekeepers individually, providing background and contextualization for each one, as I have found that how each beekeeper positions themselves both in this project and towards Science more broadly is deeply intertwined with who they are and the narratives they construct about themselves. It is my hope that the descriptions in section 6.1 will enrich the reading of section 6.2, while section 6.2 will align my analysis along my various sub-questions and main research question, providing the reader with a structured analysis.

6.1 Introductions to the Beekeepers

Despite being very heterogeneous in nature, the group of four of Austrian beekeepers, which I have had the privilege of getting to know during my time working in this project, have more than just their practice of beekeeping in common. Hence, before describing how each of them is unique, I will briefly detail how they are the same. First off, I would like to highlight that they are all male, a trend seen throughout the beekeeper participants in this project. They are generally older—ranging from late 40s to mid 70s. They are all Austrian and have lived in the country their entire lives. They all seem to live comfortably and do not rely on beekeeping as their main source of income. Although to varying degrees, these beekeepers all seem to be (for lack of a better word) *scientifically oriented*, meaning for me that they all feel they can understand to some extent the scientific debates occurring around beekeeping. As a whole, this group of beekeepers show an eagerness for participation in science and for acquisition of new knowledge of their bees and beekeeping more generally. Lastly, I would like to mention how their lives were deeply enmeshed with beekeeping, its communities, and the temporalities, both daily and seasonally, it imposes on them—tending their bees plays a central role in all of their lives. Due to their kindness and generous hospitality, I was able to get a unique look into both their participation in this project and their lives with their bees.

6.1.1 Anton

Die Imker, meines Erachtens sind schon selbst schuld, ich bin selbst bei einem Imkerverein, ich hab ihnen damals angeboten, wenns Schwierigkeiten gibt und die Völker kaputt werden, lassen wirs untersuchen, ich erledige alles, mach das für sie, den Schriftverkehr und die Proben, nehmen und einschicken, von 80 Imkern war kein einziger bereit…

[In my opinion it's the beekeeper's own fault. I am myself in a beekeeper association, and I have offered them, if there are problems and the colonies are dying, let's get it checked, I will take care of everything, do that for them, the correspondence and the samples, taking them and sending them, out of 80 beekeepers no one was willing…]

Anton is my first interview of the entire project. I am extremely nervous waiting for him to pick me up from the small train station in his quaint town. The drive to his property where he keeps his bees is pleasant. It is a sunny spring day and the whole countryside is green and in bloom. He seems to know everyone in his small village. The neighbors wave to his wife and him as we drive by. Anton's property opens out onto the river, which can be seen through a small window in his *Hütte*[10], which he built for the specific purpose of having a place for doing his beekeeping. The *Hütte* is nestled in the trees and is surrounded on all sides by a *Bärlauch*[11] patch. The rest of the property contains a small garden and a swimming hole lined with trees in bloom filled with bees, which come from the brightly colored bee hives situated atop a small hill. Inside the *Hütte*, the natural wooden walls are filled with posters about 'fun facts' on bees and beekeeping. The tall shelf to my left is full of jars of different kinds of honey. We talk across coffee and cookies on a large wooden table, covered with a checkered tablecloth. It becomes apparent rather quickly that he is very eager to share and wants to be as informative as possible. He tells me about his many life adventures with beekeeping through a series of various

[10] Translation (from German) = a small cabin

[11] Translation (from German) = wood garlic/ bear leek, a type of seasonal wild plant indigenous to Europe that is popular in Austrian cuisine.

interesting, long-winding and oftentimes funny stories. He is warm and open from the very beginning, which eases my nerves.

Anton is in his mid 70s. At any given time, Anton has 10 to 12 hives and would not want to increase the number of hives. He got into beekeeping as a hobby for retirement. He has already been keeping bees for about 20 years now but had some early experiences with beekeeping when he was young, as several members of his family have always kept bees. Anton kind of always knew he would get into beekeeping when he had more time. I learn for the first time—both from Anton and the poster behind him—that individual bees can fly up to 3 km from their hive. Subsequently, I quickly notice Anton is very knowledgeable about whatever is present in this 3 km radius around his colonies. He talks at length about what is in bloom and when; what contaminants are present; and the history of local farming in the area. In general, he gives me the impression of being very involved with his bees and the health of his colonies. It is obvious from the many stories he tells that he truly cares about his colonies and wants to know all that he can about them, which he does so by monitoring and collecting data daily. During our discussion, it becomes evident that his previous working experience carries over into his beekeeping, as he highlights, he *is* and always *has been* very methodical, recording everything he can. His job before retirement was in quality control, where he did a lot of measurements and data analysis. In analyzing his bee data, Anton even goes so far as to make his own computer programs, which track varroa mite populations in his hives. He only stopped collecting daily samples for a short time in 2012, a decision he regrets as it coincided with the introduction of neonics in Austria. He laments *and then this thing with the neonics happened and it was a mistake, because I didn't do them [daily measurements] any more (1).*

Because of his data collection and subsequent analysis of his colonies, he has spoken as the voice of the beekeepers at conferences and even to the board of Bayer. He spends ample time telling me about the discussions he has with others, giving me the impression that he is very well connected within beekeeping communities; to the farmers around him; and many Austrian scientists working in Melittology[12] and Apiology[13]. Amongst the other beekeepers, he has taken part in the most research projects. From his stories, I can

[12] **Melittology** is a branch of entomology concerning the scientific study of bees.

[13] **Apiology** is the scientific study of honey bees.

see that he has a lot of channels through which he acquires new knowledge. Every morning, Anton wakes up early to read the scientific articles he gets from mailing lists of beekeeper associations or from scientists. He talks about reaching out to his beekeeping colleagues when he has a problem with his bees or even to scientists. Anton gives many, often humorous, examples of his past mistakes and what he learned from them. It is clear he embraces informal learning processes. Despite the many research projects, he has participated in, Anton makes it clear to me that he is not a scientist. However, I notice he also separates himself from 'other, normal beekeepers', who are contributing to the problem of colony loss. He gives a brief example of how he went to these 'other' beekeepers in his association, where he teaches, and told them to better understand colony loss they should start monitoring, stating: *I will take care of everything … the correspondence and the samples, taking them and sending them(2)*, but no one wanted to. He sees their unwillingness to participate as making them passively guilty of contributing to colony loss. At a few points in our interview he disagrees as well with the decisions made by the scientists during their various research projects. He is definitely not afraid to share exactly where he feels they made mistakes. Still, one can sense his thirst-for-knowledge quality, which is coupled with a desire to quantify everything—more than all the others he provides evidence in the form of numbers. As I am interviewing him, I cannot help thinking of how these traits are ones we would traditionally associate with good attributes of a scientist. *Perhaps, it is no surprise then the scientists ask him to 'be the voices of the beekeepers' at these conferences*, I scribble down later in my research journal waiting for my train. I close the entry with: *He is definitely a citizen who does science, on his own terms, for himself without being recruited by Science*.

6.1.2 Matthias

Wir haben kein Bienensterben wir haben nur schlechte Imker

[We don't have any colony loss; we only have bad beekeepers]

I first met Matthias in Graz on the first hot day of the year. He had travelled to Graz to meet me, as I was visiting the Austrian INSIGNIA group that day for the first time. I had spent my morning and a large portion of the afternoon surrounded by bees learning how to tend to them for the first time and seeing how the different sampling devices were to

be placed. Needless to say, when I first meet Matthias, I am sure to him I look slightly disheveled—out of breath and melting in the early summer heat with a fresh sunburn and slightly swollen palm still burning from an even fresher bee sting. I meet Matthias by one of Graz's old city gates and he shows me to a quiet place nearby so that we can talk uninterrupted.

Matthias is younger than I had expected, I would guess his is in his late 40s. He is dressed in work men's clothes with slightly muddy shoes, giving me the impression that he came directly from working with his hives. We sit across from one another at a large, circular table, in an office-like setting. I do not know exactly where I am. The only things laying on the white table between us are my recorder and his copy of the informed consent. He is more direct and business-like than Anton. He answers are much less long winding and to the point. He immediately strikes me as a very busy person who does not like to waste time. Matthias has a job outside of beekeeping, like all the beekeeper participants I have met so far who are not in retirement. Unlike some of the others, Matthias does not have any familial link to beekeeping. He got his bees by happenstance. One day his neighbor asked if he would care for his three hives, as they no longer wished to continue with beekeeping. That was in 2007 and ever since his hives have been growing in numbers. He tells me he currently has 60 or 70 hives. With his hives, he runs a small business selling his honey. Despite having a job outside of beekeeping, he gives the impression throughout our interview that he sees himself as much more of an *Erwerbsimker*[14] than a hobbyist, which is also reflected in his membership in the Austrian Commercial Beekeeping Association. He states*: for instance, I am a member there, because I am simply telling myself, the Austrian Commercial Beekeeping Association does a lot of lobbying work for me as a beekeeper, the Austrian Beekeeping Association that is responsible for the small beekeepers doesn't do this at all (3).* More than the others he gives me the impression that beekeeping is a business to him, even calling his colonies *Wirtschaftsvölker*[15].

[14] Translation (from German) = commercial beekeeper

[15] Translation (from German) = commercial colonies

One of the first things we discuss is the importance for him of education, particularly formal education—this importance he places on formal education[16] is consistently present throughout the interview. He begins by stressing that although he inherited these three hives, he immediately started taking classes to learn how to keep bees *properly*. Eventually in 2014 he completed his training to become an *Imkermeister*[17]. He makes it clear that he takes pride in the fact that he learned about beekeeping through courses from the very beginning. *He never once mentions less traditional forms of learning, like 'learning by doing'*, I later note down in my research journal, as I find this peculiar: *there must have been some, because he got these hives seemingly randomly and even admits to having no idea what he was doing at the beginning*.

As we proceed through the interview, Matthias tells me a lot about his different teaching roles and expertise of beekeeping—he strikes me as very knowledgeable about beekeeping. He gives the impression that he sees himself as an expert within his own field, also offering up a lot of knowledge about beekeeping, often using very specialized language—at many times confusing for an outsider, non-native speaker like myself. He is patient with me and gladly explains in detail beekeeping terminology that I do not understand. He gives me the impression that he knows all that he needs to about beekeeping. When asked about if there is something he wants to know more about or when referring to what he researches, he talks about things that are cutting edge or are yet to be known (like sequencing genomes of local bees to see if they are a blend of different species). When I ask him about who he turns to with problems or questions about beekeeping, he replies that he really only turns to himself to solve a problem in regard to beekeeping. Still, I try to discuss with him a little more about who he turns to, to which he mentions sometimes scientists or other colleagues at the beekeeping school where he teaches, highlighting their experience and knowledge.

I am quickly getting the feeling he distinguishes himself from other beekeepers, especially from those beekeepers who he views as uninformed and uneducated, lacking

[16] Here by 'formal education', I mean taking courses on beekeeping in a traditional education environment, usually at a beekeeper association.

[17] Translation (from German) = Master of Beekeeping: It takes many years of education and training to reach this formal title in Austria.

experience. He complains to me briefly that when he goes to his local *Imkerverein*[18] people come to him asking for favors, but he does not have time to help everyone. He blames the lack of knowledge of other beekeepers for the spreading of diseases and the general lack of health of honeybees currently. Matthias surprises me when he ascribes to the 'piss-poor' beekeeping (as described by Kleinman & Suryanarayanan, 2017), wherein there is no such thing as colony loss, just bad beekeeping. He sees a trend in urban beekeeping, wherein its 'cool' to get a hive and never learn how to care for it. However, he also sees problems in experienced beekeepers who have done it the same way for 20 years with their bees dying every year and being replaced, just to start the cycle over again, but never changing. I think to myself; *you mean never learning.*

Despite presenting himself as an expert beekeeper, he does make it clear to me during the interview he is not a scientist. At one point toward the end of the interview, he suggests the scientists are missing out by not sampling a wider variety of bee products. Yet, he closes this portion of our discussion by saying, *I can't really judge in what respect this is relevant to get the data one wants, I'm a beekeeper, not a scientist(4).* Instantly giving me the impression, he thinks science here knows better. Inversing the logic, he surprises me once again by making it clear for him, scientists working in Apiology do not need to know about beekeeping—they have people to do that for them. Scientists only need to know how to analyze the data. He believes that scientists can benefit from relationships with professional beekeepers (like himself), who are able to collect what the scientists need from the bees.

By the time the interview is over, I am exhausted from the long day. I only jot down a few thoughts of the interview on the train ride back to Vienna: *Matthias, the expert beekeeper, sees himself partnering with Science to properly collect samples, but not as really taking part in scientific research…*

[18] Translation (from German) = beekeeper's association, these can in Austria range from very local to national, from associations made for hobbyists to commercial beekeepers

6.1.3 Werner

[A]ber was gänzlich fehlt ist die Bildungsmöglichkeiten für die Jungimker, für die Einsteiger, die sind gegeben bis man gehen kann, sagen wir so, ned? und das Laufen lernen, das fehlt gänzlich

[But what's missing completely are the educational opportunities for new beekeepers, for the novice. These courses teach you how to walk, let's say, no? And learning how to run they leave out completely]

It is pouring rain as I drive through the Austrian mountains to Werner's small village. The sheer terror of driving through these foreign, winding mountain roads in a thunderstorm, eases my nerves about our upcoming interview as I can only focus on the road. As I pull into Werner's small village, I give him a call to find out where to park: *we had a bit of rain here—did you notice on your drive down?* He asks me in a warm Austrian dialect, which I would describe as strong (I was later informed by my transcriber that it is not). Werner is also young in his early 50s. He greets me by my car and walks me down a small side street to his house. The rain has turned into a light drizzle by now and all around us are distant mountains speckled with low hanging clouds. We talk in his kitchen. Werner offers me coffee and has already prepared a plate of different fruits and cookies. His child comes down from upstairs when we start to talk, wanting to say hello to me and to steal a cookie or two. I instantly feel very welcomed in his home.

Unlike the others, Werner throughout the interview gets up to show me things, like a book or his data collection app. He seems enthusiastic to share his knowledge and experiences with me. He even prepared print outs of the locations of his colonies with a 3km radius included around each, which I immediately find super interesting. He tells me how he keeps his bees at higher elevations, because they like it better away from the agricultural lands. We get to talking about how he started beekeeping. His young child interrupts telling me they have their first colony this year. They seem as eager about beekeeping as their father. Beekeeping has been in Werner's family for a long time, he seems to have grown up with it. He started beekeeping because he inherited his father-in-law's hives. We talk about the history of beekeeping in Austria and how it has changed since he was a child, where beekeepers would go out every spring and just catch swarms. He tells me

how that all changed with the introduction of the varroa mite in the 1980s. Beekeeping in Europe would never be the same—the mood in the room at this point turns a bit somber. In those early years of the mite's introduction, he tells me his family lost all of their bees and actually stopped beekeeping for a while.

Werner also admits to me in that in his first year of beekeeping he lost all his bees, and only then did he decide to take courses in beekeeping—*I cannot help but to quickly think to myself what Matthias would have to say about this*. Unlike some other participants, Werner is not satisfied with the education he receives at his beekeeper's association. Multiple times he laments, *beekeeper schools only offer training until you can walk … Running you don't learn anywhere (5).* I get the feeling Werner feels like a bit of an outsider at his local association. I get the sense that he has a general distrust of his own beekeeper's association. He complains to me that they do not help him when he tries to learn more about protecting his bees from pesticides. He goes into detail, claiming the association ignores the problem, *his problem*, because the association has conflicts of interest with agricultural agendas. He also tells me about other beekeepers at the association that he tries talking with, but are unwilling to share their knowledge, especially about organic beekeeping. Werner wishes for better education and support for novice beekeepers. When I ask him where he can turn when he needs help or more knowledge, if not his association, he tells about a few beekeeping friends he has and that when he wants to learn he goes to *Erwerbsimkertagung*[19], reads books (he thinks the knowledge there is more solid), or looks at the coordinator's website.

Like the other beekeepers Werner too talks with me a great length about these 3km radii and what lies within them. One of his biggest worries, he tells me, is a neighboring Christmas tree farm, which he believes applies a lot of pesticides that are harmful to his bees. However, he was able to reach a compromise with his neighbor, who promised to mow down all flower plants before applying the pesticide. Still, Werner worries because the neighbor did not follow through on his promise last year. I learn, he chose this location for the study hives because he is hoping to find out if his hives are contaminated. Still, he makes sure to tell me that he does acknowledge the need for pesticides, stating *the next problematic cultures are also in this area, but they are not in the foraging radius, these are fruit cultures, but they work relatively cleanly, with cleanly I mean that if they have to spray, you have to unavoidably give it to them (6).* At certain points during our

[19] Translation (from German) = Commercial beekeeping conventions

interview, Werner questions the validity of scientific knowledge in regard to neonics and Roundup, a potent herbicide. For him, there is so much information there that it is hard to know where the truth lies. He also reflects on how pesticide instructions are over-idealized and do not take into account real-life scenarios, like a windy day when planting.

At the end of the interview, I ask him how he sees his role in the project. He simply replies: He sees his role in the project as a sample collector, who *will take ten samples from the three colonies (7).* I thank him for the interview and turn off the recorder. He immediately asks: *Did you get what you wanted from the interview? Was I helpful?* I am puzzled by this question. It takes a second to react: *Yes, of course. I just wanted to learn about your experiences and expectations*. He looks reassured.

6.1.4 Helmut

das würd ich mir öfters wünschen, gut, und zwar nicht nur mit Imkern, so wie ich, die sehr interessiert dran sind, sondern durchaus dass sozusagen auch Zugang gefunden wird zwischen Wissenschaft und dem normalen Imker

[I wish for this regularly, well and not only with beekeepers like myself, that are very interested, but that an approach will be found between Science and the normal beekeeper]

I am late for my meeting with Helmut, so very late. Luckily it is one of the few days in May that it is *not* raining as I am *utterly* lost wandering around his neighborhood. I ask the postman where his address is. He looks concerned: *umm… that address doesn't exist.* Embarrassed, I thank him and quickly walk away, looking in my backpack for Helmut's phone number. I call him, he is friendly, but possibly a bit annoyed that I am so late. He comes to rescue me. I am a 10-minute walk away from his actual address. I am thoroughly embarrassed at this point, but his friendly, warm demeanor lightens my mood. He asks me how long I have been in Austria and seems surprised that I have already been here for almost three years. We talk at his large wooden kitchen table over some coffee. Helmut looks younger than he is and seems quite relaxed, which makes me also feel a bit more as well. He begins our interview by telling me a heartfelt story about how he got into beekeeping. He tells me he got into beekeeping in the late 80s when he was studying landscape planning at university. A friend recommended that he take an interesting

course *Bienenkunde*[20] and it was sometime in this course that he had an Aha-moment and knew he wanted to do beekeeping—by 2007 he was an *Imkermeister*. Besides his beekeeping, his main job was raising his children, which are all now grown. He also teaches courses at several beekeeping associations. He currently has around 30 hives. Helmut explains to me in depth about the surrounding areas for each location of his colonies. I am impressed by his specialized knowledge about bees and the plants they come in contact with. He goes on to tell me that beekeeping has changed the way he thinks and interacts with nature. Spending time with his bees is meditative for him. He also shares with me his concerns for nature and wild bees, like bumble bees, worrying about the effects the contaminants have on them—especially since *the honey bees have a lobbyist, that's what we beekeepers are, but the 700 or so wild bees species in Austria, they hardly anyone lobbying for them (8).*

When talking about the surroundings of his hives (e.g. with what his bees come in contact), which in my opinion he knows very well for every season. He then goes on to talk to me at length about bee nutrition and it becomes apparent through this discussion that Helmut makes sure his bees are in locations where they get proper nutrition all season long. He stresses how he puts his bees in environments that allow them to thrive, while simultaneously talking about the awards he has won for his honey and mead, some for their uniqueness. I am left with the impression that he really cares about his bees and he values highly the quality of his product. Throughout our discussion, I get the sense that for Helmut things need to be done well and he prides himself in doing so. When choosing the hives for this project, he tells me he decided on certain specifications: not too strong of colonies in order to avoid swarming; young queens; and a good nutrition rich environment. He follows up his description with the suggestion that the scientist should give specifications next year about which kind of hive to use. I notice a call for more standardization throughout our talk.

He tells me a lot about his teaching, he even takes care of the teaching hives at an association, disclosing to me that sometimes he has to fake it a bit by bringing honey from other hives, etc., so that his students have something to learn. When I ask him what he does when he has a problem with his bees, he tells me he goes to one of his colleagues who is an expert in the area in question, stating *you cannot be top in every area of beekeeping (9).* When a student or fellow beekeeper comes to him with questions, which

[20] Translation (from German) = bee science

he cannot answer, he goes to his connections of expert beekeepers to find an answer. I get the impression that he is very well connected. He also talks about giving lectures quite a bit and is an advisor to the board of a Beekeeper's association.

When we discuss the kinds of sources that he uses to get more knowledge about beekeeping, he cites problems gaining access to journal articles he would like to read and that he simply does not have the time needed to read everything. He makes it clear to me that he is not a scientist, but believes his role is more than just data collection. He feels it is the beekeepers' responsibility to give feedback on how the devices can be improved. Before I walk home, I note down: *He knows that they are not 'normal' beekeepers. Yet, I can't help thinking he seems like the ideal citizen science beekeeper for the scientists.*

6.1.5 Summary of the Beekeepers

Table 3 below is meant to provide an overview of the beekeepers' descriptions presented above. This table is meant to give the reader a condensed version and is, thus, not a complete summary of the beekeepers—something, I believe is never truly possible to do.

	Anton	**Matthias**	**Werner**	**Helmut**
Reason for Participating	Asked by a group member of the project	Asked by a group member of the project	Hoping to find out if colonies are contaminated	Saw on the web page of a group member
Experience (yrs)	21	12	15	31
Participation in other projects	Yes, many	Yes, three	Yes, two	Yes, one
Family History	Yes	No	Yes	No
Types of Beekeeper	Hobbyist	Commercial	Hobbyist	Hobbyist
Master Beekeeper	No	Yes	No	Yes
Teaches	Yes	Yes	No	Yes

	Anton	**Matthias**	**Werner**	**Helmut**
Beekeeping				
# of colonies	10 to 12	60 to 70	~ 50	~ 30
Location of colonies	*Rural* (near river and agricultural lands)	*Urban* (city/ near gardens) and rural	*Mountains* (high elevations) and *Rural* (near agricultural lands)	*Urban* (near city parks) and *Rural* (national park, some agricultural)
Views on *colony loss*	Multifactorial	Piss-poor beekeeping	Multifactored with connections to current agricultural practices	Multifactorial, but largely unaffected, potential links to 'green deserts', i.e. nutrient poor pollen

Table 3: Summary of Section one, The Beekeepers

6.2 Main Analysis

This section will analyze the data from the four interviews along my main question and sub-questions. I will systematically reflect on each individual sub-question and use these findings to conclude with a reflection on my main question:

How do citizen science beekeepers construct their role within the broader project, INSIGNIA?

As mentioned above, this section will utilize the descriptions of the citizen science beekeepers presented in the previous section (6.1) in order to enrich the analysis by providing the reader with a deeper understanding of each beekeeper. The sub-sections of this chapter will compare and contrast each beekeeper along the lines of my sub-questions.

6.2.1 How different types of knowledge(s) meet within the project

It is not a surprise that the scientists and beekeepers, who are taking part in the INSIGNIA project, are parts of very different epistemic communities, each community with its own idiosyncratic ways of generating knowledge. In this sub-section, I will look at the different ways in which these types of knowledges encounter each other *or* whether they do at all.

To see where knowledge(s) meet, one must first look at *where* and *how* knowledge(s) are transferred. In the INSIGNIA project, knowledge about how the sampling devices were to be used and what to expect during the sampling season was communicated through an instructional booklet (see Figure 6 below) that was sent via mail to the beekeepers in combination with their first sampling device material to be inserted in three of their colonies. It is important to note that this instructional booklet was made collectively by all the scientists participating in the project and was the main source of knowledge about the project, which was transferred from the scientists to the beekeepers. The intention was that the beekeepers were to simply read the booklet and inform themselves about what was expected from them in terms of the project. The booklet was supposed to contain all they needed to know; however, if there were any problems the beekeepers were told to contact their country's project coordinator, which is a scientist. The instructional booklet and the information it contained created a clear linear knowledge transfer from scientist to citizen science beekeeper, wherein all the project planning and experimental design was conducted by the scientists and the booklet was designed to inform the beekeepers and to make them knowledgeable about the project. Here we can

see a unidirectional knowledge flow, from scientist to participant. There is no real intended meeting of different knowledges, since the participants are enrolled to be on the receiving end of the knowledge—laid out for them in the booklet. Still, moments of contestation or resistance did occur. Furthermore, there was no formal or informal method for the participants to contact one another; thus, all communication went through the Austrian project coordinator and, if the received information was deemed relevant for others, it would be passed on to them. Here again we can see the information and knowledge center in Austria around the scientist coordinator.

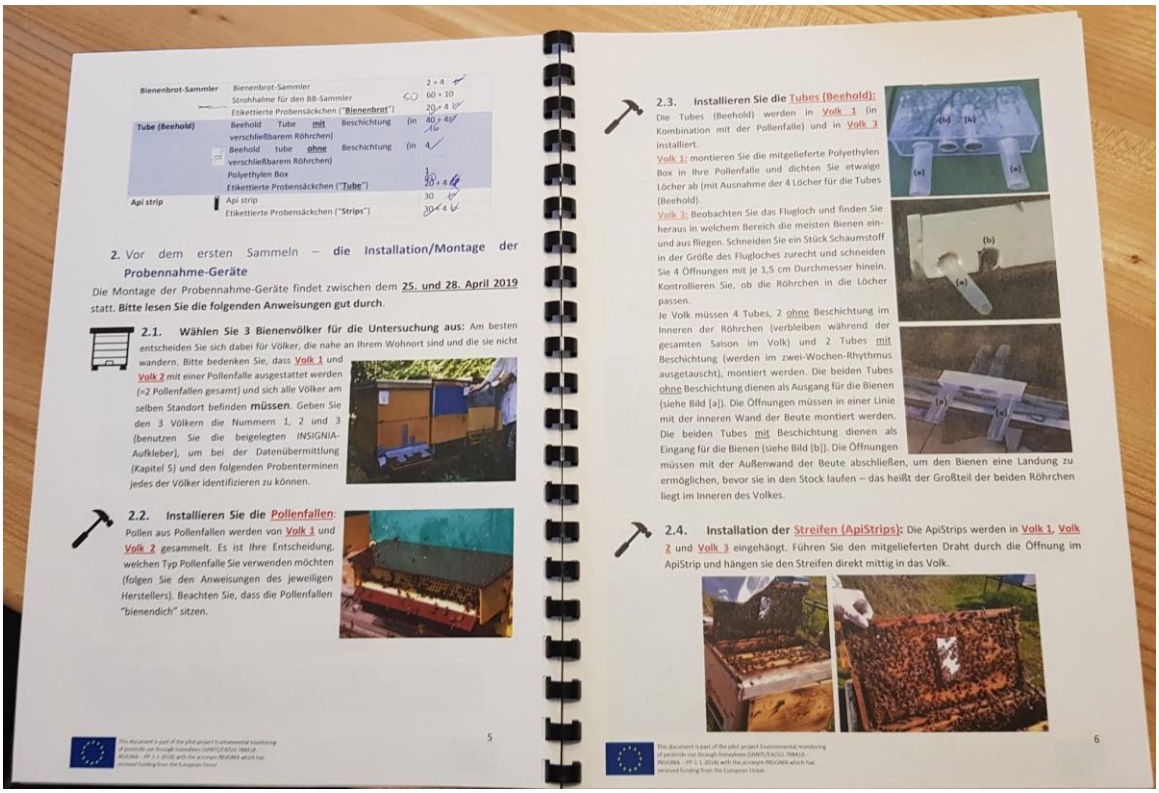

Figure 6: Austrian Instructional Booklet open to the pages explaining hive set-up. A citizen scientists personal copy, April 2019 (personal photo)

Multiple beekeepers found the instructions lacking, while Matthias, when asked if he was well informed about the project, simply replied, *I can read (10)* implying he could follow the instructions without problem. Moreover, he later stated that there were no problems with the instructions, again showing how he sees himself as an expert capable of understanding scientific instructions. In fact, nowhere in our interview does Matthias mention a moment where he challenges the instructions and knowledge of the scientists, nor does he ever try to compare his knowledge to theirs. He sees the scientists' and his own knowledge(s) as complementary to one another, but separate—with both parties

being knowledgeable (at an expert level) in their own right, but about completely distinct entities—Matthias about *beekeeping* and the scientists about the *science of bees*. He tells me:

> *I think that scientists have the huge advantage of having my beekeeping in the background and having at least one or two colleagues who are profound beekeepers, because they regularly need material for experiments, be it combs, be it brood, be it pollen, be it bees themselves, whatever, and it works that it's available when someone takes care of it and when someone knows about it (11).*

To Matthias, it seems his knowledge about bees and beekeeping can be useful to the scientists because he can provide the project with high-quality samples from his expertly tended hives. Thus, his knowledge allows for the creation of good quality samples, which then aid in the production of scientific knowledge, but to him, these are two separate things, never meeting. Here the beekeepers use their knowledge to conduct the sampling, which is then sent to the scientists to use their own knowledge in order to test the sample and hopefully learn something new. Two separate bodies of knowledge connected by a sample, working independently but cooperatively for the purpose of the project.

In contrast to Matthias, the other beekeepers sometimes question both the scientists' actions and the instructions that were given to them. It is in these moments of resistance where I see different knowledges meeting within the project. Out of the four beekeepers I interviewed, Anton was the beekeeper that challenged the knowledge of the scientists in the project the most. Yet, it remains clear that Anton gives authority to scientific knowledge over his own. During our interview, Anton talked at length about the choices of the previous citizen science projects he had worked on, some with the same scientists as this project. He talked about how the scientists always sampled in fall to test for pesticide contamination, when farmers in his area would use the chemicals in the spring time. Like all other beekeepers in the project, Anton had a key understanding of the environment surrounding his bees, talking in terms of the bees' 3 km flight radius, and how the environments changed through the year. He knew when wild plants bloomed as well as where and what farmers were planting along with the chemicals they were using. All beekeepers had this knowledge due to their regular, continual interactions with their hives—echoing the findings of Maderson and Wynne-Jones (2016). Anton's embodied environmental knowledge was in disagreement with the experimental design, which he brought up in the form of informal feedback, but nothing was changed. Anton, although happier with INSIGNIA's longer sampling time, insisted the project still missed the main

time period for pesticide application. Here he again gave feedback based upon his unique knowledge about the surrounding areas, something the scientists might not have known about, since I was told spraying times vary across Austria and Europe as well. Still, the choice of when and how to sample was made by the scientists.

There were also points of contention around the tube sampling devices (see Figure 7below), which created a small round hole for an entrance to the hive, intended to pick up traces of chemicals the bees interacted with when they walked over the sticky substance that lined inside of the tubes. Werner and Anton had a lot of trouble with these particular devices, which were for one of the three sampling hives coupled with a pollen trap meant to catch and collect the pollen from the bees entering the hive. Not only did the tubes aggravate the bees (Anton said he had never been stung as much in his life), they also leaked a white liquid on warm days, concerning Werner of the chemical compounds used in them. Werner even went one step further as to ask the coordinator about what chemicals were used and got the answer of nothing harmful. He lamented that he wished the instructional booklet would have listed the chemicals used in each device so that he could have seen for himself. Here the scientists are kind of creating a black box situation, one in which knowledges about what chemicals are safe for the bees cannot meet because the beekeepers are essentially left in the dark regarding the exact chemicals used. Furthermore, Anton told me of how the pollen traps also contained a certain amount of bee parts (e.g. heads, legs and bodies), because the tubes were so small the bees would push one another and if a bee got trapped in the meshing of the coupled pollen trap parts of them would end up in the pollen trap.

Figure 7: Close-up of Beehold tubes to provide a better understanding of its structure. University of Graz, April 2019 (personal photo

Here, we can see real-world scenarios that were not accounted for by the scientists, despite most beekeepers having been reluctant to use them in the first place and despite their warnings of the apparent perils of restricting the

small entrance way and the combination of that with pollen traps. In this instance, the experiential knowledge of the beekeepers clashes with the scientists'. However, in the end, for the sake of the experiment everything was kept the same. The beekeepers always yielded to the authority of scientific knowledge.

Another instance of resistance can be seen in the beekeepers' critiques of the instructional booklet itself. Helmut told me (in relation to the ranking of important elements of the project):

> *Yes, for me it is important that as a participant in the project I simply know what I have to do and, for me this information is also important, what do the others do and, and are there problems and, because there were some things, such as how I opened the things, yes? This booklet, some things weren't clear to me how exactly it works, yes? And then I just wrote an email and then I got an answer, some things the coordinator reserves the right that it only comes at the very end obviously, yes (12).*

Here you can see that some things that were obvious to the coordinator, were not to Helmut. The instructional booklet becomes a manifestation of the troubles encountered when two different epistemic communities meet and there are visible miscommunications, because things that seem obvious to one community, are not to the other—just like how the beekeepers knew from the beginning the entrance tubes would cause trouble for the bees. Still, Helmut trusts the knowledge of the scientists. This trust also can be seen as well in how Helmut discusses the INSIGNIA project. When asked whether he has encountered or foresees any challenges with the project he responds: *[w]ell, interesting challenges are of course exactly what this project is about, what does it really look like, with, the contamination of bees or bee products with insecticides, what does it look like, with this impoverishment of the landscape"(13).*

From this quote, one gets a sense that the INSIGNIA project is addressing the questions in which Helmut is interested. He does not foresee any challenges and there is no challenging of different knowledges occurring. Instead, he is welcoming the scientific knowledge that will be produced in the project.

The meeting of knowledges in the INSIGNIA project became most evident around certain objects, like the sampling devices or the instructional booklet. The instructional booklet is a physical transfer point of knowledge wherein scientific knowledge about how to set up the sampling devices and what to expect was supposed to be easily understandable

for the beekeepers. However, moments of resistance or contestation occurred when things were not clear, or the beekeepers' own more environmentally contextualized knowledge clashed with information given or experimental design. Still, the design of the overall project created a more linear, scientific-centered knowledge flow, wherein the scientists created and bestowed upon the citizen science beekeepers what they were supposed to do, effectively excluding them from experimental design (see Figure 8 below for a representation of the structure in Austria). Coupled with the lack of framework (at least in Austria) for the different beekeepers to discuss among each other, the project's structure (whether intentionally or unintentionally) promoted the centering of the scientists and their knowledge. Due to the aforementioned design, meetings of different knowledges tended to be limited, as the overall structure was not conducive to producing moments for knowledges to meet.

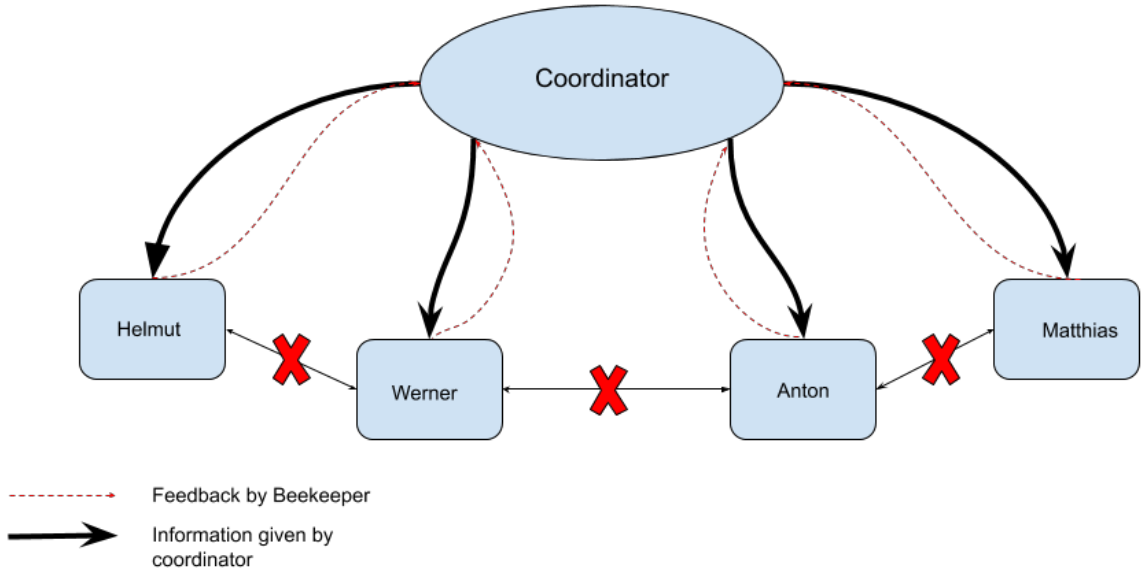

Figure 8: Communication Structure for Citizen Scientists

6.2.2 The Citizen Science Beekeepers' Understanding of their own Knowledge and its Potential to Contribute

In this sub-section I will look into how the beekeepers understand and perceive their own knowledge and what it can contribute to the INSIGNIA project. This sub-section aims to explore the beekeepers' self-conceptualizations as knowledgeable subjects and whether or not the beekeepers see their practices as knowledge production. Each Austrian beekeeper understood their own knowledge and what it could contribute to the project

slightly differently, due to their various backgrounds and educations. Therefore, in this section I will discuss each beekeeper on an individual basis.

Anton sees his background and the knowledge he gained from it as a contributing factor in how well or how able he is to participate in such projects. He worked in environmental measurement and control, giving him a like-mind for taking measurements of things. When asked about the importance of sampling he responds: *I can't say much about that, I've taken so many samples, all my life (14).* Thus, he implied sampling is easy for him, almost second nature. However, he does not see himself as knowledgeable about science itself, stating (in response to the question of what he can contribute to the project):

> *I am actually, in terms of expertise not well versed in this area except, in measurement and control technology, that was my job once … I was involved in preventative maintenance, working with measurement and control technology, and took quite a lot of environmental measurements for the company and then I was in the local council and, thus, also politically active and was environmental community council and, therefore, I have had relatively much experience, I mean in the practical application of measurement systems, etc, etc, and therefore it was a bit convenient for me, it was interesting and I'm generally a bit curious and want to know everything, no? and always want to get to the bottom of things, that's roughly how it always was and still is, even though I'm in my 70s (15).*

Here one can see how Anton conceptualizes himself as experienced and knowledgeable about how to take measurements, or in this instance samples, but not about scientific knowledge. Still, one can observe that he attributes to himself characteristics of what one would normally see as desirable in a scientist such as curiosity and a thirst for knowledge. Yet, he views taking measurements and his knowledge about it as separate from a scientific training. Anton has participated in many other projects before, where he took measurements for scientific research. Moreover, Anton has previously presented his varroa mite population measurements (that he took independently of any formal project) and the resulting trends at conferences as well as to the Austrian Parliament. He highlights this during his interview, which shows he sees himself as knowledgeable about beekeeping as well as the taking and analyzing of environmental measurements.

Yet, there is a passivity to his descriptions of how he got involved in doing these presentations—in a way he sees them as just happening to him. This matches nicely with how he describes facts. When asked about how his opinion of colony loss has developed

over the years, he simply says: *Developed, I mean developed, I have always just been put before facts, I did not know this before (16).* From this quote one can see he again takes on a passive role that the facts come to him. It is as if Anton sees himself as a kind of bystander, not an agent of his own knowledge. He is taking recordings on the varroa mite daily, yet for him it does not count as knowledge production, instead he is being presented with the facts. It becomes evident that he does not feel that he has the knowledge or means to produce facts himself. When discussing the effects of neonics, Anton reflects: *the long-term effect of the neonics is difficult to detect for a beekeeper, for a normal one, no? or not at all, because I can also only detect it when I have the test results, no? (17)* Here, Anton has to wait for scientific test results to see if his hives are affected by neonics contamination. Anton sees himself as knowledgeable about taking measurements and samples, but not about Science, whose knowledge he holds above his own. However, because he is knowledgeable about how to take measurements, he is able to contribute to the project and in return he gains both knowledge about the potential contaminants of his hives and an outlet to fulfill his curiosity.

Matthias conceptualizes himself as very knowledgeable about beekeeping, an expert of it. He places great importance on learning through formal education. When asked how he started beekeeping, he immediately mentions that he *first* took a course and then decided to get into beekeeping, saying *I initially took courses and then took over the bees* (18). Matthias continued to take courses until he reached the highest level of *Master of beekeeping* (a title that in Austria takes years of studying and formal training to achieve). Matthias further positions himself as knowledgeable about beekeeping by talking at length about his experience teaching beekeeping to both adults and children. However, he sees the teaching work he does as completely separate from his own beekeeping, stating: *I don't count this work [teaching] as beekeeping because it actually has little to do with my beekeeping. Because it not like, I care for my beehives or harvest honey or similar, but it is a knowledge transfer and a completely different story (19).* He sees teaching as a transfer of his knowledge to his pupils, further positioning himself as very knowledgeable about beekeeping.

Matthias goes on to call himself an *established beekeeper (20)* implying that he is well known and respected—he believes others seen him as a knowledgeable beekeeper. Part of the work he does to position himself as an expert beekeeper, is talking about other less-knowledgeable beekeepers who either have not or refuse to get formal education in beekeeping. Their lack of experience causes Matthias problems. When asked the question if he has noticed any changes in his bees lately, Matthias replies:

> *Not really, but, let's do it differently, I noticed that beekeeping is going in the direction of a lifestyle, it's hip when you put a colony of bees in the garden, that has the disadvantage that beekeepers, or people who keep bees, who don't know anything about beekeeping and this is exactly what causes problems, also for me, a beekeeper who knows what he is doing, because if there is a case of illness within a radius of three kilometers around my apiary, then I am not allowed to go in or out with my bees. Then I am not allowed to do anything, and of course that is a very annoying story (21).*

From this quote one can see how he makes a clear distinction between a beekeeper and a person who keeps bees. For Matthias, a person has to have training in tending bees to be considered a beekeeper. Here he further positions himself as an established, knowledgeable beekeeper.

Lastly, Matthias places himself in the role of the expert throughout the interview. One exceptional example can be seen when Matthias was asked who he turns to when he needs advice about beekeeping, he replies: *usually I solve my problems myself, it is more likely the other way around that people come to me with a request: I have a problem, can you take a look at that? This is more the case (22).* Thus, Matthias sees himself as the person other beekeepers turn to in order to solve a problem and who has the knowledge that they need to solve their own problems. When asked further who he would turn to for advice, Matthias answers: *I get it [advice] at the beekeeping school from a few colleagues who also, I would say, have between 40 and 100 bee colonies or more and who have been doing this for much longer than me (23)*. So, he only would turn to people with the same knowledge about of bee colonies and with more experience than himself, which gives them an authority on beekeeping. In various ways, Matthias positions himself as an expert beekeeper that is very knowledgeable and good at what he does. He sees his own knowledge as completely separate from that of the scientists, but his knowledge can be used in the project for collecting high quality samples. Therefore, Matthias views himself as contributing his expertise on beekeeping to the INSIGNIA project, which enables him to provide very high-quality samples for the scientists to analyze.

Werner is probably the beekeeper with the least experience in beekeeping out of the four Austrian beekeepers. He is the only beekeeper that has not done any form of teaching or taken on a leadership role in the local beekeeping associations. During his interview, he remained rather quiet about his own knowledge. Like the other beekeepers he knew a lot about what kind of things his bees come in contact with, but when it came to knowledge about beekeeping, he expressed ambiguity about which knowledge sources to trust. He

talks at length about his frustrations with the amount of knowledge that was available to him at the beekeeping schools and formal education for beekeepers more broadly. Werner asserts:

> *since then [finishing courses in 2009] I've been attending events like the commercial beekeeping convention, where there are potentially lectures by scientists or practitioners, people from whom you can learn something, watch them closely, no? The way I see it, some beekeeping schools, offer only education until you can walk, let's say it like that, in such a way, you don't learn to run anywhere (24).*

From this quote, one can get a sense of Werner's frustration for the learning opportunities, while also getting a sense of his respect for scientific knowledge from which he can learn. Still, this is not to say that Werner thinks of himself as a normal beekeeper. When asked who or what sources he turns to when he needs advice on beekeeping, Werner says that in his local beekeeping association there is a group of three or four people that will get together and discuss beekeeping. Additionally, in terms of sources, Werner says that he will, *occasionally go to a lecture to hear something new, but the mass of our beekeeper colleagues there are relatively uninterested (25).* He conceptualizes himself as more interested than the large majority of his peers, yet, at no time in his interview, did Werner portray himself as an expert of beekeeping. He definitely does not see himself as having equal knowledge to scientists, instead he has something to learn from them.

Helmut sees himself as a very knowledge beekeeper, who is also well known in his community. He is a travelling lecturer and has been a board member of his local beekeeping association. He is modest about his accomplishments and knowledge stating that it just kind of accumulates. When asked who he turns to when his needs advice about beekeeping he responds:

> *When I need advice, then, mostly it's the other way around, mostly people ask me, yes? Because I am often contacted through this whole teaching activity, yes, called up, questions at the association, or over the computer. When I ask, then I know, then it's mostly specific questions in a field, field and I have my beekeepers, who are specialized in this field. For example, I have a friend, who is responsible in Austria for organic beekeeping, so if I have a problem there, if someone asks me about it, then I go him, yes? Or if I want to know something about breeding, then I know a very good breeder from the association that I*

ask … I know, so to say, people who are specialized in something somewhere, and I'm talking to them, directly, personally (26).

In this quote he positions himself similarly to Matthias, stating that he is the person people usually come to for advice. However, he positions himself as a knowledge broker of sorts where his students come to him and if he does not know himself, then he knows a specialist who does. He later reflects on how no one can be a specialist on everything, so when he does need advice he talks with specialists. Therefore, I think this passage shows how Helmut sees himself as very knowledgeable about beekeeping, yet perhaps not as much of an expert of his own knowledge like Matthias, because he does mention needing the help of specialists from time to time. He definitely distinguishes himself from what one would call a normal beekeeper, as he presents himself as highly knowledgeable and a teacher of others. It becomes apparent that Helmut enjoys teaching and sharing his knowledge about beekeeping with others. He finds that is it is a lot of fun to see the excitement when he teaches other people new things about beekeeping.

Furthermore, more than the other beekeepers Helmut sees his knowledge about bees and beekeeping as giving him a more holistic view of the current state of honey bee health. He feels working with bees has given him a different way of interacting with nature, of experiencing it. He does not see his knowledge as contributing to anything new, scientifically speaking, but instead providing a more holistic overview—broader and more inclusive than scientific knowledge. I see this as also tied into how he sees himself as having a deeper, embodied connection with nature. When asked if he thinks that there is anything that the scientists could profit from the knowledge of beekeepers, he replies:

Yes, sure, or something because I can imagine, because scientists work mostly in a very narrow field or something and a beekeeper sees this probably more holistically, I can quite imagine that there could be a more intensive interesting conversation, so not that there would come new scientific findings on the part of the beekeeper, but perhaps this holistic view could then also be scientifically useful, yes (27).

Here, he sees that his more holistic knowledge can help scientists see the situation more broadly. He also sees his holistic viewpoint as having the potential to help the project. He sees his knowledge of beekeeping as allowing him to offer suggestions on how to improve the sampling devices and optimize the process so that *it is also easier, as a beekeeper, who is maybe not so interested in scientific things, can easily apply it and still get a verifiable result (28).*

6.2.3 How the beekeepers relate to the scientific knowledge and incorporate it into their practices

This sub-question can be seen as a complementary question to sub-question number two (section 6.2.2). However, in this section I will look at how the citizen science beekeepers relate to scientific knowledge and how they incorporate scientific knowledge into their practices. In order to do this, I will look at the ways in which the beekeepers acquire new scientific knowledge as well as how scientific knowledge is used in their everyday practices.

One trend that was seen throughout all four beekeepers was their thirst or curiosity for new scientific knowledge. All of the beekeepers said they read scientific articles or articles from the main coordinator's website (that sometimes has blog posts about new findings and other projects in German). It is also important to mention that at some point in each interview each of the beekeepers told me about their struggles to access scientific literature with which they would have liked to engage. Oftentimes the literature is in English (which was harder for some than others) and when they wanted to struggle through the English or use a translator, the beekeepers often were not able access to the scientific journals—effectively blocking them out of these scientific knowledge access points.

Anton's practices, in comparison to the other beekeepers, resemble the most what one would think of as traditional scientific practice. He tells me how he gets up every day very early to read articles, some from scientific journals on bees and beekeeping. He tells me often, as mentioned above, that curiosity is a part of his personality. Moreover, as previously stated, Anton made and designed his own computer program to track varroa mite populations in his colonies for which he took daily measurements and still does. He did this on his own outside of science, but still sought the approval of a scientist to *make sure it wasn't nonsense (29)* to which the scientist replied, *no, it works (30).* Here the knowledge he created using the program of his own design is brought to Vienna to a scientist to be checked for validity, clearly showing that Anton highly values the scientific knowledge of the scientists and is appealing to the authority of scientific knowledge by bringing his program to be checked by it—only through the validation process does his program become valid to Anton. Thus, demonstrating that Anton sees his own knowledge production as subordinate to that produced by science and it is only through the

validation process wherein the program is checked and approved of by a scientist does the data gain more value to him.

Anton definitely sees scientific methods as the way to uncover the truth and believes in science. When neonics first came to Austria, he was taking a hiatus from daily recordings—something he deeply regrets, stating: *and then this whole thing with neonics happened and it was a mistake, because I didn't do it anymore back then (31).* Through this quote one can see that Anton feels he has made a mistake, showing that he values the knowledge produced by collecting and analyzing the data on the varroa mite populations—something, which resembles traditional scientific methods. This can also be seen in how he discusses the presentations that he has given at beekeeping conferences. When talking about a presentation, Anton says: *my previous speaker also gave a talk, and I came after him, and apparently, I did a pretty good job refuting him, not because I attacked him, but because of the argumentation (32).* He talks about how he was able to refute the arguments of the Bayer representative because he was able to use rational argumentation, another key facet to traditional science.

Anton appeals to the authority of Science and sees scientific knowledge as the ability to make statements. He says, in regard to the environment: *yeah, well it is the environment that is suffering right now, yes? One can assume this and say that actually Science would have to give us guidelines on what can be improved, because they can reason this, research it and pass it on to politicians if possible, because I can say what I want at home, but no one will react (33).* Here, we can see how Anton believes it is Science that is able to produce the correct knowledge to be able to tell society how to best act. Still, Anton also implies that Science currently is not doing this, e.g. telling society how to best act, like it should and is able to. Through this quote we also see how Anton believes that he does not have the proper amount of authority, like Science does, to affect change, because no one will listen to him.

Matthias had the least to say on the topic of scientific knowledge and how he incorporates it into his practices. I think this speaks to *both* how he sees his own knowledge of beekeeping as separate from the knowledge of scientists and how he views himself as a knowledgeable expert beekeeper who already knows a lot about beekeeping. When asked what kinds of sources he uses to stay up-to-date on beekeeping, he tells me that he uses some online specialist forums to keep up-to-date on the current trends in order to see in what direction things could develop. He also mentions that when he has the chance, he attends lectures by different specialists to learn something. When asked about whether he reads scientific literature, he says he would look through professional

literature or through beekeeping magazines, especially if a colleague recommends something interesting. Still, he remains quite passive, highlighting that he stays up-to-date on the trends, but when compared to the others, he does not include it in his everyday routine. Matthias's more passive stance and focus on the new and exciting trends in beekeeping research positions him as the expert who already knows all that can be known about current beekeeping and is willing to learn if something new arises. As mentioned above, his stance also reaffirms his clear distinction between beekeeper knowledge and scientific knowledge, what he sees as completely separate, with opportunities to be mutually beneficial. When asked about whether he gets articles from the coordinator, Matthias replies: *[t]he coordinator has so much of it [scientific literature] that he can cover you in it endlessly (34),* which gives one the sense that Matthias finds the amount of articles available a little useless for him, keeping a separation from scientific knowledge.

Werner has a more ambiguous relationship with scientific knowledge. He does not engage heavily with scientific literature in the forms of journal articles because of difficulties with most of the literature being available only in English. When asked if he reads scientific articles, he replies: *it is a bit hard, they are mostly in English, no? And, I mean I struggle through, but for pages on end, I am too dumb (35).* Werner is also a bit untrusting of the knowledge from scientific articles and trusts the knowledge contained in books more. When asked if there are areas in which he is interested in the results of scientific studies, he replies: *let's say it like this, when they are bound in a book, then yes (36).* Here it becomes apparent how Werner trusts the knowledge in books more than research articles, even if the books are written by a scientist. One of his favorites is by Thomas Seeley, a famous American Professor of Biology at Cornell. Werner trusts Seeley, because he views him and his knowledge as unaffiliated, i.e. free from conflicts of interest. Werner reflects further on how it is hard to know what to believe because there are many conflicting scientific studies, especially around controversies like neonics. He says:

> *I believe that many [studies] are bought, no? I mean, I can't figure out the difference with my background knowledge, no? I mean the truth will be somewhere in the middle… But if you look at everything else now it is either, from completely harmless to completely highly poisonous, no? and there is nothing in between, no? … and those actually, I mean the whole, many of these reports what I see that is about the topic, poisonous or non-toxic, no? (37)*

Werner highlights the conflicting information in different studies as well as an inability of Science to deal with grey areas or multiple sublethal, cumulative effects (see

Suryanarayanan & Kleinman, 2017). This quote again shows that Werner believes he does not have the ability to critically analyze these various articles in order to find out the truth about the controversy around neonics and its effects on honey bees. It is also important to mention that Werner is the beekeeper most affected by colony loss. When trying to alter his practice to better cope with colony loss and pesticide contamination, Werner turns to a trusted beekeeper friend who also happens to be a biologist whose information he feels he can trust. Werner positions himself as someone who cannot interpret and analyze scientific findings by himself. Instead, for this he turns to a trusted colleague who is both beekeeper and scientist to translate information and to validate what information to trust. In relation to the question on who should be responsible for informing normal beekeepers on scientific findings, science or other beekeepers, he says: *I think this has to be an interplay, no? Because what Science creates, no? It's not understandable for everyone, no? Even if it's good, no? But to put it in use, there needs to be someone in between, no? (38).* For Werner it is hard to relate to scientific knowledge as he does not feel he has the proper ability to interpret different, contradicting studies. From the quote one can see that Werner feels that there needs to be a translation occurring of scientific findings into a form that beekeepers, like himself, can understand and use. Additionally, Werner's statement shows how this translation must also inform beekeepers which findings contain good, reliable information—something he does not feel he is able to do on his own. This further demonstrates the uncertainty Werner feels about which scientific studies to trust. As mentioned above, Werner trusts in the knowledge in books written by scientists more than scientific articles and incorporates the knowledge he gained from reading the books into his practices, like what type of bee box to use or where to place his hives.

Helmut highly values scientific knowledge and scientific findings. He believes that science can uncover the truth. He took part in previous projects that looked into the pollen diversity in samples of pollen he provided. He says it was surprising to see what his bees actually interacted with, stating: *so there we know pretty much exactly which plants are involved, that it is very diverse, I was very surprised that for example in spring blossom honey there is a lot of fruit (39).* Here the results of the sampling showed exactly what was there. Thus, even though Helmut is very knowledgeable about the area where he keeps his bees, scientific knowledge allows a more precise understanding. It is this more precise understanding that drew Helmut to the INSIGNIA project, stating: *It would be interesting most of all, in the course of the project, how it [pollen distribution/pesticide contamination] really looks, yes?(40)* Helmut sees the results of the sample analysis as

providing a more accurate picture of what is there, showing both his trust and belief in the authority of scientific knowledge.

Helmut feels the need to stay up-to-date on trends and new discoveries in beekeeping, since he is a teacher of beekeeping and needs to provide his students with contemporary information as well as be able to answer their questions. He explains:

> *I am always interested in absorbing something new, and, you know, you cannot be the best in all areas of beekeeping, but you can stay informed so that you are aware of these new trends, there are various methods now, where they are trying to get a grip on the varroa problem using purely biological methods, yes? For me, getting more informed in this area, is, yes … especially as a lecturer you should actually be ahead, so to speak, and propagate these [new] methods, but in order to be able to teach something, you have to try it out yourself, so I would like to be a bit stronger in this area [organic beekeeping] (41).*

Through this quote, one gets the feeling that Helmut feels the information he needs is out there, he just needs to spend the time to interact with it more so that he can implement it in his own hive and teach it to his students. Thus, his own lack of certain knowledge in areas of beekeeping, like biological treatments for varroa mite, is not the fault of science or a lack of available information. Instead, it is dependent on his own motivation, i.e. he just needs a bit of time to learn these new methods. Helmut turns to scientific information, either in the form of scientific articles or beekeeping journals, when he wants to know more or learn something more to add to his beekeeping practice, like organic beekeeping.

When looking for new knowledge about beekeeping he attends lectures and goes to the annual commercial beekeeping convention where lectures are given about the current research and an annual symposium, where, so to say the latest findings are shown. However, Helmut is hesitant to trust in information he finds in online forum discussions, as *one can never really verify the quality of what is written or who is writing (42). S*till, Helmut has trouble accessing scientific articles and when he does, he finds reading every article (sent to him by the coordinator or his commercial beekeeping association) too time consuming. Helmut states: *I take a look at them [scientific articles] occasionally, it's always a question of time, you sit at the computer for half a day and phew, yes, that's the problem, so occasionally sure, but now not deliberately, I mean I don't have to make a scientific publication (43).* This quote shows that Helmut has a good understanding of the

academic practice (for scientists to stay up-to-date on the discourse), but that he clearly does not feel the need to do the same as he is not a scientist.

In conclusion each beekeeper did interact with scientific knowledge during their beekeeping practices, although to varying degrees. However, a lack of access both due to language barriers and institutional structure (i.e. lack of open access journal articles) was noted by them. Still, there seems to be a more linear transfer of knowledge, where the beekeepers see themselves not fully equipped to interact and interpret scientific knowledge. Furthermore, there is also an element of trust involved when choosing what knowledge to incorporate. For example, Werner trusts the knowledge in books, or the knowledge produced by certain scientists, like Seeley.

6.2.4 How the beekeepers relate to the controversies surrounding colony loss?

Suryanarayanan and Kleinman (2017) describe how polarizing the debates surrounding colony loss have become with even beekeepers not being unified about the probable cause. This section will look into how the four citizen science beekeepers interviewed for this thesis relate to colony loss, one of the biggest controversies currently affecting beekeeping and how this controversy influences their reasons for participating in the INSIGNIA project.

Anton sees the problem as very complex and multifaceted. He laments about the improper use of neonics and the need for better crop rotation. He also knows honey bee viruses are dependent on other external factors like pesticides, which for Anton is further proof of a complex multifactorial problem. He sees the farmers' methods as leading to the contamination of the whole environmental system, not just the honey bees, which he sees as an indicator species. Furthermore, he sees colony loss as a product of the fact that no one is taking responsibility for the consequences of neonics usage. When discussing his presentation to Bayer (a producer of neonics,. Anton explains:

> *[O]f course I have accused the company Bayer, because they are to blame, right? We don't need to discuss this, it was their fault, of course they denied everything and he [the head of Bayer] answered that they are not to blame but the user, so of course I went home and told my friends the farmers that they are to blame … unfortunately the farmers did not really get upset [laughs], they got upset with me (44).*

This quote shows how, according to Anton, Bayer (the producer) says the farmers are to blame for using the substance incorrectly. However, as Anton states, the farmers do not get mad at Bayer for this accusation. Instead, the get mad at Anton—effectively leaving no one to blame when neonics ends up in the environment. Anton also believes that beekeepers themselves are to blame, because they are unwilling to participate in the collection of data (in the form of samples) when there is a problem (i.e. a locally concentrated increase in honey bee colony die-offs) in order to see what is causing it. Anton was ready to actively collect data on the declining colonies in his area, but other beekeepers from his local beekeeping association were not interested. He later cites other problems of access to proper testing. He says that beekeepers, who want to get their hives tested to see what went wrong after a colony or multiple colonies die out, can send a sample to the ministry but beekeepers never hear back. Complicating the situation, according to Anton is that beekeepers who would want to get their samples tested in other ways would have to pay out of pocket to get it done at a lab, which can cost around 500 euros. So oftentimes honey bee die-offs go unreported or un-researched, which is why beekeepers *want* to participate in research like INSIGNIA, because they get results on their hives—one major reason for his participation.

Matthias does not believe that colony loss as a trend or emergent problem is real. Instead, he ascribes to the 'piss-poor' beekeeping theory (as described by Suryanarayanan & Kleinman, 2017), wherein colony loss is not caused by environmental factors or contamination, but by poor beekeeping practices. When asked if he has noticed any changes in his bees in the last few years, he replied no. He contends:

> *we don't have colony loss; we only have bad beekeepers … that is my opinion. We have bad beekeepers, that are not trained well, that don't take care, that don't want to take care, or can't take care [of their bees] … I will be honest with you, that is much more of the problem, than the possibility of colony loss (45).*

Matthias goes on to give examples of new beekeepers who buy hives that have no way of treating or assessing varroa mite infestations as well as old beekeepers, who are *incompetent*. They say (according to Matthias): *I have been doing this for twenty years, it has always worked, it will continue to work (46).* However, Matthias claims that *in the spring all his colonies are dead, and he tries again, same tactics, the next spring all of his colonies are dead … but he does everything right, because he has been doing this for twenty year and it has always worked (47).* These two passages show the importance that Matthias places on knowledge, especially formal knowledge. He includes in his explanation of 'piss-poor' both novice beekeepers who do not want to learn as well as

old, long-time beekeepers who have in his example bad beekeeping practices and also do not want to learn. Through this Matthias is completely able to separate himself and his colonies from the controversy of colony loss, which only comes down to the bad practices of uneducated beekeepers. Here the problem does not lie with scientific knowledge or ways of knowledge production, but in the lack of knowledge of beekeepers. Matthias, a well-educated, expert beekeeper remains unaffected.

Among the four beekeepers, Werner is the most affected personally by colony loss. He has definitely experienced loss over the years. Still, he remains ambivalent about the direct causes for the high number of losses he has experienced over the years. Some losses he admits were his own fault, while others he sees as mostly linked to the pesticides used in the fields near his bees. Most of his bees at one point or another were next to farmer fields (e.g. corn, fruit and Christmas trees). He claims that these bees suffer more losses than the bees he keeps at higher altitudes (where farming is no longer possible). The bees at higher altitudes should be less healthy and less productive than ones in a warmer climate; however, Werner observes the opposite. He uses this observation as proof that colonies next to farm fields tend to experience greater losses, due to probably pesticide contamination.

Nevertheless, Werner is reflective about farmers' needs for pesticides in order to farm on a large scale and sees a solution wherein farmers need to be more responsible with their applications, e.g. mowing all blooming flowers before applying sprays so that bees are not attracted to the area. Furthermore, Werner takes into consideration how pesticide contamination can occur when application instructions from the pesticide company does not match real-world scenarios, stating *the corporations have completely shifted the responsibility on to the farmers, no? With a one hundred percent perfect application, of course, the damage would be minimal (48).* Despite having a seemingly understanding stance to the use of pesticides, it is his belief of colony decline through pesticide contamination that informed his choices on both his participation in the project and which colonies to use. Like Anton, Werner is highly aware of the expensive cost for having samples from his colonies tested as well as the lack of other options to get his colonies tested for a low-cost. For the project, he chose three colonies which are next to a Christmas tree farm. The farm uses harsh pesticides that he believes harm his colonies. Werner hopes the tests done through INSIGNIA can show if his hives are still being contaminated (even after the farmer promised to change his practices). He explains, *I am excited for the results, no? Because next week he [the Christmas tree farmer] would like to, for example, spray the fields again, whether the samples then show something, that I*

am curious about, no? Or whether nothing is found, because he promised me that he would mow down everything that was blooming, no? (49)

Helmut, as mentioned before, is very knowledgeable about the foraging diversity in the 3km radius surrounding each one of his colonies. He prides himself in choosing advantageous locations for his colonies with plenty of high-quality foraging options for his bees and correlates this to not having personally noticed any signs of colony loss himself but does still believe it is a trend. Helmut asserts:

> *the locations I have should all be very suitable for the bees, otherwise I would not have these yield quantities, otherwise I would have problems with the bees. I just haven't noticed any yet, yes, at least not on a massive scale, these sub-lethal stories, where they don't die off dramatically, but simply a bee colony does not develop properly, I also haven't noticed yet, but naturally one can easily overlook such a thing (50).*

This quote shows how Helmut sees his choice of location as protecting his bees from the contributing factors of colony loss. However, he does remark that he might have overlooked some signs of colony loss in his colonies because it is difficult to differentiate a weaker colony from one that is suffering from a certain ailment. Still, Helmut is well aware of its potential causes, both additive and sublethal. In choosing locations he avoids what he calls intensive farming, something he directly links to bee death stating he has heard of a place in Austria *with very intensive farming and there one already hears of problems, not just selective, but in some cases really massive (51).* For him the choosing of a location becomes very important because two of the factors leading to colony loss can be mitigated by proper location choice (if possible, e.g. access to locations, etc.). According to Helmut, *naturally this is not a monocausal story. It has always been, it always had several sources (52).* He sees three main causes one being the varroa mite, and other pesticides, and lastly *the impoverishment of biodiversity (53).* Helmut feels *these three factors certainly interact (54).* Still he feels that these subtle effects are hard to notice, because there are many reasons for why a colony might not be doing well. He sees impoverishment of biodiversity as a large factor and calls farm fields *green deserts (55)* because the fields look green to people, but they have nothing for the bees to forage, which is compounded by the lack of healthy nutrients in staple farming crops like corn. His focus on the depletion of biodiversity in the environment matches with his overall focus on his holistic view of honey bees and beekeeping. With his knowledge of proper placement of bee colonies, he is able to avoid noticeable effects of colony loss.

When it comes to finding the source of colony loss, Helmut believes in the knowledge of Science and its ability to find answers. When asked if his opinion of colony loss has developed or changed during the past few years, he replies:

> *Yes, of course, because with a certain amount of experience also comes a growth in knowledge, that one simply gets from this experience … I was always a bit skeptical that it was only monocausal, the varroa-mite, but it has only been a few years since Science has been able to prove that there are other factors here, yes? Especially this story with the neonicotinoids, that these very well may have effects, only sublethal ones on the mental performance, or memory performance, or communication performance of the bees, that is proven now, yes? and now one can have the courage and say guys, if you are doing a talk, this is state of the art, yes? That it is not just the beekeepers themselves who are to blame, because they do not have the varroa mites under control, so in this sense it also broadened my own knowledge, so to speak, and I am a multiplicator of sorts, by giving lectures, of course you can also pass it on and of course that also helps, that is the good thing about scientific histories, or investigations, that you, or results, that you can then also say that please there is evidence here that there are different factors here, yes? (56)*

This quote shows Helmut's trust in the authority of scientific knowledge and that only through scientific findings is he able to understand the causes of colony loss. Here he sees science as the sources of knowledge that he then can spread further, as he is a teacher. He also discusses how he is able to use scientific findings to make a point by providing the proper evidence of causes of colony loss.

6.2.5 How the citizen science beekeepers position themselves towards scientists

In this section I will explore how the four citizen science beekeepers position themselves towards the scientists, highlighting possible tensions but also beneficial interactions, while also explaining instances for each of the four beekeepers.

Throughout the interview when Anton discusses the topic of how he got involved with a research project, he introduces the story by *getting a call from a scientist,* wherein he tells of a scientist calling him up and personally asking him to participate in some way. When discussing the first time he was asked to participate in research he talks about how

he was personally asked at a convention by a scientist, stating: *then I met him [the scientist] at some conference in our region, and he asked me whether or not I would like to take part in bee investigations, I said yes, anytime, no problem, and so it began (57).* This being the first he is asked in person (he did not get a call). However, the scientist still asked him personally and Anton replied eagerly, stressing that it is not too much trouble. Anton goes on to relate this back to his job experience with environmental measurement and control technologies, which he sees as helping him participate by equipping him with the knowledge of how to properly take measurements. Whenever he discusses his participation, he always makes sure to highlight that he was asked, which highlights the scientist wanting him or needing him to participate as well as Anton having a personal relationship with the scientist. For Anton it is important to have this personal relationship with the scientist, where they come to him in order to ask for help. He describes another incident: *I have for example in 2015, we did a study in the flight radius and it was indeed in May, we studied the puddles in the fields, with XYZ from [environmental NGO], he called me and I said no problem, I'll do it, take samples, just like that, sent, they came and picked up the sample (58).* Anton shows that he sees himself in a way as a colleague of the scientists stating that *we* research.

Anton also turns to a couple scientists when he needs advice, listing a few. He places these scientists in a position of authority as individuals that know more than he does and are able to help him know which journal articles or studies to believe, perhaps even more than his colleagues. He sees scientists, not himself, as the people who can analyze studies in order to see if they are truthful. When talking about a study on the half-life of neonics he maintains *whether the study is correct, I don't know, I haven't checked it, but there are scientists that can do that (59).* Anton positions himself as someone who works personally with scientists yet does not have the same ability to know scientifically, i.e. judge studies or make knowledge claims about scientific findings.

Matthias sees himself as a colleague of the scientists in the project, providing the scientists with high-quality samples to use in their research. Matthias feels that scientists who study bees *don't have to be beekeepers at all (60)* because that is what beekeepers are for. It is the beekeeper who provides the scientists with samples. Matthias explains,

> *I think, scientists have the big advantage of having my beekeeping in the background and at least one to two colleagues that are profound beekeepers, because they regularly need material for experiments, be it honeycombs, be it brood, be it pollen, be it bee mass, whatever, and it works that those are available if someone is taking care and if someone is familiar with it, and thus*

> *it's a thing where I simply say this is, I don't think bee scientist need beekeepers per se, because they have them in house, if they want to know something in more detail they just go see the colleagues that know about the management of beehives, and that's it (61).*

Through his explanation, one can see how Matthias positions himself as an asset to the scientists, because he makes high-quality samples available to them. He goes on to talk about how he sees things today as very specialized, which draws a strong line between beekeeper and scientist, where each is specialized in their own fields and through a partnership the scientists get the materials they need. This viewpoint informs how Matthias sees his interactions with the scientists. When talking about how he came to be involved in the project, Matthias explains: *the coordinator approached me because we have already worked together on other projects and he asked me if I had a bit of time for a project and could provide a few bee colonies and I said, yes why not (62).* This statement by Matthias further shows how he sees himself as a provider of samples for scientists. He sees himself as their colleagues, expert in his own right but not a scientist, he is someone they turn to for reliable samples, different but experts in their own fields.

Werner sees scientists as more knowledgeable and able to potentially provide answers, through the testing his samples, to his problems of potential contamination of his beehives by the Christmas tree farm. He eagerly offers up his hives for sampling to the scientists when they first talk. He really wants to engage and actively goes to conferences and conventions to gain more knowledge and talk with researchers. He also has a certain appreciation for the famous scientist Thomas Seeley, who he looks up to, trusting the information he has in his books. He does not feel that he is on the same level as the scientists or that he can critique the scientists' choices.

Helmut has a strong appreciation for scientists. In fact, he was inspired to start beekeeping by attending a professor's course and obviously has a lot of respect for this professor. He values the information on the website of the Austrian scientist coordinator as a source of scientific information. As stated in the previous section, Helmut feels that beekeepers can offer a more holistic view of beekeeping to contrast the narrow viewpoints of scientists. Still, he sees himself as separate from the scientists. When asked if he had any fear about the INSIGNIA project, Helmut responded *fear*s, *yes, I cannot think of any right now, I hope, I mean, I can't say anything about the scientific method, I don't know what, I take samples and the scientists do their work (63).* This passage shows how Helmut sees what the scientists do as separate from his own role as a beekeeper in the project. He does not feel that he can speak about the scientists' work. Helmut's view point

about scientists aligns itself to his views on scientific knowledge, which he sees as being able to uncover the truth.

6.2.6 How is epistemic authority negotiated within the INSIGNIA project

In this section I will look into who exactly in the project gets to make and attribute knowledge as well as how these decisions are negotiated. Before I begin, I think it is important to provide a reminder of the structure of the project. The beekeepers, in year one, were supposed to be using the sampling methods to find out which will be the best to use for a broader test with more beekeepers next year, meaning the scientists hope that any problems that arise could be smoothed out before next year. As mentioned in the first sub-question, the beekeepers were given an instructional booklet and told to let their coordinator know if anything went wrong or they needed help. As mentioned before, there was no formal, coordinated way for beekeepers to give feedback or communicate amongst each other, effectively centralizing the knowledge flow around the country coordinator. Moreover, the four interviews conducted for this thesis occurred early on in the sampling season, with perhaps one sample being taken before the interview. Therefore, the four beekeepers had, at the time of the interviews, only a little time to interact with the actual epistemic process of the project.

Anton was the only beekeeper that had a lot to say or criticize about the scientific projects they have participated in, INSIGNIA included. Anton does sometimes question the choices that the scientists made in the projects he has participated in. For example, when talking about a previous project he tells about how he was frustrated by the decisions of the scientists. According to Anton the, scientists are not sampling for contamination during time periods when the contaminants would be present, and the bees contaminated. Multiple projects Anton participated in previously sampled in the fall, while Anton says farmers spray mostly in the springtime. Here Anton challenges the decisions of the scientists and believes he knows better or that the scientists are not being very logical. Comparing past projects with INSIGNIA, he laments:

> *I have complained a couple times … I have also criticized the sampling intervals, because in the fall I don't need to take any samples, because it's nonsense, it is money out the window in my opinion, every 14 days, especially during this time, the current project is a bit late, because here the time for spraying is in spring and they are already spraying away (64).*

He says he told his complaints to the scientists, but nothing in the project was changed, even if it ran for three years. Anton is more pleased with INSIGNIA finally choosing to sample for a longer period of time, but he still wishes the sampling season was longer as the farmers are already spraying before the start of the project. Moreover, Anton discusses the transportation and storage of samples, which are not always handled properly because they are oftentimes being unfrozen and refrozen, meaning that the percentage of neonics contamination is being reduced since the chemical deteriorates rather rapidly when not frozen, effectively reducing the amount of the chemical present in the samples and in Anton's mind skewing the results of the test. He states: *and I said, okay the whole project [not INSIGNIA] was based off of datasets that didn't really correspond to the truth, because they were degradation rates, but okay (65).* These times where Anton expresses his opinions and questions the choices of the scientists, he tries to affect decisions and change the way the experiments could be run however, in the end the scientists have the last say.

For the other three beekeepers there is not much to be negotiated, like Helmut said *I take samples and the scientists do their work (66).* He follows the instructions given and takes the samples. Helmut does not criticize or offer improvement on the process itself, only shortly suggesting the beekeepers should be able to communicate more. Matthias as well sees a clear distinction between himself and the scientists. When he was asked if there was anything about the sampling devices that he could see needing improvement, he talks about how other parts of the colony could be tested, like the waste of the bees, which the beekeepers have to check regardless. Thus, the process would not require any extra input on the part of the beekeeper. However, Matthias closes this statement by saying, *[w]ell I mean like I said, to what extent it is relevant in order to get the data one would like, that I cannot judge, I am a beekeeper, not a scientist (67).* This passage from Matthias nicely demonstrates the strict separation he sees between himself as a beekeeper and the scientists. He cannot speak about the relevance of sampling a certain bee product, because he is not a scientist. Epistemic authority is given to the scientists as they are the ones with the knowledge to properly judge what is and is not relevant to get the data the project wants.

Werner shows a similar understanding of his duties in the project, he states: *[m]y role. That I believe is relatively clear. I will take the ten probes from the three colonies (68).* Here Werner sees his place in the project as the person that takes samples. However, he does not mention the scientists. He does not feel that he can or is able to contribute knowledge to the project or offer suggestions. Still, he, like the others, gets results (i.e. more

knowledge) about his hives in exchange for providing the samples. Werner, like Anton, chose hives that he thinks are contaminated, as he needs results but has limited ways to access proper, affordable testing. Matthias also comments on this:

> *I am currently also in another project, its deals with viral load in bee hives, it is not uninteresting, above all, a virus lab test costs around 500 euros or more, that I don't want to pay and this being the case, when there is the opportunity, then I gladly participate (69).*

Matthias rationalizes the reasons he is participating as he is able to get expensive tests performed on his hives in exchange for his participation through providing samples. In a way it can be seen as a mutually beneficial exchange. The beekeepers get knowledge about their bees and the scientist get data collected. Still, Anton asserts: *the long-term effects of neonics is difficult to detect for a beekeeper, a normal one, no? Or not at all, because I can only detect it if I have the lab test results, no? And a test costs for pesticides around 500 euros, no? (70)* Which shows that, in his opinion, the beekeepers are reliant upon expensive, scientific tests in order to figure out the cause of the decline of their colonies. Furthermore, it is only through a scientific laboratory test that beekeepers can gain measurable results showing neonic contaminations. Anton explains further that in Austria there is a lack of federal support for beekeepers to get their samples tested and these projects offer a way for beekeepers to get their colonies tested. This importance of scientific projects to get samples tested becomes apparent when Anton tells of another beekeeper whose bees had died and who came to him asking for help and he replied: *I have to check, because what I know is that no project is running at the moment, where should we turn? (71)* Anton goes on to explain that the possibilities to get testing through governmental means only ends with *the sample rotting somewhere along the way and will in no way lead to results (72).* Sometimes when he turns to the scientists to ask if they can help, they cannot because of a lack of funding, so all Anton can do is *take samples and destroy them (73),* because no one will analyze them. Through his story one gets a sense for the situation that Austrian beekeepers are left with and how these projects, like INSIGNIA provide beekeepers with access to testing, something that they need. Still, a hierarchy and separations remain, the scientists analyze, and the beekeepers take samples. Moreover, the beekeepers are not asked for their feedback on the set-up of the experiment (i.e. the original experimental design) in the first year, e.g. sampling intervals or length of sampling season. As Anton (when asked what he would improve about the project) nicely puts it:

Well, we could do a little exchange of experiences after and everyone, yes that would be good, no? That would be good, if an exchange of experience was done, it's so, we all participate, but no one asks us if we are okay with what we have been tasked with, no? Because I could say something [laughs] (74).

6.2.7 How do Citizen Science beekeepers construct their role within the broader project, INSIGNIA?

Each of the four Austrian citizen science beekeepers construct their roles in the project based upon their own background and social positioning both in society and with other beekeepers. They bring their knowledge about beekeeping and other things (such as Anton's precise measurement training) into their roles in the project to inform how they position themselves. Still, it is important to consider that these four citizen science beekeepers are not what one would call a 'normal' or 'typical' beekeeper by which I mean these beekeepers are actively engaged in their community and in positions of leadership. For example, Helmut and Matthias are both certified masters of beekeeping, a title that takes years of training to achieve. They are also both teachers of other beekeepers and are often people to whom other beekeepers come to for advice and answers. Anton gives lectures around the country to try to inform other beekeepers about his own findings as well as to try to help other beekeepers get their hives tested. He is also someone other beekeepers come to when they need help or a problem solved, just like Matthias and Helmut. Anton is also politically active as he has petitioned parliament multiple times for more services for beekeepers. Werner, although not as established as the other three, is also very active and interested in science including the current state of the colony loss controversy. Moreover, all of the beekeepers have participated in similar projects before and actively seek more opportunities to participate in future projects. The citizen science beekeepers themselves reflect on the fact that they themselves are not representative of 'typical' or 'normal' beekeeper. Helmut maintains:

What I naturally find very interesting, these projects, these citizen science, European projects … I would wish that were more often, good, and indeed not only with beekeepers like me that are very interested but rather, so to say, access is found between Science and normal beekeepers that has three or five colonies, yes? That would be quite interesting, they are partly, that one finds more of a connection, they are partially, they don't have any access to them [citizen science projects]. Yes, clearly, I mean people like me that are quite interested, they will take part in such a project, they will be very eager to

participate in such a project, but if you do it, but to do it on a broader basis is quite an interesting thing (75).

Through this quote, we can see one example of how Helmut sees himself as not a typical beekeeper but instead one who is as a very interested and eager to participate in scientific research. Yet, he reflects on the potential benefits of involving other less-engaged beekeepers might bring, like a broadening of the sample base.

Despite their willingness to participate and collectively proven high level of knowledge both about beekeeping and their surrounding environment more broadly, the beekeepers all mention their main role in the project was that of sample collectors, to varying degrees. The beekeepers are all aware of their limited ability to affect change to the experimental structure or knowledge production process. How the beekeepers accept and take on this role is shaped by how the beekeepers make-sense of themselves. Anton has a thirst for knowledge and a general interest in collecting data through measurement, something which he believes he got through his professional job. He ran daily data collection for years and designed his own computer program to track the trends in it. Anton presented his findings at conferences. He seems to be doing science but other means or what Callon and Rabeharisoa (2004) would dub *research in the wild*. Because of his background, Anton would like to engage more with the other beekeepers as well as partake in decisions about experimental design. However, when asked what he feels his role in the project is, Anton too replied: *I am a, a, yeah, a relatively cheap co-worker [laughs] (76)*, showing that Anton is aware of his limited role when it comes to the project.

Matthias also reflected on their role as sample collector, stating: *My role in the project will be to simply provide data. This means that I am the one in the field who tries to get as many reasonable samples as possible to evaluate them in the laboratory (77).* However, for Matthias this is how it should be. As shown in the previous sections, Matthias sees himself as an expert of beekeeping which scientists studying bees do not need to be knowledgeable about because they can simply have a partnership with 'profound' beekeepers. In this relationship the skilled beekeeper provides data for the scientists and the laboratory to analyze and the beekeepers, at least in these projects, get to have free tests run on their colonies, giving the beekeepers more knowledge about their colonies. Unlike Anton, who shows interest in being more active in the knowledge production process, Matthias seems satisfied in his role, seeing the beekeepers and scientists as experts in their own right, doing their corresponding roles for the outcome of the project.

Werner also feels that his role in the project is very clear by saying: *My role. I believe it's relatively clear. I will take from the colonies ten samples (78).* Through it becomes clear that Werner sees his role as a taker of samples, not as someone who is collaborating alongside the scientists. His stance fits with how he perceives himself as not very knowledgeable on scientific matters. He does not feel like he is doing science, but rather helping scientists do science.

Helmut positions himself as offering a more holistic view to the scientists and giving feedback to them on how to better tweak the sampling devices from a beekeeper's perspective. He asserts:

> *the devil is in the details, yes? As you can seek, so to say, how is the exact setting, what do you have to pay attention to in this project? So that us beekeepers provide the information, this works or doesn't work, surely I still have a few ideas, certainly also a few questions that will come up during the project, that here, we are the ones to implement it directly, and with direct implementation there are always problems (79).*

Here, we can see that Helmut positions himself and the other beekeepers as the people in the field who are implementing the sampling device, focusing more on his role as implementer of the sampling device system, not on the role of collecting samples. Nevertheless, the beekeepers are mostly providing data and not participating in the scientific process, they work mostly separately from the scientist as partners tasked with a specific role and not more collaboratively, wherein citizen scientists take an active role in the running of the experiment. This is further complicated by the knowledge flows from scientist to the beekeepers, with little space created for feedback to the scientist or sharing amongst the beekeepers.

To sum up, while none of the beekeepers view their work as *doing science* per se, their individual positions, rationales and self-conceptualizations vary considerably. Before moving on to the discussion section of this thesis, I want to provide a tentative typology of four types of citizen scientists in this project that I feel became palpable and that are defined especially through their relation to institutionalized Science in the INSIGNIA project. The four types of citizen scientists I identify are (1) the amateur scientist, (2) the specialist, (3) the assistant, and (4) the expert.

The amateur scientist (Anton): I view Anton as the person most closely aligned with the idealized notion of a citizen scientist, in a more Iwrinian sense of the term, i.e. citizens

doing science both outside and alongside of Science on their own initiative to help tackle controversies that Science cannot solve alone, such as environmental controversies like colony loss. In his daily practice as a beekeeper, he employs a rigorous methodology of recording different features of his beehive. In our interview he mentioned that he is already going way beyond what the project coordinators asked him to do. His position towards Science in this project is characterized by ambivalence. Even though he clearly employs a scientific rationale in his practice, he does not claim to be a scientist. Still, he is critical of the bee science in the project, especially in terms of the novel monitoring devices. His position is also characterized by the fact that he is an established expert in the Austrian landscape. He frequently gives talks and is an important node for both scientists and peers alike. In my interview I found that while he is not claiming the role of the scientist, he does put himself on eye-level with the scientists in the project, since he has much more experiential knowledge he can draw upon and has been following both the scientific and political developments in Austria for the past two decades. At the same time, he voiced the most frustration in the project, and somewhat cynically described his own position within the project as that of a *cheap coworker,* which, given his reported problems of making himself heard, may not be seen as entirely unwarranted.

The specialist (Matthias): Similarly to Anton, Matthias also is embedded in the Austrian landscape of beekeepers and has a lot of experience working with scientists. Like all beekeepers, he does not claim the label of scientist for himself. However, Matthias does position himself as an important actor in the project. In his view, he is providing the project with high-quality data and material. Being able to do so is the result of a strong formalized training and the resulting expertise. In this aspect, Matthias differs from Anton, since he holds a much less critical position towards the project. He seems to be very content with a clear separation of roles and views it as a precondition for the success of the project.

The assistant (Werner): Of all my interview partners, Werner seems to hold the least amount of confidence in terms of his knowledge and contribution to the project. He has a very clear idea about his role in the project: providing data. In this sense, I view Werner as holding the role of the assistant, doing what is necessary for the project to succeed, but without being aware of the value of his knowledge. Thus, he does position himself as subordinate to the scientists in the project, which stands in contrast to Anton's critical and Werner's confident stance. He is hopeful Science will be able to provide answers to the question of the cause(s) of colony loss, possibly because amongst the four participants he is the one most affected. However, at the same time he is harboring

suspicions about scientific autonomy, suspecting that a lot of studies on the phenomenon are biased because they have been influenced by industry's interests.

The expert (Helmut): Helmut's positioning struck me as especially interesting, since he seems to have an astute understanding of his role in the project on the one hand, while also being very enthusiastic about it. His confidence in Science's ability to solve problems, while also being aware of the unique perspective his experience affords him makes for an interesting contribution. He does not merely view himself as a provider of data, but rather as an expert on the ground with a holistic understanding of the complex interplay of actors in the project.

7 Discussion and Conclusion

7.1 My role in this project: social science to the rescue?

One thing I was constantly reflecting upon both while doing my field research (i.e. interviewing the citizen science beekeepers) and writing this thesis, was my own role in the project and what it means. What does my participation *do* and *who* does it affect? What was my intended role and am I able to live up to it? What is the role of Science and Technology Studies in this project? Am I an outside observer or am I am a part of this project? As my role was explained to me, I was told that INSIGNIA was a two-year-long project, wherein they (the consortium of scientists), through engagement with citizen science beekeepers, were testing non-invasive sampling methods as well as creating instructional guidelines and a methods for citizen science beekeepers, with the aim to easily implement and aid in monitoring both biodiversity and pesticide contamination on a large scale. My role was to gather the experiences of the beekeepers (I chose to interview them) and see what could be improved upon for next season so that the beekeepers felt heard.

When hearing the word citizen science, I had the initial impression that the beekeepers would be working collaboratively with the scientists—I guess I was imagining what Haklay (2018) or Vayena and Tasioulas (2015) would rate on the more 'intensive' end of citizen science participation. Nevertheless, I soon learned that my involvement was the only formal form of official feedback the beekeepers could use, besides talking with their national coordinator, mostly via emails. I feel it is important to mention that these emails were just from one beekeeper to the coordinator and never between beekeepers (although, the beekeepers in Austria were given the other participants' email addresses). Furthermore, the concerns beekeepers were having were rarely shared over the list serve to all of the participating countries and scientists. Thus, I quickly realized that I am the sole mediator between the scientists (as a whole) and citizen scientists. Leaving me wondering: *is this what STS or the social sciences more broadly should be tasked with?*

I did my job over the last months diligently and tried my best listen to their concerns; to gain insights into what the citizen scientists want to be improved for next year; and to gather all of their suggestions and to pass them on to the scientists. Still, I cannot help but wonder, *is this really my place?* For me the answer is, as the Austrians would say, *Jein* (a combination of the words yes and no). I do feel it could be beneficial for the citizen scientists and scientists to create more space in the experimental structure to engage

with one another more collaboratively. Kleinman and Suryanarayanan (2019) show that through collaborative experimentation trust is built between scientists and beekeepers, which is integral for effective communication. Furthermore, I learned from beekeepers like Anton and Helmut that they feel they have more to say and different viewpoints to offer. Still, others like Matthias and Werner were content with this level of engagement. As stated in chapter 2, Haklay (2013, 2018) argues for a more contextualized, flexible understanding of citizen science participation, wherein the amount or level of engagement is dependent on the requirements of the individual citizen scientist. Thus, giving them the opportunity to move between different levels of engagement, without placing a value judgement upon which level is more desirable. Haklay's understanding does away with a one-size-fits-all participation model for citizen science projects and, as this thesis has shown, different citizen science participants have different understandings of what they consider a desirable level of engagement, which make the one-size-fits-all model limiting for some, while potentially overwhelming for others, e.g. those beekeepers with time constraints. A more socially-responsive architecture for citizen science projects—one which offers *flexibility* in participation—would perhaps allow for this diversity by allowing citizen scientists to take on a more active role in deciding their level of involvement.

My own role in the project created another level of translation between both the scientists and the beekeepers and, sometimes, even between the beekeepers themselves with me acting as a middle-man. Unfortunately, there is not much literature available about the role(s) of an STS researcher in citizen science projects. Instead, most literature on citizen science and the social sciences, like Heiss and Matthes (2017), focuses on the development of social science citizen science projects, not on the potential role of a social scientist in a natural science citizen science project, like INSIGNIA. Looking at similar STS studies, like Suryanarayanan and Kleinman (2017) and Maderson and Wynne-Jones (2016), the STS researchers took more of a view from afar approach, wherein they interviewed different actors across a controversy or project and tried to understand the different perspectives, but unlike myself, the researchers did not take an active role in collecting the experiences and proposing possible changes for the project itself as the project as on-going.

Although Kleinman and Suryanarayanan (2019) argue that trust-building through collaborative experimentation (e.g. mutually designing, conducting an experiment and *time* spent together) helps to foster effective collaborations between beekeepers and scientists, I do see some advantage to my role as a translator and moderator. Kleinman

and Suryanarayanan (2019) contend “asymmetries in social status and real differences in the kinds of knowledge” (p.2) between beekeepers and scientists create complications in their relationship, as “conflicts are evident regarding *what* and *whose* knowledge is considered most valid” (Maderson and Wynne-Jones, 2016, p. 89). Furthermore, Maderson and Wynne-Jones show in their study that “[b]eekeepers often find that their perspectives are not granted the same weights as other actors [e.g. scientists or policy makers]” (p. 89). It is these differences, asymmetries and difficulties in communication that my role in the INSIGNIA project can help to reduce, as my work can be seen as helping to translate between the two actor groups as well as giving the beekeeper citizen scientists a platform to voice their options in a more official and unified manor. Still, as shown by Kleinman and Suryanarayanan (2019) direct collaboration and discussion could also be beneficial.

Still, I think it is also important to take into consideration the size of international citizen science projects, like INSIGNIA. Such large projects already require complex frameworks and substantial coordination required, which could create a problem of project infrastructure that allow all the citizen science to communicate their needs effectively. Not only because of the language barriers but also the sheer amount of discussions that would need to occur if (taking INSIGNIA as example) all 28 scientists and 16 citizen scientists all had equal weight in the decision-making process. In my opinion, more research is needed into how to effectively incorporate citizen scientist into areas of *deeper engagement* (e.g. research design, analysis, writing articles) especially in larger transnational citizen science projects as well as what forms of funding and governance for citizen science projects could promote deeper engagements.

7.2 What kind of citizen science is this anyway?

Thinking about my role as the mediator between the scientists and the citizen sciences also made me reflect on what kind of citizen science is INSIGNIA practicing? It definitely is not practicing citizen science how I originally imagined it, but that I have learned is not necessarily a bad thing. As shown in the state of the art, citizen science is one term that subsumes many different definitions and practices. Still, I feel it is important to look at where on the spectrum of citizen science practices the INSIGNIA project would fall.

When looking at Vayena and Tasioulas’s (2015) typology I believe INSIGNIA would fall into their first category of crowd-sourcing, which the authors define as “participation in a project established and governed by professional scientists, e.g. individuals contribute relevant data, observations, etc.” (p. 482). The INSIGNIA project was definitely established

and run by professional scientists with the beekeepers contributing data in the form of samples. Yet, the original intent was more that the beekeepers also provide feedback on the implementation of the innovative sampling devices—how Helmut envisions his role. So, I think the INSIGNIA goes slightly beyond the beekeepers just providing data, as they are asked to provide feedback. However, this typology highlights the fact the beekeepers were not consulted in the construction of the experimental design or running.

In terms of Haklay's (2013) levels of citizen science typology, the type of citizen science practiced in the INSIGNIA project most closely fits to Haklay's second level *Distributed Intelligence*, wherein the citizen science participants are used as basic interpreters and data collectors. However, the citizen science practice in this project falls short of the higher levels, because the beekeepers are not included in the *problem definition* of the experiment. Indeed, it is important to remember that Haklay stresses that no one level should be thought of as inherently better than another. Nevertheless, Haklay (2018) also asserts that it should be seen as beneficial to the project to try and achieve the highest level of participation as possible. Although the proper fit should be decided on an individual case-by-case basis adapting to the needs of both the citizen scientists and the scientists—taking into account that the needs of the citizen science participants are not homogenous—I remain skeptical that the needs of both groups can be met equally when the project is designed completely by one group.

Haklay (2018) offers up a third typology to help categorize citizen science projects by comparing knowledge level (skill) vs. engagement level, identifying four different types of citizen science participation. The citizen science participation in INSIGNIA most closely resembles what Haklay would call high level of knowledge/low engagement. In this type of participation, the knowledge of the citizen scientist is high which contributes to data quality and the engagement is low which according to Haklay can be beneficial because it means less of a time commitment. Haklay identifies the key benefit of this engagement as "the impact of well-educated participants on the outcomes of the project … since participants can understand what the project owner is trying to achieve and the importance of rigour [sic] in carrying out the task. It can also allow the use of disciplinary jargon in the explanations and instructions to participants" (2018, p. 60). All of this is true of the beekeepers in the INSIGNIA project who are all very knowledgeable about beekeeping. It is important to note that Haklay stresses "[s]implistic assumptions that only full inclusion at a deep level is appropriate for citizen science projects should be avoided. Instead, they should consider how people at all levels of education and engagement gain from, and contribute to, citizen science activities" (p. 61). However,

Haklay also stresses it is also important for such a project to make possible the opportunity for participants to move between different levels of engagement depending on their current requirements.

In conclusion, typologies of citizen science, like the ones discussed above, seek to aid in the definition and description of citizen science, while also providing a way to reflect on project structure through different lenses. For example, Haklay's (2013) 'levels of participation' typology provides a way to look at the citizen science being done in INSIGNIA through the lens of the roles of the citizen scientists, sensitizing one to both the current imagined role of the beekeeper citizen scientists as well as the possible other role-levels to consider. Vayena and Tasioulas's (2015) typology sensitizes one to the amount of engagement practiced by the citizen scientists, allowing for reflection on the amount of engagement created by INSIGNIA's infrastructure and whether it matches the expectations of the beekeepers. Lastly, Haklay's (2018) knowledge level (skill) vs. engagement level helps to categorize citizen science projects by comparing the knowledge level of the citizen scientists to the project's engagement requirements. Thus, this typology helps to think about the types of knowledge the citizen scientists, like the knowledgeable beekeepers in INSIGNIA do, and how their knowledge can benefit the project.

Following these typologies, INSIGNIA's citizen science could be described as a crowd-source-like project, where in very knowledgeable citizen scientists, through a moderate commitment of their time, participate as both *data collectors* (by collecting high-quality samples) and *basic interpreters* (by providing general feedback on the sampling devices). No one typology can fully describe every aspect of a project. Still, the each offers a unique lens through which to reflect on different aspects of citizen science projects as well as offering a reminder that no one way of doing citizen science is better than other. Instead, all the authors of these typologies stress the type of citizen science in a project must best suit the needs of both the citizen scientists and the scientists.

7.3 Mutually beneficial or mutually enriching? Definitely Austrian

This section addresses the nagging concerns I had about why the beekeepers chose to participate in the project in the first place. First off, I want to preface this discussion by saying this has nothing to do with the project itself or the scientists that run it. Instead, the base problem, as I have come to see it, lies with the lack of support for beekeepers from the Austrian government. All of the Austrian beekeepers highlighted one of the main

reasons for their participation in the project, and other projects, was to get their colonies tested. Laboratory testing is expensive, running around 500 euros or more per test, and some causes of bee death (e.g. neonics contamination) cannot be determined without a laboratory test, leaving beekeepers to only speculate the cause of death of their colonies. As Anton explained in detail, it is very hard for a beekeeper in Austria to get their hives tested even when they are experiencing a large die off. They have two *official* options. In one option, the beekeeper can go to the police and make a formal incident report and, according to Anton, if they are lucky someone will come out and take a sample. The second opinion for the beekeepers is to go to a specific Austrian district authority (German: *Bezirkshauptmanschaft*) to give a sample and report the loss, but no results are given to the beekeeper of possible cause of death, according to Anton. Thus, beekeepers never find out if their sample was even tested. The third *unofficial* option for beekeepers is to take part in a scientific research project, like INSIGNIA. This happens so often that when a fellow beekeeper comes to Anton, asking for help to get the death of his hives investigated, his first reaction is to think if there are any ongoing scientific research projects in Austria that he could participate in. Sadly, in this instance there were none.

The lack of inexpensive ways to test their colonies draws beekeepers in Austria to these scientific studies. These studies, like INSIGNIA, are mutually beneficial for the scientists and the beekeepers. Scientists get samples along with tended colonies to collect from as well as beekeepers to do the collecting, while beekeepers get knowledge about their colonies in the form of laboratory test results. However, since these studies in Austria become basically the sole means for some beekeepers to get their hives tested, a certain dependency on these studies is developed. It is this dependency that I feel limits the possibilities for mutually enriching experiences, since beekeepers need these studies to gain access to testing. Thus, they are more willing to accept the experimental design or requirements made by the scientist and perhaps less willing to critique the experiment. Suryanarayanan and Kleinman (2017) in their in-depth look into the production of ignorance highlight how regulatory bodies arise from specific histories, which create certain structures that then become taken for granted over time—making invisible certain value choices, like perhaps which types of environmental issues to give priority to. Sadly, I do not feel that these inequalities can be fixed by Science. Instead, I think this is a problem for policy makers in Austria, who need to consider both the needs of beekeepers and better options for environmental monitoring.

7.4 Some concluding reflections in a more personal tone

Dear Science, yes I mean you with the capital 'S'—let's have a chat. I have noticed your presence throughout my work on this thesis, maybe not always *explicitly*, but you never really left and I think it is time we talked about it. In all the conversations about the project that I have had with the beekeepers you were present, affecting the ways in which the beekeepers saw their roles in the project. This is *citizen* science, which if we are taking on a more Irwin-esque definition of the term should *democratize* the scientific process and let citizen scientists and scientists work collaboratively. Yet, the beekeepers did not see themselves as doing Science or on an equal plane with scientists, which, I have to say, is *not* completely the fault of the scientists for not engaging with them more. No, how I see it, it's also kind of your fault, Science, for being this unattainable ivory tower of sorts, full of knowledge and secrets at which these beekeepers can only wonder—and not enter. *But*, I think, when you really look at it, they are already doing science. I mean look at Anton, he is *practically* doing science—no, no, he *is* doing science—but he says he doesn't. *How can this be?*

Perhaps Anton says he is *not* doing science, because he has this grandiose, culturally-embedded idea of you, Science (all high and mighty)—he draws these boundaries himself. Indeed, this idea of you is destructive to both the citizen science and you, Science, because it prevents him from having the confidence to engage fully and to challenge the scientists—something that would be democratizing, like citizen science has promised. Citizen science promises to help fix complex controversies, that you haven't been so good at solving alone—like colony loss—by bringing together scientists working on finding answers and the people it is most affecting. This is not to say that I don't think you have been trying, Science. You have opened up a lot and tried different engagement methods, but what I am trying to address with you goes deeper than that, it is more insidious, subtly causing problems in projects. The people engaging in these projects, like Anton, still see you as above them, a bit unattainable, causing them to place the scientists above them, creating imbalances. I am at a loss too, Science, as how to fix this. How do you fix these imbalances if it we do not acknowledge their deep seeded cultural roots, which perpetuate the belief that science cannot be done unless one has a formal scientific training?

I have one idea for you Science, open up more. Don't just engage the public in your work. Tell them about you faults, your messiness. Allow them to see you out of your ivory tower. True change in power imbalances can only come when both parties meet in the middle. Showing more of your true self Science, might help people see you differently and help them start to believe that they too can do science, but maybe with a small 's' this time. Only then, in my opinion, can space be created to allow for a more ideal form of citizen science, wherein scientists and citizen scientists work together to create socially relevant knowledge.

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Appendix

List of Figures

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List of Abbreviations

AFM	French Association of Muscular Dystrophy Patients
AIDS	Acquired Immune Deficiency Syndrome
ARCS	Arenas for co-operation through citizen science (a swedish citizen science platform)
CCD	Colony Collapse Disorder
COLOSS	Prevention of Honey Bee COlony LOSSes (an international association for honey bee research)
CORINE	Coordination of Information on the Environment Database +
C.S.I.	Citizen Science Investigation
ECSA	EuropeanCitizen Science Association
EPA	Environmental Protection Agency's (United States)
EU	European Union
GEWISS	Bürger Schaffen Wissen (a german platform for citizen science)
GMOs	Genetically Modified Organisms
HRS	Human Right to Science
INSIGNIA	Citizen Science Investigation for Pesticides in Apicultural Products
MD	Muscular Dystrophy
Neonics	Neonicotinoid, a class of insecticides
NSF	National Science Foundation
PLR	Participant-led Research
RSC	Human Right to Science and Culture
SSR	social science research
STS	Science and Technology Studies
US	United States

German Quotes

1.) Und dann ist das mit den Neoniks passiert und das war ein Fehler, weil ich das damals nicht mehr gemacht hab (Anton)

2.) ich erledige alles... den Schriftverkehr und die Proben, nehmen und einschicken (Anton)

3.) und da bin ich zum Beispiel auch Mitglied, weil ich mir ganz einfach sage, der österreichische Erwerbsimkerbund macht für mich als Imker sehr viel Lobbyarbeit, das macht der österreichische Imkerbund, der für die Kleinimker zuständig ist, überhaupt nicht (Matthias)

4.) wie inwiefern das Relevanz hat um an die Daten zu kommen die man möchte kann ich zu wenig beurteilen, ich bin Imker, kein Wissenschaftler (Mathias)

5.) Imkerschulen, bieten nur Ausbildung bis zum, bis man gehen kann ... das Laufen lernt man nirgendswo (Werner)

6.) die nächsten Problemkulturen sind auch in dem Bereich, aber die sind nicht mehr Flugbereich, das sind Obstkulturen, die arbeiten aber relativ sauber, unter sauber verstehe ich, wenn's, wenn's spritzen müssen, das hat man notgedrungen zugestehen muss, ned? (Werner)

7.) ich werde von den, von den drei Völkern, die zehn Proben nehmen (Werner)

8.) die Bienen haben ja, die Bienen haben, haben ja eine Lobby, ja? das sind wir Imker. Aber wer, die, um die 700 Wildbienenarten in Wien ah in Österreich, die es gibt, haben kaum eine Lobby (Helmut)

9.) man kann nicht in allen Gebieten der Imkerei voll Top sein (Helmut)

10.) Ich kann lesen (Matthias)

11.) ich denke, Wissenschaftler haben den Riesenvorteil meine Imkerei im Hintergrund zu haben und zumindest ein bis zwei Kollegen die profunde Imker sind, weil die brauchen ja regelmäßig Material für Versuche, sei es Waben, sei es Brut, sei es Pollen, sei es Bienenmasse, was auch immer, und das funktioniert, dass das dann zur Verfügung steht wenn sich jemand darum kümmert und wenn sich jemand damit auskennt (Matthias)

12.) ja für mich ist schon wichtig, dass ich als, als als Teilnehmer an dem Projekt einfach, weiß was ich zu tun hab und, für mich auch diese Information wichtig ist, was machen die anderen und, und gibt's Probleme und, weil manches war, wie ich da zum Beispiel wie ich die Dings aufgemacht hab, ja? dieses Heftchen, war mir manches nicht klar wie das genau abläuft, ja? und dann hab ich halt, eine Mail geschrieben und dann hab ich eine Antwort bekommen, Ro, manches behält sich der [Koordinator] vor, dass es ganz zum Schluss erst kommt offensichtlich, ja (Helmut)

13.) Naja, interessante Herausforderungen sind natürlich genau das was da jetzt dieses Projekt betrifft, wie schaut es wirklich aus mit, mit, Belastung von Bienen bzw. Bienenprodukten durch Insektizide, wie schaut es aus mit, mit dieser Verarmung der Landschaft, (Helmut)

14.) dazu kann ich nichts sagen, ich hab ja mein Leben lang so viele Proben genommen (Anton)

15.) Ich hab, ich bin eigentlich von der fachlichen Seite überhaupt nicht bewandert in diesem Bereich außer, außer in Mess- und Regeltechnik, das war mein Job einmal ... ich war in der Instandhaltung und habe Mess- und Regeltechnik, Steuerungstechnik, und und und da gearbeitet und hab relativ viel Messungen gemacht im Umweltbereich auch, in der Firma und auch dann ich war dann im Gemeinderat und und und, ja, okay und politisch auch tätig und war Umweltgemeinderat und daher hab ich relativ viel Erfahrungen gehabt, auch in der praktischen Anwendung von Mess-Systemen etcetera etcetera und daher ist mir das ein bissl engegengekommen interessant wars na? und ich bin ja überhaupt ein bisschen neugierig [lacht] und will alles wissen, ned? und will immer den Dingen auf den Grund gehen, so ungefähr war das und ist noch immer, obwohl ich xx Jahre (Anton)

16.) Entwickelt, ich mein entwickelt, ich bin immer vor Tatsachen gestellt worden, ich hab das ja vorher nicht gekannt (Anton)

17.) die Langzeitwirkung von den Neoniks ist es schwer zu, erkennbar für einen Imker, an normalen, ned? oder gar nicht weil ich kanns auch nur erkennen dann wenn ich die Untersuchungsergebnisse hab, ned? (Anton)

18.) Ich habe zuerst Kurse gemacht und dann die Bienen übernommen (Matthias)

19.) ich zähle diese Arbeiten nicht zur Imkerei weil die eigentlich mit meiner Imkerei wenig zu tun haben. Weil das ist nicht jetzt dass ich meine Bienenstöcke betreue oder Honig ernte oder Ähnliches, sondern das ist Wissensvermittlung und eine ganz andere Geschichte. (Matthias)

20.) eingesessener Imker (Matthias)

21.) Nicht wirklich, weil, machen wir's anders, mir ist aufgefallen, dass Bienenhaltung eher so in Richtung Lifestyle, es ist hip wenn man sich ein Bienenvolk in den Garten stellt, geht, das hat den Nachteil, dass Imker, oder das Menschen Bienen halten, die von Bienenhaltung keine Ahnung haben und genau daraus resultieren Probleme auch für mich, eingesessener Imker, der weiß, was er tut, weil wenn es im Umkreis von drei Kilometern rund um meinen Bienenstand einen Krankheitsfall gibt, dann darf ich mit meinen Bienen nicht raus und nicht rein. Dann darf ich gar nichts tun, und das ist logischerweise eine sehr lästige Geschichte (Matthias)

22.) Meine Probleme löse ich im Regelfall selbst [lachen] sondern es ist eher andersrum dass Leute zu mir kommen mit der Bitte du ich hab da ein Problem, kannst du dir das mal anschauen? (Matthias)

23.) Den hol ich mir auf der xyz Imkerschule von ein paar Kollegen, die auch, ich sag einmal zwischen 40 und 100 Bienenvölker oder mehr haben und die das schon viel länger machen als ich (Matthias

24.) Das hab ich dann glaub ich 2009 durchgehabt und seither besuch ich so Veranstaltungen wie der Erwerbsimker[?tagung?], wo es Vorträge gibt von vielleicht Wissenschaftler oder prakt, die was Leute haben wo man lernen kann, solche auf die Finger schauen, ned? Ich seh's [?leider die einen?] Imkerschulen, bieten nur Ausbildung bis zum, bis man gehen kann, sagen wirs einmal so, das Laufen lernt man nirgendswo (Werner

25.) auch gelegentlich zu einem, zu einem Vortrag fahren, neues zu hören, aber die Masse von unseren Imkerkollegen da ist relativ uninteressiert ned?" (Werner)

26.) wenn ich Rat brauche, dann, meistens ist es umgekehrt, meistens fragen mich die Leute, ja? Weil ich doch durch diese ganze Lehrtätigkeit doch auch öfters kontaktiert werde, ja, angerufen, Anfragen so im Verein, oder über den Computer, wenn ich frage, dann weiß ich, dann sind es meistens zu einem Gebiet spezielle Fragen und da hab ich meine Imker, die auf dem Gebiet spezialisiert sind, zum Beispiel hab ich einen Freund, den [Name] der ist verantwortlich in Österreich bei Bienen Austria für die Bio Bienenhaltung, wenn ich da ein Problem habe, wenn mich jemand fragt, dann gehe ich dorthin, ja? Oder wenn ich etwas zur Zucht wissen will, dann hab ich im Verein einen sehr guten Züchter ... Ich weiß sozusagen, Leute die halt irgendwo spezialisiert sind auf irgendetwas, und die sprech ich an. Direkt persönlich (Helmut)

27.) Ja schon, oder was weil, ich kann mir schon vorstellen oder was weil, Wissenschaftler halt immer doch meistens auf einem sehr engen Gebiet arbeiten oder was und ein Imker das wahrscheinlich ganzheitlicher sieht, kann ich mir durchaus vorstellen dass da ein intensiveres Gespräch durchaus interessieren, also nicht jetzt da dass da neue wissenschaftliche Erkenntnisse seitens des Imkers kommen würden, aber vielleicht diese gesamtheitliche Sicht doch doch dann wissenschaftlich auch was bringen könnte, ja. (Helmut)

28.) damit das auch ein einfacher, als ein Imker, der vielleicht nicht so jetzt an wissenschaftlichen Dingen interessiert ist einfach anwenden kann, und man trotzdem ein verifizierbares Ergebnis bekommt. (Helmut).

29.) und hab einmal das durchgecheckt ob das Programm nicht ein Blödsinn ist. (Anton)

30.) nein es passt (Anton)

31.) Und dann ist das mit den Neoniks passiert und das war ein Fehler, weil ich das damals nicht mehr gemacht hab (Anton)

32.) mein Vorredner der hat auch einen Vortrag gehalten und ich bin hinten nach gekommen, und anscheinend hab ich den ganz gut aufgemacht nicht durch, weil ich ihn angegriffen hab, aber aufgrund der Argumentation (Anton)

33.) Naja, das ist, das ist die Umwelt bei, leidet ja momentan, ned? [ja] kann man ja annehmen und sagen [ja], ned? dann müsste eigentlich die Wissenschaft ja eigentlich die Leitlinie geben, was man verbessern könnte, ned? weil die können das ja alles begründen [ja] erforschen und ja, das weitergeben an die Politik wenns geht, weil, ich kann daheim sagen was ich will, da wird keiner reagieren. “ (Anton)

34.) Der [Koordinator] hat so viel davon, der kann dich eindecken mit Studien ohne Ende (Matthias)

35.) Ist ein bisschen schwierig, die sind meistens in Englisch verfasst, ned? Und, ich mein ich kämpf mich schon durch, aber halt, aber seitenlang für das bin ich zu dumm [lachen] (Werner)

36.) Sagen wir es einmal so, wenn sie einmal in ein Buch gebunden sind, dann schon (Werner)

37.) Ich glaub, dass viele gekauft sind, ned? ich mein, den Unterschied kann ich mit meinem Hintergrundwissen nicht rausfinden, ned? Ich mein die Wahrheit wird irgendwo in der Mitte liegen … Aber wenn du sonst jetzt alles schaust ist entweder, von komplett unschädlich bis komplett hochgiftig, ned? und dazwischen ist aber nichts, ned? … und die eigentlich, ich mein die ganze, die ganzen, viele von diesen Berichten was ich sehe, dass gehts um das Thema ned, Gift, giftig oder ungiftig, ned? (Werner)

38.) Das muss ein Zusammenspiel sein glaub ich, ned? Weil, das was die Wissenschaft hervorbringt, ned? das ist nicht für jeden verständlich, ned? wenn es auch gut ist, ned? Aber jetzt für das Umsetzen da, da gehört noch wer dazwischen, ned?” (Werner)

39.) dort also da wissen wir ziemlich genau, welche Pflanzen daran beteiligt sind, das ist sehr vielfältig, ich war sehr erstaunt darüber, dass zum Beispiel im Frühjahrsblütenhonig sehr viel Obst dabei ist” (Helmut)

40.) würde mich natürlich auch interessieren vor allem jetzt auch im Zuge des Projektes wie es wirklich ausschaut ja? (Helmut)

41.) schauen dass ich immer Interesse hab auch Neues aufzu, aufzunehmen, und, es ist so, man kann nicht in allen Gebieten der Imkerei voll Top sein, aber schon informieren, dass man einfach diese neuen Strömungen, die es gibt, es gibt jetzt hier verschiedene auch Methoden, wo versucht wird, diese Varroa-Problematik in der Griff zu bekommen mit rein biologischen Methoden, ja? auf dem Gebiet sich weiter zu informieren ist für mich … Vor allem als Vortragender sollte man ja da eigentlich sozusagen vorne sein und diese Methoden propagieren und, aber um etwas lehren zu können, muss man es selber ausprobiert haben, also da möchte ich noch intensivieren auf dem Gebiet, ja.(Helmut)

42.) kann man nie über, über die, die Qualität des, des was da geschrieben wird beziehungsweise desjenigen der schreibt wirklich verifizieren (Helmut)

43.) da schau ich vereinzelt schau ich einmal rein, es ist immer eine Frage der Zeit, man sitzt dann den halben Tag am Computer und puh, ja, das ist das Problem, also vereinzelt sicher, aber jetzt nicht gezielt, ich mein ich muss ja keine wissenschaftliche Publikation machen, ja (Helmut)

44.) ich hab ja natürlich die Firma Bayer beschuldigt, weil sie schuld sind, ned? das brauchen wir gar nicht diskutieren, es war ihre Schuld, sie haben natürlich alles abgestritten und dieser hat zur Antwort gegeben, dass sie nicht Schuld sind, sondern die Anwender [okay], bin ich natürlich heimgefahren und hab dann meinen Freunden den Bauern rundherum erzählt, dass sie schuld sind, nicht die Firma Bayer, naja gut, aber leider haben sich die Bauern eher weniger aufgeregt sondern, die haben sich aufgeregt über mich (Anton)

45.) Wir haben kein Bienensterben wir haben nur schlechte Imker … Das ist meine Meinung. Wir haben schlechte Imker, die nicht gut ausgebildet sind, die sich darum nicht kümmern, die sich nicht kümmern wollen oder kümmern können … sag ich ganz ehrlich ist das viel eher das Problem das wir haben als das wir ein Bienensterben hätten (Matthias)

46.) die sagen ich mach das seit zwanzig Jahren so, es hat immer funktioniert, das wird auch weiterhin funktionieren (Matthias)

47.) Im Frühjahr sind alle Völker tot. Und er probierts wieder, selbe Taktik, nächstes Frühjahr wieder alle Völker tot, er kauft sich wieder Völker ... aber er macht alles richtig, weil er macht das schon seit zwanzig Jahren so und es hat immer funktioniert (Matthias)

48.) Die Konzerne haben da die ganze Verantwortung auf die Landwirte abgeschoben, ned? bei der hunderprozent perfekten Ausbringung wird das schon so sein, dass, dass die Schäden gering sind, ned? (Werner)

49.) ich bin auf die Ergebnisse gespannt, ned? Weil nächste Woche möchte er zum Beispiel die Kultur wieder spritzen, ob sich in diesen Proben dann was zeigt, das bin ich schon gespannt, ned? oder ob man nichts findet, weil er versprochen hat er mäht alles nieder was blüht, ned? (Werner)

50.) die Standorte die ich hab dürften alle für die Bienen sehr gut geeignet sein, sonsts hätte ich nicht diese Ertragsmengen, sonst hätte ich nicht, sonst hätte ich Probleme mit den Bienen. Ich hab halt noch keine bemerkt, ja, zumindest nicht in massivem Ausmaß, diese sub-letalen Geschichten, wo halt, nicht was dramatisch abstirbt, sondern einfach ein Bienenvolk so sich nicht ordentlich entwickelt, hätte ich auch noch nicht bemerkt, aber sowas kann man natürlich leicht übersehen" (Helmut)

51.) mit sehr intensiver Kultur und dort hört man schon Probleme, also nicht nur punktuell, teilweise wirklich massiv.(Helmut)

52.) natürlich keine, keine monokausale Geschichte ist, ja? Es hat immer wieder, es hat immer mehrere Ursachen (Helmut)

53.) die Verarmung der Artenvielfalt (Helmut)

54.) diese drei Faktoren spielen sicher zusammen. (Helmut)

55.) grüne Wüste (Helmut)

56.) Ja schon, weil einfach mit, mit einer gewissen Erfahrung auch mit dem Zuwachs von Wissen, dass man einfach mit dieser Erfahrung bekommt .. ich bin schon immer skeptisch gewesen, dass es nur monokausal die Varroa-Milbe ist, aber auch die Wissenschaft hat ja das erst seit einigen Jahren nachweisen können, dass es hier auch andere Faktoren gibt, ja? Vor allem auch diese Geschichte mit den Neonikotinoiden, dass das sehr wohl, sehr wohl Auswirkungen, nur subletale auf die, auf die Geistesleistung, oder Gedächtnisleistung, oder Kommunikationsleistung der Bienen Auswirkungen hat, dass das jetzt auch nachgewiesen ist, ja? und jetzt kann man sich auch trauen und sagen Leuteln wenn man einen Vortrag wo hält, bitte das ist, das ist State of the Art, ja? dass also nicht nur die Imker selber Schuld dran sind, weil sie die Varroa-Milbe nicht im Griff haben, also insofern hat sich da sozusagen auch meine Wissen verbreitet und, und als, irgendwo bin ich Multiplikator mit, dadurch dass ich Vorträge hält, halte, das kann man natürlich auch weitergeben und das hilft natürlich dann auch, das ist ja das Gute an wissenschaftlichen Geschichteln, oder Untersuchungen, dass man, oder Ergebnissen, dass man das dann auch sagen kann bitte hier gibt es evidente Beweise, dass, dass es hier verschiedene Faktoren gibt, ja? (Helmut)

57.) getroffen auf irgendeiner Tagung in, eh bei uns in der Region, war da anwesend und hat mich gefragt ob ich mich nicht beteiligen möchte an Bienenuntersuchungen, ich hab gesagt ja jederzeit, kein Problem, so hats begonnen (Anton)

58.) ich hab zum Beispiel 2015 haben wir Untersuchungen gemacht im Flugbereich der Bienen und zwar im Mai, die Pfützen in den Feldern haben wir untersucht, mit dem XYZ von Umwelt NGO, der hat mich angerufen und gesagt, sag ich kein Problem, ich mach das, Proben nehmen, zack, eingeschickt, die haben die Proben geholt, die sind so selbst rausgefahren (Anton)

59.) ob die Studie stimmt weiß ich nicht, ich habs ja nicht überprüft. Aber da gibt es ja Wissenschaftler die können das" (Anton)

60.) die müssen überhaupt nicht Imker sein (Matthias)

61.) Ich denke, Wissenschaftler haben den Riesenvorteil meine Imkerei im Hintergrund zu haben und zumindest ein bis zwei Kollegen die profunde Imker sind, weil die brauchen ja regelmäßig Material für Versuche, sei es Waben, sei es Brut, sei es Pollen, sei es Bienenmasse, was auch immer, und das funktioniert, dass das dann zur Verfügung steht wenn sich jemand darum kümmert und wenn sich jemand damit auskennt und von daher ist das eine Geschichte wo ich ganz einfach sage das ist, ich glaub nicht, dass Bienenwissenschaft jetzt Imker an sich brauchen, weil sie die im Haus haben, wenn die irgendwas genauer wissen wollen, dann gehen sie ganz einfach zu den Kollegen, die von der Bewirtschaftung der Bienenvölker Ahnung haben und damit hat sich's. (Matthias)

62.) [Der Koordinator] ist auf mich zugekommen, weil wir schon in anderen Projekten zusammengearbeitet haben und hat mich gefragt, ob ich für ein Projekt ein bisschen Zeit und einige Bienenvölker zur Verfügung stellen könnte und ich hab gemeint ja warum nicht. (Matthias)

63.) Befürchtungen, ja, würden mir jetzt keine einfallen, ich hoffe, ich mein (..) die, über die wissenschaftliche Methode kann ich nichts sagen, ja also, die die, wüsste ich jetzt nicht was, was wa, ja, ich nehme and die Wissenschafter machen ihre Arbeit (Helmut)

64.) ich hab mich schon ein paar mal beschwert weil ich hätte die Probenintervalle, hab ich auch kritisiert, ned? weil im Herbst brauch ich keine Proben nehmen, weil das ist Holler, ned? ist rausgeschmissenes Geld meines Erachtens, alle 14 Tage speziell in dieser Zeit, das Projekt jetzt geht eher ein bisschen später, weil bei uns die Spritzzeit so Frühjahr ist [ja] und die spritzen schon fleißig, (Anton)

65.) und hab gesagt okay die ganze Projekt xxx beruht auf Datenlagen die was eigentlich nicht der Wahrheit entsprochen [ja] haben, weil ja Abbauraten vorhanden sind, aber okay (Anton).

66.) ich nehme and die Wissenschafter machen ihre Arbeit (Helmut)

67.) Na ich mein wiegesagt, wie in wiefern das Relevanz hat um an die Daten zu kommen die man möchte kann ich zu wenig beurteilen, ich bin Imker, kein Wissenschaftler. (Matthias)

68.) Meine Rolle. Die glaub ich ist relativ klar. Ich werde von den, von den drei Völkern, die zehn Proben oder, ziehen (Werner)

69.) Ja, ich bin jetzt gerade mit xxx in einem Projekt, da gehts um die Virenbelastung in Bienenvölkern, das ist auch nicht uninteressant vor allem, eine Virenlabor-Untersuchung kostet irgendwo 500 Euro oder mehr, das will ich mir als Imker nicht leisten und von daher, wenn es diese Möglichkeit gibt, dann nimmt man an sowas gerne teil (Matthias)

70.) die Langzeitwirkung von den Neoniks ist es schwer zu, erkennbar für einen Imker, an normalen, ned? oder gar nicht weil ich kanns auch nur erkennen dann wenn ich die Untersuchungsergebnisse hab, ned? und eine Untersuchung kostet bei, für Pestizide ungefähr 500 Euro, na? (Anton)

71.) ich muss mich schlau machen, weil, was ich so weiß, lauft momentan kein Projekt, wo sollen wir uns hinwenden. (Anton)

72.) Nur die Probe vergammelt irgendwo am Weg und wird in keiner Weise zu irgendeinem Ergebniss führen (Anton)

73.) Sag ich ja also kann ich die Proben nehmen und vernichten (Anton)

74.) Naja wir können Erfahrungsaustausch nachher machen und jeder, jeder, ja, das wäre günstig, ned? Das wäre, generell günstig, wenn man Erfahrungsaustausch macht [klopft] auch Zukunft Biene Projekt, ned? das ist, wir machen alle mit, aber fragen tut uns keiner, ob uns das passt was da angeschafft worden ist ned? weil ich, ich ich könnte schon was sagen [lacht] (Anton)

75.) ich natürlich sehr interessant find, dieses, diese Projekte, diese Citizen Science, europäischen Projekte ... das würd ich mir öfters wünschen, gut, und zwar nicht nur mit Imkern, so wie ich, die sehr interessiert dran sind, sondern durchaus dass sozusagen auch Zugang gefunden wird zwischen Wissenschaft und dem normalen Imker

der halt seine drei oder fünf Imker hält, ja? Das wäre durchaus interessant, die sind teilweise, dass man da mehr Verbindungen findet, die sind teilweise, haben einfach keinen Zugang dazu, ja? ja, klar, ich mein so Leute wie ich, die halt interessiert sind, die nehmen an so einem Projekt, die reißen sich eher darum dass sie an so einem Projekt teilnehmen, wenn man es aber, aber das in auf einer breiteren Basis zu machen ist durchaus eine interessante Sache (Helmut)

76.) ich bin ein, ein, ja ein relativ günstiger Mitarbeiter [lacht] (Anton)

77.) Meine Rolle im Projekt wird sein, dass ich ganz einfach Daten zur Verfügung stelle. Das heißt ich bin derjenige im Feld draußen, der versucht an soviele vernünftige Proben wie möglich zu kommen, um die dann im Labor vernünftig auszuwerten (Matthias)

78.) Meine Rolle. Die glaub ich ist relativ klar. Ich werde von den, von den drei Völkern, die zehn Proben oder, ziehen (Werner)

79.) ich sag im der Teufel liegt im, steckt im Detail, ja? wie man auch sieht, sozusagen, wie ist das genaue Setting, wie, was muss man beachten bei diesem Projekt ja? also dass sozusagen da von uns Imkern die Information kommt, das funktioniert oder funktioniert nicht, ich hab sicher noch einige Ideen, ja auch sicher auch einige Fragen die im Laufe des Projekts auftreten werden, dass wir sozusagen da, die sind, die das direkt umsetzen, und bei der direkten Umsetzung treten immer Probleme auf. (Helmut)

Questionnaire English

Introductory words: First, I would like to thank you for taking the time to meet with me today and discuss your participation in the INSIGNIA pilot project. I would like to start with asking you a few questions:

Personal Perspectives—Retrospective	
I would be interested in hearing your personal (family) **history** with beekeeping. Could you please tell me about how you got involved with beekeeping?	
What are your general impression of the things your bees may come in contact with, in terms of what they have to forage from and potential hazards they may be exposed to? • How would you describe the land use of the surrounding area?	
Their relation to their Bees	
Could you tell me a bit about the bees you are keeping? • How long have you had them? • Do you produce honey commercially? • What does a typical day beekeeping look like for you? • Have you noticed any changes in your bees in the recent years? • How many bees colonies that you know of are there locally in your surrounding area?	
In recent years the phenomenon of colony loss has become a salient topic. I would be curious to hear about your experiences and your opinion on this topic. • How has your opinion on the subject change over time?	

Personal Knowledge (Practices)	
Could you tell me something about beekeeping that I might find surprising?	
Could you briefly describe for me how you keep yourself informed about beekeeping? • Has anything about your beekeeping changed over time? • What kinds of sources do you generally use to stay informed? • Which forms of communication do you use to stay up to date?	
Do you engage in any form of record keeping/storing any new information you learn?	
Do you partake in a beekeeping community? If so, could you please describe it to me?	
In which areas do you wish that you were more informed? • Is there any person or thing you look to when you feel you need advice about beekeeping? • Are there any areas about which you are particularly curious about what science has to say?	
Is there anything you wish the scientists knew more about? • Do you think there are any issues on which the scientists could also benefit from learning from beekeepers?	
Experiences with INSIGNIA project	
How did you come to be involved in the INSIGNIA project? • Could you please tell me a bit about how you imagine your role within the INSIGNIA project? • In what ways do you feel you are contributing to the project?	

Have you partaken in any research project before INSIGNIA or done any previous monitoring of your bees? If, so could you tell me a little more about your participation/monitoring?	
For the next two questions, I would like you to order from most to least relevant the terms on the cards provided and explain to me why you ordered them in this particular way. There is also a blank card in case you would like to add your own term. • Could you please rank the following aspects of INSIGNIA's data collection process in order of importance? • In which area do your think the research of INSIGNIA will be most impactful?	
What are your expectations for the project in the future? • What do you hope to learn from your participation in the project? • What kind of impact do you expect this project to have? • What are some of the concerns you have regarding the project?	
Closing questions	
Is there anything else that you wish to discuss?	
Do you have any thoughts on how the sampling device could be improved?	

Questionnaire Deutsch

Introductory words: Zunächst möchte ich mich gerne dafür bedanken, dass du dich die Zeit genommen hast, mich heute zu treffen um über Ihre Teilnahme am INSIGNIA Pilotprojekt zu erzählen. Ich möchte mit Ihnen deswegen gerne ein paar Fragen besprechen.

Personal Perspectives -- Retrospective	
Ich würde gerne etwas über deine persönliche Geschichte mit der Imkerei erfahren. Könntest du mir erzählen, wie du damit begonnen hast?	
Könntest du mir ein bisschen was über die Umgebung erzählen, in denen deine Bienenstöcke stehen? Wie wird sie hauptsächlich genutzt? Mich würde auch dein allgemeiner Eindruck davon interessieren, mit welchen Schadstoffen ihre Bienen in Kontakt kommen.	
Their relation to their Bees	
Könntest du mir als nächstes ein wenig von deinen Bienen erzählen? • Wie lange hast du sie schon? • Produzierst du kommerziell Honig? • Wie sieht denn ein typischer Imker-Tag aus? • Ist dir in den letzten Jahren eine Veränderung bei deinen Bienen auf gefallen? • Wie viele Kolonien gibt es deines Wissens an deinem Standort? • Wie viele Orte in der Region, an denen Proben genommen werden gibt es deines Wissens?	
In den letzten Jahren hat das sogenannte Bienensterben viel Aufmerksamkeit auf sich gezogen. Mich würden besonders deine Erfahrungen und deine Meinung zu diesem Thema interessieren.	

• Wie hat sich deine Meinung zu diesem Thema in den letzten Jahren entwickelt?	
Personal Knowledge Practices	
Könntest du mir etwas über die Bienenzucht sagen, von dem du glaubst dass es mich überraschen würde?	
Könntest du mir ein bisschen was darüber erzählen, wie du dich über Bienenzucht auf dem Laufenden halten? • Hat sich über die Zeit etwas an deiner Bienenzucht verändert? • Gibt es bestimmte Quellen, die du regelmäßig nutzt um informiert zu bleiben? • Tauschst du dich auch mit anderen aus? Was für Kanäle benutzt du im allgemeinen?	
Legst du auch in irgendeiner Form Aufzeichnungen an?	
Bist du Teil einer Gruppe, die sich regelmäßig über Imkerei austauscht? Zum Beispiel in einem Verein oder auch im Internet? Könntest du mir ein wenig darüber erzählen?	
Gibt es bestimmte Gebiete auf denen du sich noch mehr informieren möchtest, bzw. Eine interessante Herausforderung oder Problem? • Was machst du, wenn du einmal Rat zum Thema Bienenzucht brauchst? • Gibt es Bereiche, in denen du die Ergebnisse der Wissenschaft sehr interessiert?	
Gibt es etwas von dem du dich wünschen würdest, dass die Wissenschaftler*innen mehr darüber wissen? • Gibt es deiner Meinung nach Themen bei denen die Wissenschaftler mehr vom Wissen der Imker profitieren könnten?	
Experiences with INSIGNIA project	

Wie ist es dazu gekommen, dass du an dem INSIGNIA Projekt teilnimmst? • Was erwartest du was deine Rolle im Projekt sein wird? • Gibt es eine Herausforderung oder ein Problem, bei dem du mehr Wissen benötigen würdest?	
Hast du schon einmal an ähnlichen Projekten teilgenommen oder hast du schon einmal ein Monitoring deiner Bienen gemacht? Wenn ja, könntest du ein wenig darüber erzählen?	
Für die nächsten beiden Fragen würde ich dich bitten, die folgenden Stichworte und Themen, die auf den Karten stehen, von am meisten bis am wenigsten relevant zu ordnen. Bitte erklärst du auch ein bisschen warum du sie so angeordnet haben. Es gibt auch eine Blanko-Karte, falls du noch etwas ergänzen möchtest. • Ordnest du bitte folgende Aspekte der Datensammlung in INSIGNIA nach deiner Wichtigkeit. • Wo glaubst du, dass das größte Wirkungsfeld von INSIGNIA liegen wird?	
Was sind deine Erwartungen für das Projekt in der Zukunft? • Was erwartest du dich von deiner Teilnahme am Projekt? • Was für einen Einfluss erwartest du dich von dem Projekt? • Hast du irgendwelche Befürchtungen im Bezug auf das Projekt?	
Closing questions	
Könntest du mir etwas von der Bienenzucht erzählen, von dem du denkst, dass es mich überraschen könnte?	
Gibt es noch etwas, dass du wichtig fändest und wir noch nicht angesprochen haben?	
Hast du irgendwelche abschließenden Gedanken, z.B. wie das Sampling Device verbessert werden könnte?	